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SUPPLEMENT TO "THE ELECTRICIAN," NOVEMBER 1, 1895.

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

VOLUME XXXV.

FROM MAY 3, 1895, TO OCTOBER 25, 1895.

LONDON:
Printed and Published for the Proprietors by GEORGE TUCKER, at the Offices of "THE ELECTRICIAN," Salisbury-court, Fleet-street, E.C.

1895.

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Best Belting Company—699
"Best" Miner's Safety Lamp Company—405
Blackpool Electro-Hydropathic—68
British Electrical Manufacturing and Engineering Company—863
Cambridge Scientific Instrument Company—107
Capital and Counties Electricity Supply Company—341
Celline Art Metal Works—699
Connolly Bros.—245
Cork Electric Light and Power Company—279
County of London Tramways Syndicate—68
Cramp Manganese Bronze Company of Great Britain—279
Crystal Electric Lamp Company—733
Dawson (Robert) and Co.—833
De Mare Incandescent Gas Light System—107
Douglas Southern Electric Tramway Company—863
D.P. Battery Company—107
Electric Organ Company—279
Electric Ozone Syndicate—439
Electric Sign and General Advertising Company—833
Elliott's Moulding and Joinery Company—661
Fielding and Platt—594
Galloways, Limited—405
Harrington Electric Light Company—141
Harrow Electric Light and Power Company—374
Headland's Patent Electric Storage Battery Company—799
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I.E.S. Accumulator Company—474
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Val D'Aosta Electric Power Company—211
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ABBREVIATIONS:—*Div., Dividends; Mtg., Meetings of Shareholders; Rev., Revenue; Rpt., Reports of Directors; Stat., Statutory Returns.*

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Altrincham Electric Supply—Stat., 107
Aluminium Industry Company—Rpt., 35
Amazon Telegraph Company—375, 405; Mtg., 863
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Andrew (J. E. H.) and Co.—Stat., 439
Andrew's Foreign Syndicate—341
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Anglo-Portuguese Telephone Company—Stat., 107; Div., 309
Armstrong (Sir W. G.) Mitchell and Co.—Div., 699
Automatic Electric Railway Signal Company—Stat., 375
Babcock and Wilcox—Div., 566; Mtg., 661; Stat., 767
Baily, Grundy and Barrett—Stat., 375
Belfast Street Tramways Company—Mtg., 535
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Birmingham Central Tramways Company—35; Mtg., 564
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Blake and Knowles Steam Pump Works—69; Stat., 141
Bournemouth and District Electric Supply Company—Mtg., 105; Stat., 627
Brazilian Submarine Telegraph Company—Rpt., 68; Stat., 505; Mtg., 104; Div., 175, 279, 833; Rpt., 862
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Denison Auto-Telegraph Machine Syndicate—Stat. 375
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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 885. [No. 1. Vol. XXXV.] FRIDAY, MAY 3, 1895. PRICE SIXPENCE.

NOTES.

THE exhibits of electrical interest at the Royal Society's *conversazione* on Wednesday evening, although numerous, comprised, as usual, nothing of startling novelty, unless indeed Prof. GOTCH'S "Malapterurus Electricus" may be so termed. Dr. JOHN HOPKINSON showed his huge mild cast-steel magnet, and it may be permitted to hope that some day time and funds will allow him to show similar magnets of various brands, say from the softest iron up to tungsten-steel, and thus enable us to see with our own eyes the effects of chemical constitution and physical condition upon this interesting phenomenon of the "soaking-in" of magnetism into large masses of magnetic metal. Close at hand the curve-tracers of Profs. FLEMING and HICKS were in close juxtaposition. Dr. FLEMING also showed samples of his well-known resistances, consisting of fine platinoid wire wound longitudinally over porcelain insulators, the ends being kept apart by a spiral spring so that the resistance-wires are kept taut even when expanded by rising temperature. Mr. CROMPTON showed a fine example of his latest form of potentiometer, and upstairs was responsible for an array of electrical cooking apparatus. Prof. AYRTON initiated all comers into the many advantages of his much-discussed "Students' Simple Apparatus for Determining the Mechanical Equivalent of Heat." Prof. EWING was also at work explaining his hysteresis-meter. Close to the latest form of siphon recorder, exhibited by Dr. ALEX. MUIRHEAD, Prof. GEORGE FORBES showed his mechanical analogue of the phenomena of submarine telegraphy, to which we recently referred. Some objects, at first glance not at all unlike Roman remains, were exhibited by Major CARDEW; these, on closer inspection, were found to be sample insulators, incrustations, and wooden-bearers taken from the St. Pancras mains.

AN exhibit which, in spite of the "mephitic vapours" given off, attracted considerable attention, was that of Prof. ROBERTS-AUSTEN. This centre of attraction consisted of an electric furnace as used by Prof. AUSTEN for the melting of chromium, titanium, platinum, and other metals. For the purposes of exhibition, however, iron nails proved nearly as effective as the more precious metals. Prof. AUSTEN'S furnace consists of a fire-clay case containing a magnesia-crucible. Two adjustable carbon-poles pass horizontally into the furnace, and the arc is deflected by means of an electro-magnet right on to the material to be fused. An image of the molten contents of the furnace was admirably projected by means of a lens and mirror on to the screen. Another most interesting exhibit was the platinum electro-pyrometer devised by Mr. CROMPTON, and described by him in his lecture at the Society of Arts, published in our last issue. Major HOLDEN showed some hot wire instruments, the indications of which were magnified and projected on to a screen.

PROF. EWING'S beautiful instrument for the rapid and accurate determination of the hysteresis of iron samples was greeted at the Institution of Electrical Engineers last week with a chorus of praise tempered by a few gentle criticisms, or rather suggestions of criticism. Potential users concurred in hailing the apparatus as the very thing they had long been waiting for, and co-workers in the same field were not stinting in their eulogies. "None but those who have worried over thousands of rings with a ballistic galvanometer, and worked the planimeter until their eyes ached, can know what a boon the thing is," writes one well experienced in the capricious temperament of transformer iron.

SEVERAL speakers hinted at the possibility of eddy currents in the iron sample and brass-clamps vitiating the readings, whilst others, as we ourselves did, thought there might be an appreciable "fanning" effect when the sample was rapidly rotated. Both the objections were, however, conclusively disposed of. Mr. ALEXANDER SIEMENS and other practical men were not, however, easily satisfied that the treatment, viz., punching out, filing, and annealing, to which the sample strips have to be subjected before testing, left them in the same state as they originally were in the sheet. This point, being largely a matter of opinion and experimental skill, was not cleared up quite so satisfactorily as the others, though Prof. EWING'S experience does not lead him to attach very much importance to the objection, provided his recipe is followed, and the sample strips are treated in much the same way as the actual stampings they are intended to represent.

IF the intention of the Government, when acceding to the appointment of a Special Committee to inquire into the telephone service of the United Kingdom, was to secure a public pronouncement in favour of the nationalisation of the telephone service, they have certainly succeeded in their object. After the irrelevancies of the Deputy-Chairman of the London County Council, the Telephone Committee was

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treated to the Report of a Special Committee of the London Chamber of Commerce, which, though it had much to say about "properly controlled competition," "varying rates for limited services," compulsory working of "unprofitable areas," and other similar desirable things, did not, either in itself or by the mouths of two of its compilers, tell the Telephone Committee how these *desiderata* were to be obtained, except by Government purchase. And so with most of the other witnesses. They were sadly aggrieved, but all their suggested remedies, except State management, were successively disposed of by one or other of the members of the Telephone Committee.

A Bill for facilitating the construction of light railways in Great Britain was introduced by the President of the Board of Trade on Thursday evening last week. This measure cannot be said to have met with a warm welcome. But as most of the opponents of the measure happened to be opponents of the Government, their remarks were no doubt largely based upon the well-known political problem of making out that Codling was the farmers' friend and not Short, a principle which makes it almost as difficult to ascertain the genuine opinions of members of the Legislature as it is to ascertain the real merits of a system advocated by a big American monopolistic corporation. The Bill introduced by Mr. Bryce is nothing more than the legislative embodiment of the suggestions made in the Report of the Conference appointed by the Board of Trade to consider the question. Promoters of light railways will have to lay their schemes before County Councils, and these bodies, if they consider a case has been made out, will have power to authorise such undertakings, the burden of supplying details being left, as is now customary, to the Board of Trade, who will settle, first of all, whether the line is of sufficiently small importance to be authorised without Parliamentary sanction; secondly, under what conditions it shall be worked; thirdly, mode of obtaining land. It is satisfactory to note that the idea of subsidising these undertakings from the national of municipal sources is emphatically repudiated. We agree with the President of the Board of Trade in thinking that the inertia of the agricultural mind in regard to these novel undertakings will probably be overcome, first of all by the construction of one or two such lines by our trunk railway companies, and that afterwards there will be no insuperable difficulties in raising money in the ordinary manner for the construction of other lines. Mr. Bryce has, in our opinion, put the whole question of subsidising in a nutshell. The matter is, as he pointed out, in the stage of experiment. It may ultimately turn out that the making of these lines is so great a public benefit that either the Treasury or the Local Authorities should be authorised to afford pecuniary assistance if need be. But at present no case has been made out to justify such a marked departure from the usual English mode of procedure. The cordial co-operation of landlords and Local Authorities should make these light railway schemes go through, if there is any real life in them. It is to be hoped that electric traction engineers are preparing to press the many advantages or electricity on the minds of our agriculturists.

Although of only theoretical importance, the investigation of Prof. Carhart into the variation of internal resistance of voltaic cells when generating currents, an account of which appears in another column, is of considerable interest. The disturbing influence of polarisation has been eliminated as far as possible by taking what almost amount to instantaneous readings, the cell furnishing current for only very short intervals of time. The experiments upon a Gassner dry cell show a remarkable decrease of internal resistance as the current increases, a similar decrease being shown by other cells. This does not appear to be due to polarisation, for, as Prof. Carhart observes, such would not serve to emphasise, but to diminish, the effect. It would nevertheless seem advisable to test for polarisation by repeating the observations with the levers so placed that the interval of time between closing the circuit and charging the condenser is, say, doubled or halved. Some allowance might then possibly be made for certain cells, if it were found that an error had thereby been introduced. The Gassner cell, in particular, has very little, if any, provision against polarisation, and the variation may be even greater than shown by the figures that are given. A similar set of accurate experiments upon the variation of internal resistance with time, when constant currents, instead of transient, are being generated, would be of greater practical interest. The same apparatus, slightly modified, might serve for the purpose. The investigation would probably show that the value of the internal resistance of a cell cannot be even approximately stated without reference to the current that was flowing at the time of measurement.

If we consider how full of interest submarine cable work is, whether approached from the mechanical or from the electrical engineering, from the practical or from the theoretical side, the technical and descriptive literature of the subject must be judged singularly deficient. We trust, however, that the series of articles by Mr. H. D. Wilkinson, which recommences in the present issue after a lapse of some two years, will do not a little to fill one at least of the many lacunæ in the history and technique of submarine telegraphy. In his former articles Mr. Wilkinson dealt mainly with the equipment and minutiæ of a modern cable-ship, and described some of the better-known vessels, from the old "Monarch" to the "John Pender." The present series will deal with cable tests, cable-laying, and shore-end repairs. We do not know whether experts are under any moral obligation to make their particular corner of knowledge attractive to ignoramuses who happen to live in the world outside, but hitherto writers on cable matters have not shown any outward and visible sign that they recognise any such responsibility. Maze-like diagrams of connections almost worse than those of a central station switchboard and phenomenonly distended equations have a decided tendency to weary anyone but an expert or an enthusiast.

Light Railways Bill.—This Bill was down for second reading last night.

Royal Society.—A Paper on "Alternate-Current Dynamo Electric Machines," by Dr. Hopkinson and Mr. E. Wilson, was down for reading at the meeting of the Royal Society yesterday.

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Institution of Electrical Engineers.—The following new members were admitted to the Institution at the last meeting:—Member: F. G. Hart. Associates: J. N. Atkinson, H. Brazil, A. E. Hadley, W. H. Nimmo, H. Phillips, S. L. Rhys Price.

The "Gymnote."—Further trials are about to be made with the French submarine torpedo boat "Gymnote." The Commelin and Desmazures accumulators on board this vessel have recently been replaced by those of the Laurent-Cely type.

Personal.—Mr. T. C. Martin has been elected to the post of president of our esteemed American contemporary, the *Electrical Engineer*, and Mr. J. Wetzler has been elected vice-president and treasurer. These changes arise out of the lamentable death of Mr. G. M. Phelps, which we recorded in our last issue.

Leicester.—It may interest out readers to learn that Mr. Alfred Colson, M.Inst.C.E, who has been responsible for so many details of the Leicester electric supply station, is the President of the Incorporated Institution of Gas Engineers, and examiner in "gas manufacture" at the City and Guilds of London Institute.

Proposed Electrical Utilisation of the Water Power of the Nile.—Mr. Prompt, inspector-general of Egyptian Railways, proposed, at a recent meeting of the Egyptian Institute, a scheme to electrically employ the water power of the Nile to the extent of 40,000 H.P.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repairs.
Latakia—Cyprus	Nov. 27, 1894.	—
St. Louis—Noronha	Mar. 12, 1895.	April 25, 1895
St. Vincent—San Thiago	April 5, 1895.	April 25, 1895.
Gibraltar—Tangier	April 24, 1895.	—

Steam Engines (Persons in Charge) Bill.—The Committee on this Bill consists of 17 members—viz., Mr. Allan, Mr. Brunner, Mr. Fenwick, Col. Gourley, Mr. Hardy, Mr. Heath, Sir A. Hickman, Sir E. Hill, Sir B. Hingley, Sir J. Joicey, Sir S. King, Mr. Wilson Lloyd, Mr. Paulton, Mr. Renshaw, Mr. John Wilson (Durham), Mr. Woods, and Mr. Wrightson.

Reduction in Cable Rates.—The Eastern Telegraph Company announce that the rates for messages to Argentine, Uruguay, Paraguay, and Brazil (except Pernambuco) are now reduced to 5s. per word. The Direct United States Cable Company also announce that the rate for messages, viâ Galveston, for Argentine, Paraguay and Uruguay has been reduced from 5s. 9d. to 5s. per word.

Royal Institution.—The annual meeting of the members of this Institution was held on Wednesday, Sir James Crichton-Browne presiding. The annual report of the Committee of Visitors for the year 1894 was read and adopted. The real and funded property now amounts to above £102,000, entirely derived from the contributions and donations of the members and friends of the Institution. During 1894 62 new members were elected.

The "Drehstrom" in Russia.—The Kolomensk engineering works are now being fitted up with an electrical installation, by which the whole works will be driven electrically. There will be in all 34 electric motors of a total capacity of 440 H.P. The generating plant will comprise two "drehstrom" generators of 250 kilowatts, one of 50 kilowatts, and three continuous-current dynamos of 88 kilowatts each for lighting purposes.

City and Guilds of London Institute.—The session 1895-96 will commence in October next, when the courses of instruction in Engineering and Chemistry at the Institute's Colleges will continue, and cover a period of two to three years. Particulars of the entrance examination, scholarships, fees, and courses of study may be obtained from the respective colleges, or from the head office, at Gresham College, Basinghall-street, London, E.C.

The Laval Steam Turbine.—At the *Western Mail* buildings at Cardiff a Laval 5-H.P. steam turbine and dynamo has been put down for experimental purposes by the manufacturers, Messrs. George Thomas and Co., of Manchester. By its means a portion of the new buildings is supplied with electric light. The turbine is running at a speed of 30,000 revolutions per minute, this being reduced by suitable gearing to 3,000 revolutions for the dynamo.

The German Association of Electric Supply Stations.—The annual meeting of the Vereinigung der Vertreter von Elektricitätswerken will be held at Munich on June 25th and 26th, immediately before the meeting of the Verband Deutscher Elektrotechniker. The aim of the Association, which consists at present of representatives of 40 German and four foreign electric supply stations, is to promote the interests of the supply stations by means of reports, statistics and debates.

The Belt Line Tunnel.—A *Times* cablegram, dated Philadelphia, May 1st, states that the Baltimore and Ohio Railway began to send traffic through the Baltimore Belt line tunnel, which has been constructed to facilitate traffic under Baltimore between the north and the Washington tunnel. It is 7½ miles long, and has cost $8,000,000. These trains, as our readers are aware, will be drawn by electric locomotives when everything is completed.

Electrical Bills in Parliament.—On Monday last the London County Council Money Bill passed the Examiners on Standing Orders of the House of Commons. The Bill provides, among other things, £21,000 for the electric lighting of the Victoria Embankment and Waterloo and Westminster Bridges.——The Standing Orders Committee, presided over by Sir John Mowbray, has declined to dispense with the standing orders in order to allow the Great Northern and City Railway to add a provision to their Bill enabling them to use steam in substitution of, or in addition to, electricity upon the line from Finsbury Park to the City.

Dr. von Stephan.—On Friday last the German Emperor sent an autograph letter of congratulation to Dr. von Stephan, Postmaster-General, who celebrated the twenty-fifth anniversary of his appointment as head of the German postal service on Friday last. The whole telegraph system was also placed under his control immediately after the founding of the Empire, and the number of telegraph offices has increased under his management from 1,070 to 13,300. The municipalities of Cologne and Bremen, on Friday last, conferred their freedom upon him. Dr. von Stephan, it is said, had to leave Berlin a few days ago in order to avoid the ovations of his friends.

A Prize for a Compass Indicator.—The current number of the *Elektrotechnische Zeitschrift* contains an advertisement of the German Admiralty offering 3,000 marks (£150) for the best solution of the following problem:—The direction of the compass-card of a ship to be automatically transmitted to any part of the ship, so that a ship can be steered by it. The invention must be suitable for service conditions. The decision to rest with the Naval Secretary of State, who reserves the right to make use of the selected invention for the Imperial Navy without payment to the inventor. Schemes should be submitted to the Reichs-Marine-Amt, Nautische Abtheilung, Berlin, not later than April 1, 1896.

Electric Light Inspection in Canada.—The *Canadian Gazette* announces that by proclamation of the Governor-General of Canada, the Canadian Act respecting inspection of the electric light came into effect on April 1st. Certain formalities have yet to be arranged before the measure will be fully in operation. The work of inspection will be performed by present gas inspectors, without any increase of salary. Under the Act electric lighting companies are required to register. Certificates of registration will be renewable from year to year from July 1st. A special set of inland revenue stamps has been devised as receipts for the payment of inspection fees.

Electric Traction Currents and Physical Laboratories.—The *Elektrotechnische Zeitschrift*, speaking of the interruptions to physical work by electric tramways, says that opinions on this point are still divided, although the question has been repeatedly a subject of discussion. The question, however, requires a speedy solution. For this reason the technical committee of the Elektrotechnischer Verein of Berlin, in conjunction with the Physico-Technical Institute, are making experiments on the matter of earth leakage currents and the changes in the magnetic field caused by electric traction. At

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the same time current literature is to be searched, and those who have special knowledge of the subject are to be requested to state their experience. It is intended to collect materials for a report on the matter at the meeting of the Verein this month, and it is expected that a large number of experts will record their experience.

Press Telegrams.—Mr. A. Morley, in answer to Sir S. Northcote, said in the House of Commons on Monday last that he had stated on the 4th ult. that he was willing to arrange for an investigation into the loss from Press telegrams if satisfactory assurances were given that the Press would abide by the result, and would undertake not to oppose the necessary legislation for a revision of the charges if it should be shown that they were insufficient. As to the telegraphists, he was not aware that he stated that the telegraph department "must be placed upon a commercial basis." What he did say was that "a great commercial department like the Post Office could not afford to disregard commercial principles"; and he added that he was supported in this view by the report of the Select Committee on the Revenue Departments in 1888, in which attention was called "to the fact that the department of the Postmaster-General in all its branches is a vast Government business which is most likely to continue to be conducted satisfactorily if it should continue to be conducted with a view to a profit as one of the revenue-yielding departments of the State."

Central Technical College.—The following extracts from the 1894 Report of the Council of the City and Guilds of London Institute may prove of interest:—The Council have reason to believe that the change of name has been to the advantage of the College. The total number of regular students is now 222, against 205 in 1892-93. The distribution of students pursuing a complete course of instruction, as laid down in the programme, and attending all four departments during the past three sessions, is as follows: Civil and mechanical engineering course, 71; physics and electrical engineering course, 95; chemical course, 20. The number of students attending the courses of instruction provided for those who intend to follow a chemical career has doubled. The present laboratory and workshop accommodation does not allow of any material increase in the number of students in the engineering and physical departments, but the Council trust that the number entering the chemical department may continue to increase until it also is full. The College was opened to students in January, 1885. There are now in all 150 past students who have gained the Diploma. The Council venture to think that the careers of these amply show that the instruction provided has been such as to fulfil, to the full extent anticipated, the objects for which the College was established. These objects were to give to London a College for higher technical education, in which advanced instruction should be provided in those kinds of knowledge which bear upon the different branches of productive industry; the courses of instruction were arranged to suit the requirements of persons training to become technical teachers, or preparing for higher posts as engineers and chemists.

The Electrical Equipment of the New Post Office at Leeds.—The electrical equipment of the new post office at Leeds, which is now approaching completion, provides not only for lighting the whole of the building by the electric light, but also for putting electrical power to uses to which it has not hitherto been applied in any post office. The boiler house and dynamo room are situated in the basement. Three boilers of the water-tube type will be laid down, each capable of evaporating 3,000lb. of water per hour into steam, at 125lb. pressure per square inch, current is supplied by three Willans-Holmes sets, and the dynamos will each supply 340 amperes at 108 volts. There are to be in all 36 arc and 563 glow lamps, chiefly of 16 c.p. At the four corners of the main building electric hoists connecting the different floors are being erected. The vacuum and pressure pumps of the pneumatic despatch arrangements will be worked by an electric motor. In the new telegraph room several improvements upon existing arrangements are to be introduced, the most important change being the substitution of secondary for primary batteries for telegraph purposes. It is estimated that about 200 secondary cells will be sufficient to replace the whole of the primary batteries. Accumulators will also supply the currents in the large new telephone room, which is being prepared in view of the acquisition of the trunk telephone lines by the State. Some of the rooms in the new building are so far apart as to be beyond the range of the ordinary speaking tubes. Telephones are therefore being fixed in the rooms of the postmaster and heads of departments, in order to facilitate the management of the different branches.

Contact Resistance of Metals.—In the *Comptes Rendus* of the 22nd ult., M. Edouard Branly describes some experiments recently carried out by him in regard to the electric resistance between two sheets of metal in close contact with each other M. Branly employed thin sheets, 48mm. square piled one on the top of the other, and compressed together by a weight of 6 kilogrammes. Electric connection was made with the column by means of sheets of brass at the top and bottom of the pile of plates. When a sheet of zinc was placed between two of copper, the contact resistance was very small and remained constant; but when a sheet of aluminium was placed between two sheets of bismuth, the resistance was quite appreciable and increased with time. Thus, in one experiment, the resistance was, to start with, 0·4 ohm, and 25min. after the contact had been made it was 0·74 ohm, and 5 hours after it was over 3 ohms. If the experiment was varied by putting the sheets of Bismuth together and separating the aluminium from the bismuth by a sheet of brass, there was no appreciable resistance. M. Branly remarks that his experiments show that for certain metals, such as copper and zinc, the surface of contact is not the seat of any appreciable resistance; but for others, such as lead-aluminium, lead-iron, tin-aluminium, tin-iron, bismuth-iron, bismuth-aluminium, &c., there is an appreciable resistance. When the 6-kilogramme weight was replaced by one of 26 kilogrammes, the resistances at the beginning and the resistances as measured later on were smaller, and the same was the case when the pile of sheets was compressed in a vice; but in all these cases a higher resistance was found than one would have expected according to current notions, and this resistance always increased with time. This contact resistance of two metals in air can, M. Branly states, be altered by mechanical shock or by electric spark.

Finsbury Technical College.—The following extracts from the 1894 Report of the Council of the City and Guilds of London Institute may prove of interest:—The eleventh complete session of the day department ended in July last, and the number of students in attendance was 197, as compared with 213 in the previous session. The decrease was due to the smaller number of second-year students in the mechanical and electrical departments, a larger proportion than usual of first-year students of the previous session having failed to obtain promotion to the second-year course; the attendance during the current session has again risen to over 200. There has been a steady increase in the number of students attending the course of instruction in industrial and technical chemistry. The students following the mechanical engineering course number 5, the electrical engineering course 99, and the chemical course, 47. During the year the refitting of the benches in the chemical laboratory, commenced in the previous year, was completed, and has added greatly to the efficiency and comfort of the department. The equipment of the electrical laboratory has been increased by the purchase of the polyphase apparatus used for the transmission of power at the Frankfort Electrical Exhibition. The Mordey alternating dynamo in the electrical laboratory, and the new testing machine in the mechanical laboratory, have proved valuable additions. In the evening department of the College, 1,091 tickets were sold during the session to 922 individual students, as against 1,183 tickets sold in the preceding session to 980 students. The number of tickets taken by apprentices under 20 years of age, who are admitted at half fee on producing their employers' certificate, was 283, as against 359 in the previous session. The decrease in the number of evening students attending the College may be partly due to the influence of the polytechnic institutions in and around London, for it has shown itself mostly in the classes in plumbing, machine design and electric technology.

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MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 757, Vol. XXXIV.)

The Parsons Steam Turbine.—In this country the Parsons, and on the continent the de Laval, steam turbines are, as far as the author is aware, the only representatives of rotatory steam engines in electric supply stations. It is not necessary here to enter into the many and great difficulties which have been encountered in the efforts to develop a commercial rotatory steam engine—though, it is a curious fact thatthe very first recorded engine, that of Hiero, was rotatory—but it may be stated that practically all these difficulties have been overcome, at any rate where high speed is not objectionable, and a thoroughly efficient and serviceable motor has been produced in the Parsons steam turbine.

There are many so-called rotatory engines in which veiled reciprocation of the working parts occurs; but a true steam turbine is that in which the simple rotation of the working parts is caused either by the impulse of a directed jet of steam or by the reaction of its issue from a nozzle or other orifice. In the Parsons engine the effective head of the live steam is distributed in the same manner as the hydraulic head of a drowned turbine; in other words, the action of the steam on the vanes is partially by impulse and partially by reaction. It would be more correct to say, perhaps, that this engine resembles a series of drowned turbines, inasmuch as the steam passes *seriatim* through a number of sets of guide blades and vanes, the latter all being arranged on one shaft. The steam acts during outward, radial flow; and when it has reached the outer edge of one set of revolving vanes it is guided by the fixed blades to the centre again, whence it once more flows radially outward between the next set of revolving vanes.

This will be made more clear by reference to the accompanying illustrations. Fig. shows the 61 elevation and Fig. 62 the plan of a Parsons engine coupled direct to a 100-kilowatt (134 E.H.P.) dynamo, drawn to a scale of ¾in. to one foot. This engine was designed to run at about 4,800 revolutions per minute, with steam supplied at about 100lb. on the gauge; and for a reason which will presently be stated, the steam is usually superheated several degrees. The turbine case is shown at *a*, and contains, in this particular engine, seven sets of vanes, built up of sheet brass. A longitudinal section of the admission end of the turbine is shown in Fig. 63. Steam is admitted through a double-beat throttle valve, which is controlled by the governor; and after admission it passes directly towards the centre until it arrives inside the first set of vanes. By impact and reaction it exerts a torque on these vanes, and glides over their surface and is discharged into the next guide passage, through which it passes to the inside of the second set of vanes. A loss of head—or pressure —and a fall in temperature takes place continuously throughout the vane passages; and finally the steam is discharged into the air or into a condenser at as low a pressure as may be desired.

In order to comply with the conditions of high efficiency it is necessary for the vanes to have a high peripheral speed, and it will easily be seen that for structural reasons this will render a high speed of rotation necessary. On this account it becomes a matter of necessity, when the dynamo is to be coupled direct to the engine, to design a special form of electric generator. The same conditions of high efficiency make it preferable to keep the initial pressure of the steam constant, if the speed is to be constant, rather than to throttle down the initial pressure to suit the load; and this further makes it necessary to reduce the period of admission, as it were, by alternating it with frequent periods during which the valve is closed. The ratio of the admission period to the interval of no-admission which follows will, of course, depend on the load; and it is controlled by the governor. Thus, at light load, the

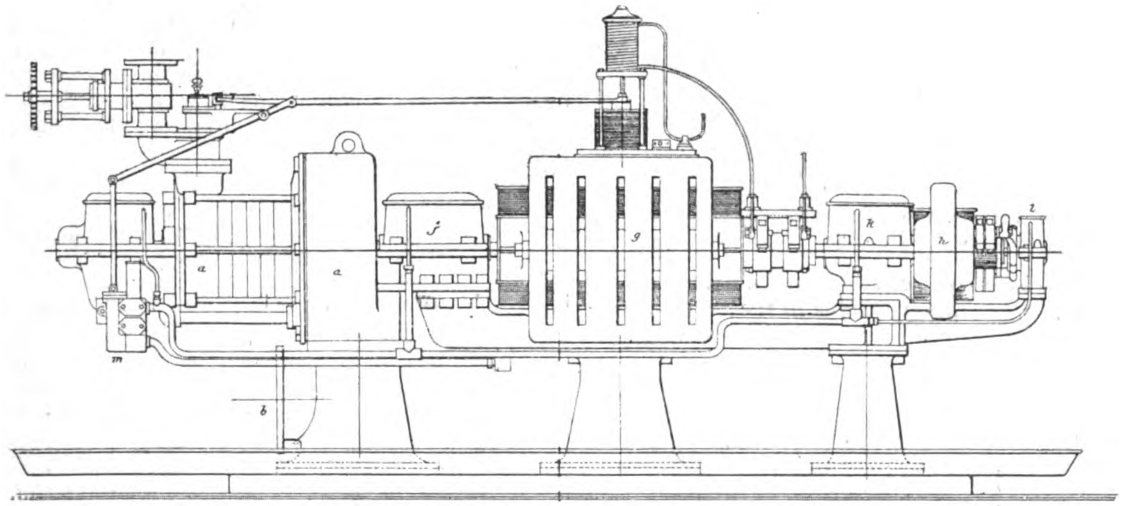

Fig. 61.—Longitudinal Elevation of Parsons Steam Turbine Coupled to 100 kilowatt Alternator. *a* = Turbine Cases. *b* = Exhaust. *g* = Alternator, surmounted by electric governor. *h* = Exciter. *j* and *k* = Bearings. *l* = End Bearing. *m* = Oil Circulation Pump.

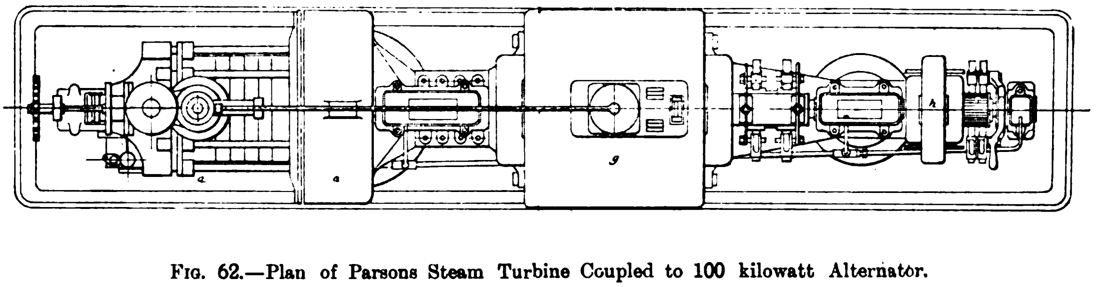

Fig. 62.—Plan of Parsons Steam Turbine Coupled to 100 kilowatt Alternator.

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steam enters in a quick succession of puffs; at higher load the puffs are more prolonged; and at full load they blend into practically one continuous blast. This is shown clearly in the

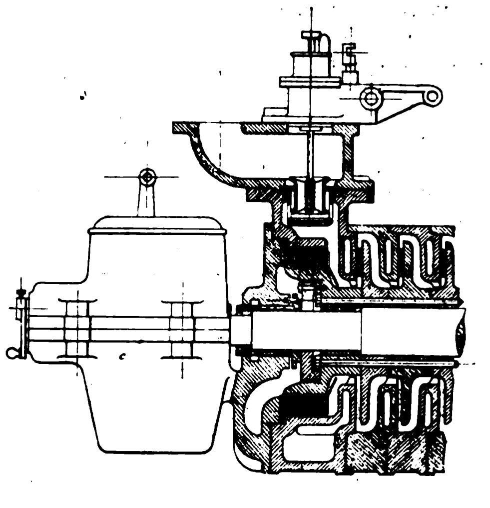

FIG. 63.—Parsons Steam Turbine.—Longitudinal Section of Turbine Case. c = Oil Box.

pseudo-indicator cards of this engine, in Fig. 64. It is not possible to "indicate" a steam turbine in the ordinary way, as there is nothing analogous to "stroke"; but variations

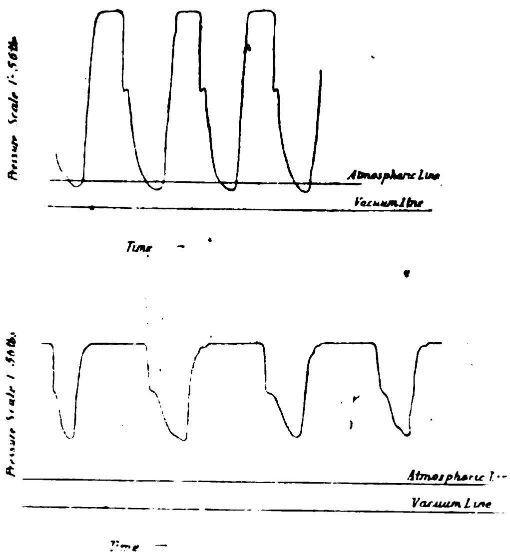

FIG. 64.—Pressure—Time Diagrams of Parsons Steam Turbine.

of pressure may be indicated by attaching an indicator and moving the cord with a uniform speed by hand. The result of this is shown in Fig. 64.

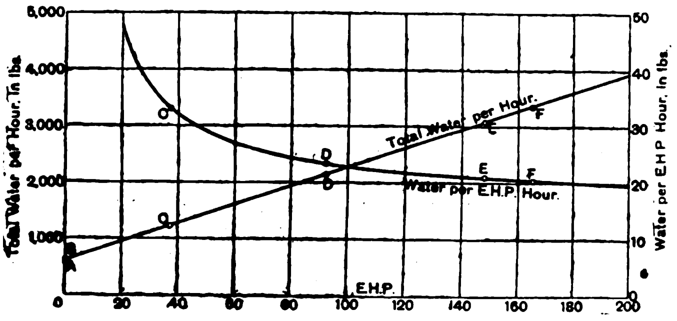

FIG. 65.—Steam Consumption of Parsons Steam Turbine.

In the same sense that it is impossible to "indicate" one of these engines, it is true also that they have no indicated H.P.; but it is convenient to call the rate of total working of the steam on the vanes the I.H.P. Prof. Ewing estimated, in a series of trials which he conducted on this engine—the one shown in the illustrations—that with an electrical output of 100 kilowatts the total power was about 179 I.H.P. The consumption of steam per I.H.P. per hour, at full load, was found to be 15·7lb., measuring the feed water; and at half load, about 17lb. per hour. These figures were based upon the measured consumption of 28lb. per Board of Trade unit of electrical energy, or 20·9lb. per E.H.P. per hour, at full load. The relation between load and consumption follows very nearly the Willans straight-line law; and the idle load was found to be about 36 H.P. The steam was superheated to 400° F., and had an initial pressure of 100lb. on the gauge.

Prof. Ewing's experiments were conducted in August, 1892. By April, 1893, considerable changes in the proportion of the working parts had been introduced into the engine; and at that time another series of trials was conducted by Prof. Kennedy with even more satisfactory results. The engine tested by Prof. Kennedy was of the same size as the previous one, but alterations internally enabled it to develop 150 kilowatts with a steam at 100lb. on the gauge. It ran at about 4,500 revolutions per minute, and it was direct-coupled to a continuous current dynamo. Fig. 65 is taken from Prof. Kennedy's report, and shows the steam economy. Further details of the trials are given in the following table, which is derived from the same source:—

Trials of a Parsons Steam Turbine and Dynamo, by Prof. A. B. W. Kennedy, April, 1893.

—	A	B	C	D	E	F	G
Duration of trial, in minutes ..	35·5	34·0	72·0	93·0	122·0	46·5	7·0
Mean boiler pressure, lbs. per sq. in.	95·8	98·5	97·0	94·6	94·5	97·1	97·0
Corresponding mean temperature degrees F.	335·2	337·0	336·0	344·4	334·3	336·1	336·0
Actual mean steam t'mp'rature close to engine, degrees F....	330·3	331·3	356·0	371·0	401·0	391·0	380·0
Amount of superheating	...	...	20·0	36·6	66·7	54·9	44·0
Mean vacuum, lbs. per sq. in. .	14·3	14·1	14·28	14·28	13·95	14·11	13·8
Mean injection temperature, degrees F.	59·0	63·3	64·4	58·6	70·7	61·7	...
Mean hot-well temperature, degrees F.	62·6	68·9	72·9	75·2	89·8	80·6	...
Mean revolutions per min. ...	4,268	4,385	4,480	4,475	4,655	4,625	4,592
Mean current, amperes	...	...	105·5	260·3	420·7	482·5	576·5
Mean E.M.F., volts...............	265·1	267·2	264·9	264·3	263·3	254·9	264·7
Mean kilowatts	...	...	27·94	68·8	110·8	123·0	152·6
Mean E.H.P.	...	...	37·45	92·21	148·5	164·9	204·6
Total water used, lbs.	370	370	1,480	3,330	6,290	2,590	...
Total water per hour, lbs.......	625	653	1,233	2,148	3,094	3,342	...
Water per kilowatt hour, lbs.	...	...	44·1	31·2	27·9	27·2	...
Water per E.H.P. hour, lbs....	...	...	32·9	23·3	20·8	20·3	...

There can be little doubt that a great deal of the excellence of these results is due to the use of superheated steam. With wet steam the turbine gives far less satisfactory results, owing to the internal friction developed by the particles of water.

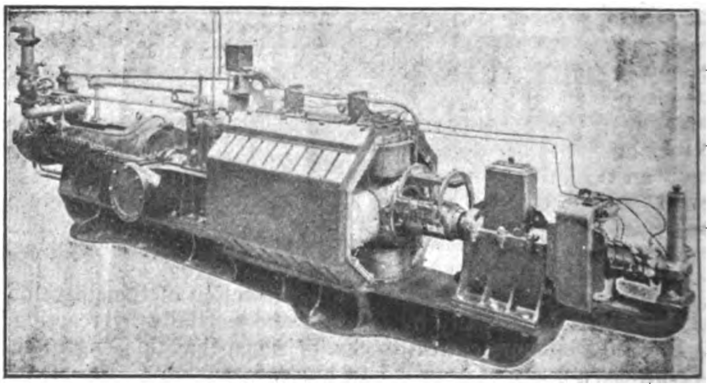

FIG. 66.—Parsons Parallel Flow Steam Turbine and Dynamo.

In this engine there is no cylic change of temperature of the parts, as in a reciprocating engine—except, perhaps, when the puffs are very far apart—and consequently there is not the same tendency to condensation of steam. If the steam is superheated before admission, it will remain dry almost if not

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quite until the exhaust takes place. In this way the clogging action of the steam is reduced to a minimum, and a high degree of perfection is attained.

Another point in favour of the engine is the absence of vibration from its foundation, due to the absence of reciprocating motion from its working parts. This valuable property has led to its adoption in supply stations where vibration would be liable to cause a nuisance; and in cases where trouble had already arisen from the vibration of reciprocating engines, a solution of the difficulty was found in the substitution of steam turbines.

A recent modification of the Parsons steam turbine is shown in Fig. 66, and has been introduced into electric supply stations. In this engine the steam has a "parallel flow," instead of the "radial flow" which occurs in the earlier patterns.

(To be continued.)

ELECTRICAL PLANT AT THE CREWE WORKS.

It is only by an excursion round such gigantic and varied engineering works as those of the London and North-Western Railway, at Crewe, that one can adequately realise, on the one hand, the extent to which electrical appliances have already been utilised in railway engineering, and, on the other hand, the immense field for their application, which as yet remains quite unapproached. If it is true—and it most certainly is true—that in the phenomena of electricity the railway engineer has found the solution of his most brilliant and ingenious devices, and a means to ends without which modern railway practice could never have come into existence, it is also impressed upon one, when the lines on lines of vast workshops and countless locomotives meet one's eye, that there are still wide areas of engineering practice where electrical science is not even a competitor with older and more mechanical methods of work. In the face of such rivals, electricity will have a hard struggle before it can attain the complete triumphs in railway engineering which some enthusiasts have predicted for it. Not that it can never triumph, but that the progress towards this elimination of older practice must of necessity be but a gradual one.

Already progress has been made, and that not merely in the subtler and lighter engineering work involved in signalling and allied inter-locking of railway plant, but also in the heavy engineering of the workshops, as well, of course, as in railway electric lighting. In the Crewe works many interesting applications of electric power have been made, and we are informed that hitherto great success has attended.

One of the most important of these applications is a 20-ton gantry crane in the boiler shop. This has recently been erected for riveting purposes, and it is most instructive to watch the ease and precision with which the operator, who stands on a raised platform just on the level of the work, can move the boiler about and adjust the plates to the hydraulic riveting machine. On the gantry crane, high overhead, there is no operator, the three motors being manipulated entirely by the man on the level of the work. Everyone who knows anything about boiler-shop practice will appreciate the saving in time and the precision of work thus rendered possible. The man stands with five small levers before him. With four of these he directs the movements of the electric motors in the crane, which moves on longitudinal and transverse rails at a height of 50ft. With the fifth lever he manipulates the hydraulic riveter. The four electrical levers manipulate the three motors—which give the boiler the three degrees of motion—and an electromagnetic brake, by which the work can be instantly locked in place when properly adjusted.

There are several similar gantry and other electric cranes in some of the other shops. One of these, a four-ton crane in the new wheel shop, we are, through the kindness of Mr. F. W. Webb, enabled to illustrate. It is largely to the ingenuity and enterprise of Mr. Webb, the well-known locomotive superintendent of the London and North-Western Railway, that the electrical developments of which we have to speak in this article have taken place, and that others are in rapid progress. The 4-ton electric crane, shown in elevation and plan in Fig. 1, is operated by three small motors, each of which drives through a worm gear. The lifting motor runs at about 1,800 revolutions per minute, maximum speed, and develops about 8 84 H.P. The long traversing motor runs at 1,860 revolutions per minute, and develops about 7·3 H P. The cross traversing motor runs at 1,250 revolutions per minute, and develops about 4·4 H P. These motors are supplied with electric power at 110 volts, through the switching and rheostat gear on the floor level, from the power mains which are carried along the shops. All the other cranes are arranged on practically a similar plan, differing only in the speeds and amounts of power developed.

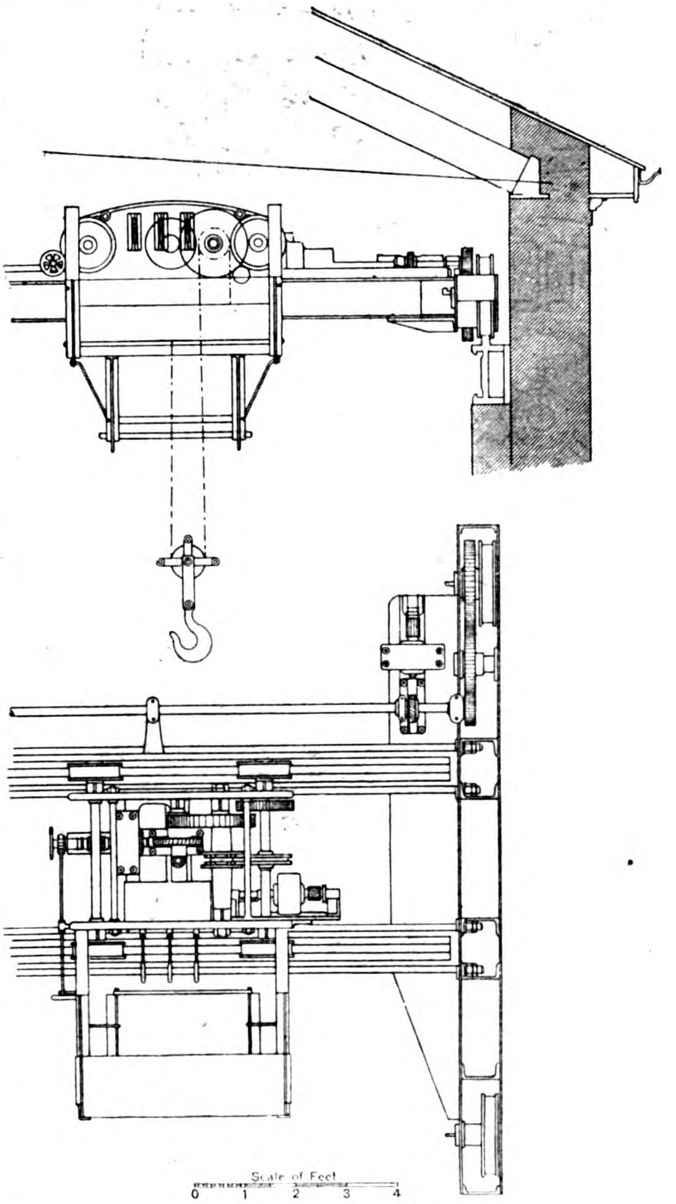

FIG. 1.—4-ton Electric Gantry Crane.

One of the most interesting features of the electrical plant at the Crewe Works is the extent to which the fitting and repairing, and similar shops, are wired for small electric tools, such as tube-cutters and drills. Many of the shops have been wired down the pillars between the bays, so that by means of a piece of flexible cable and a portable plug these tools can be used at various parts of the workshops. We believe it is intended to wire still more of the shops in this manner; and there is no doubt that this ought to prove one of the most useful and facile applications of electric power in these shops.

In our opinion the most ingenious, and perhaps the most useful of the electric machine tools which we saw at Crewe Works, was the "Webb" locomotive tube-cutter, for cutting away the furnace tubes of locomotives under repair and for trimming off

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the ends of new tubes. The machine is wonderfully light and portable, and it does its work in a manner and with a speed which must vastly astonish anyone who has been accustomed to

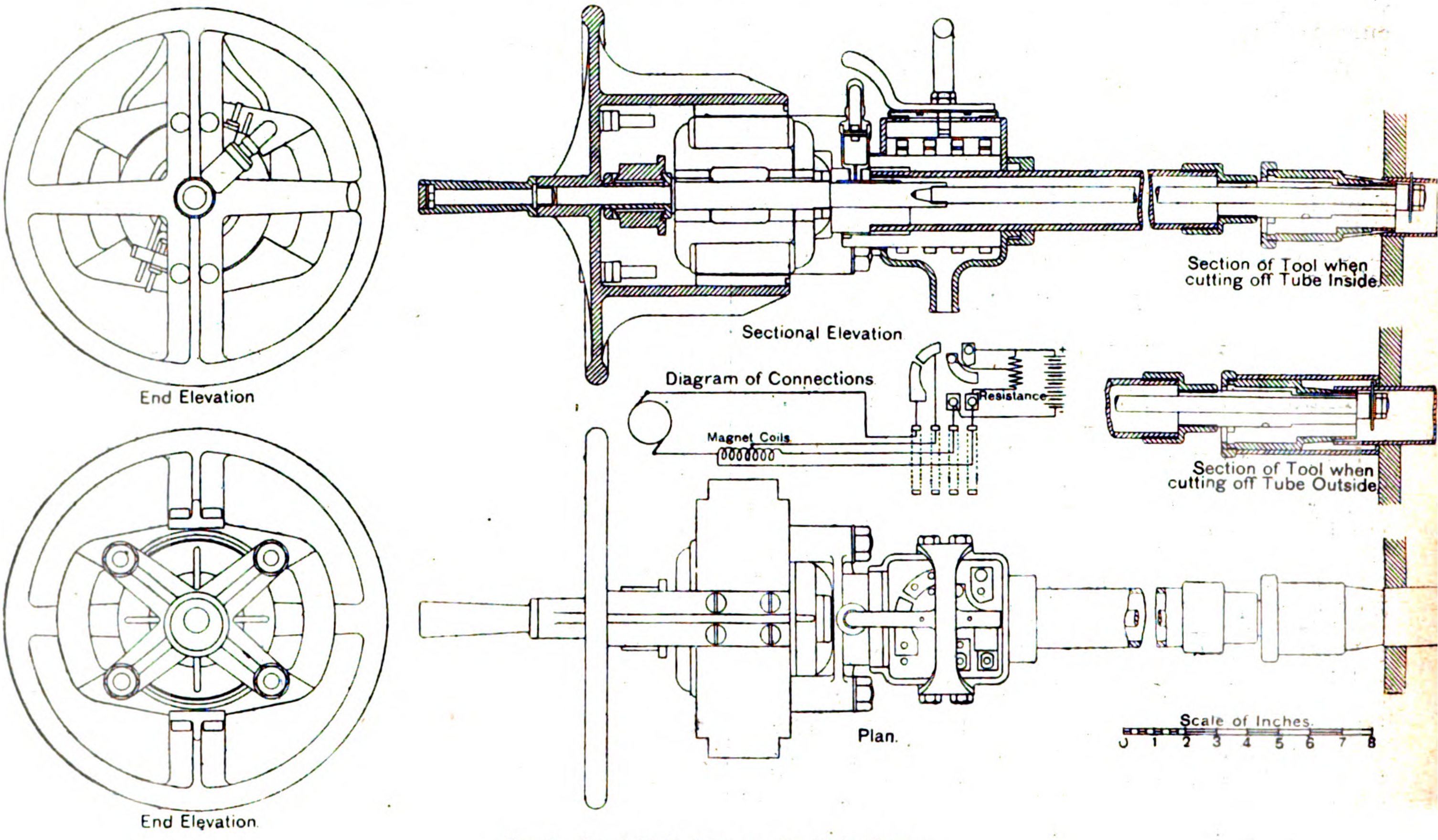

FIG. 2.—The "Webb" Locomotive Tube Cutter.

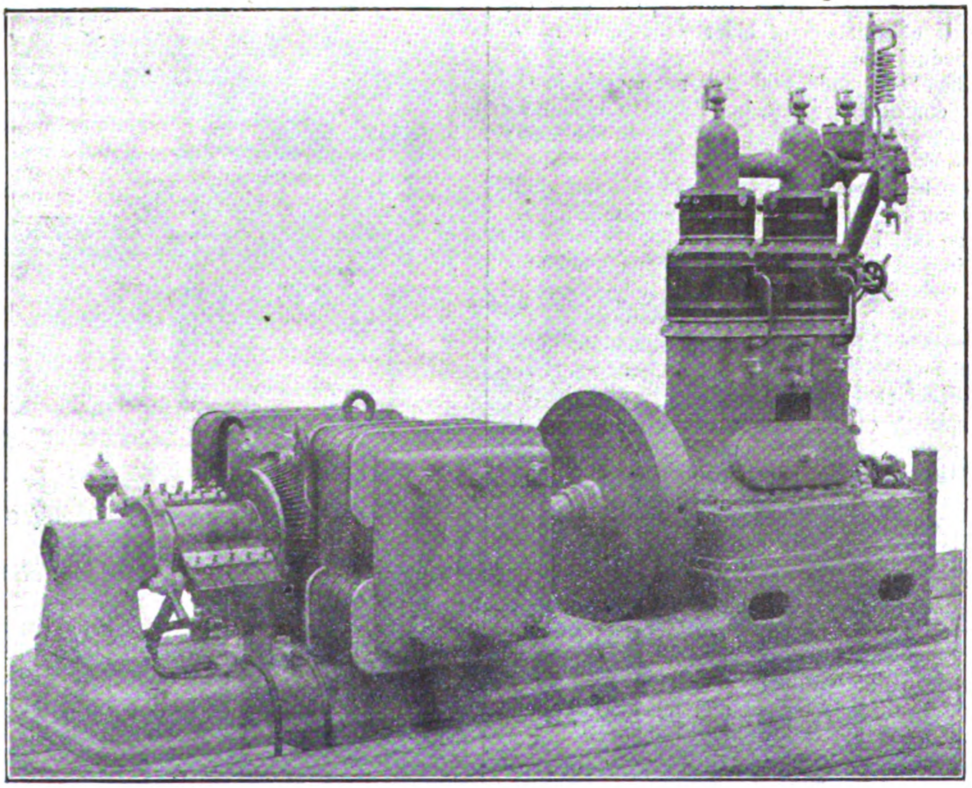

FIG. 3.—"Crewe" Steam-Dynamo Set.

the slow and laborious hand methods of getting out locomotive tubes. In fact, with the electric cutter, the furnace tubes of an entire locomotive can be detached in a little over half-an-hour, whereas it used to take from three-quarters to a whole day by the old methods. In several examples which we witnessed, it did not take more than 12sec. or 15sec. from the moment when the tool was in place to the moment when the cut was finished.

The "Webb" tube cutter is made in two or more patterns,

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slightly varied according to the position of the cut on the tube. In Fig. 2 we give a set of scale drawings of the cutter for the smoke-box end of the boiler. The cutter for the fire-box end differs only in minor details. The position of the smoke-box cutter for both inside and outside cutting is shown. The cutter consists of a long spindle, at one end of which there is a 1½in. circular saw and at the other end an electric motor; while, in addition, there are switches for starting and stopping the saw, and an arrangement of cams whereby the saw can be made concentric or eccentric to the tube. The saw end of the cutter is poked into the tube, as shown in Fig. 2, the operator resting the motor end on his shoulder. While this is being done, the saw is set concentrically with the tube, fitting it quite loosely. When in position, the saw is set in rapid revolution, attaining a speed of about 3,000 revolutions per minute, and when running at full speed it is gradually thrown out of centre, the cutting teeth being thus pressed against the inside of the tube, and then revolved so as to make the saw centre describe a circle round the axis of the tube. This, of course, carries the cutting teeth round the tube on the inside, and the eccentricity being sufficient to push the teeth beyond the outside of the tube, a complete cut is made. To withdraw the cutter it is simply necessary to stop the saw, and to throw it into its concentric position, when the tool may easily be drawn out. One of these little machines had, we were informed, cut off as many as 10,000 furnace tubes without requiring any repair.

Portable electric drills are largely used, and it need hardly be said that a very large saving results as against hand labour. These tools are simple in construction, and need not be described in detail; but there is one form to be seen which perhaps may be referred to as being of more than ordinary interest. This is a drilling and rosebitting machine which is carried on a small truck to run on the narrow gauge railway which is seen everywhere in the works, or when necessary it can be wheeled on the shop floor. Centred in the body of the truck is an arm which can be moved radially through an arc of about 180deg., and on this arm is carried a drill spindle capable of being lowered or raised as desired. This tool is at present used for drilling and rosebitting holes in the frame plates of locomotives. The little truck is wheeled up to the frame to be operated on, and without further movement all holes within the range of the radial arm can be at once drilled or rosebitted as the case may be.

The electric power for the motors and lamps is derived from a number of dynamos scattered about the widely extended works, the machines in most, if not all cases, being driven by separate engines coupled direct. There is a large battery of E P.S. cells for steadying and forming a reserve of power for the lamp circuits. A special set of shops is set apart to the purpose of building the "Crewe" dynamos, which are used in these works, and elsewhere over the entire North-Western system. An interesting point in connection with these is the fact that all the parts are made to templet, so as to be interchangeable. The advantage of this plan on so gigantic a system as the London and North-Western Railway will be at once seen, and it will, no doubt, contribute to the reduction of the cost of the electrical plant on that railway system. The dynamos are, of course, made in various sizes and patterns, according to the class of work for which they are built. The armatures are, in general, drum wound; and the field winding is adapted to special requirements. Fig. 3 shows one of the "Crewe" dynamo sets for an incandescent lamp circuit. This particular machine is designed for an output of 550 amperes at 120 volts.

In the field of electric welding substantial work of an experimental nature is being done. A Thomson-Houston electric welding plant, capable of dealing with work in sizes up to 1¼in. wrought iron or steel bar, has been erected in a shop adjoining one of the smiths' shops. This plant is used both for welding and forging, and at the time we saw it it was being employed for forging rings and bosses on a number of wrought-iron rods.

We cannot leave the Crewe Works without noticing a feature in the incandescence lighting circuits which is not commonly met with. We refer to the "Webb and Thompson" ceiling rose, which is used in the goods stations and other places. The leads are tapped by means of two sharp-pointed screws which are screwed through the leads until they penetrate between the strands of copper. The two leads are clamped into the base of the rose without any preparation or removal of the insulation where the joint is to be made: and the contact of the pointed screws and the copper strands is a mechanical one, without solder. We understand that this simple form of ceiling rose is no less effective and safe that it is simple, and that it has been used with success for some time by the London and North-Western Railway Company. There are, perhaps, other places where it might be used. The rose is the invention of Mr. F. W. Webb and Mr. A. M. Thompson, of the North-Western Railway Company, to whom our best thanks are given for the kind assistance they have rendered us in our preparation of this account of electrical progress at Crewe Works.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, May 3rd.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting. The following Paper will be read: "Single-Phase Alternate-Current Motors," by A. C. Eborall.

MONDAY, May 6th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture, "Recent American Methods and Appliances Employed in the Metallurgy of Copper, Lead, Gold and Silver," by James Douglas.

ROYAL INSTITUTION.

5 p.m. Monthly Meeting.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting at the Westminster Palace Hotel. A Paper will be read on: "Street Subways for large Towns," by Mr. Charles Mason.

TUESDAY, May 7th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "Alternating and Interrupted Electric Currents," by Prof. Forbes, F.R.S.

WEDNESDAY, May 8th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper will be read: "The Extraction of the Rarer Metals from their Oxides," by Prof. Roberts-Austen, F.R.S.

THURSDAY, May 9th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "The Liquefaction of Gases," by Prof. Dewar, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at the Society of Arts, John-street, Adelphi. The following Paper will be read: "On the Recent Development of the Single-Acting High-Speed Engine for Central Station Work," by Mark H. Robinson.

IRON AND STEEL INSTITUTE.

10:30 a.m. Annual Meeting at the Society of Arts, John street, Adelphi.

FRIDAY, May 10th.

IRON AND STEEL INSTITUTE.

10:30 a.m. Annual Meeting at the Society of Arts, John-street, Adelphi.

PHYSICAL SOCIETY.

5 p.m. Meeting at Burlington House. The following Papers will be read: (1) "On the Iodine Voltameter," by E. F. Herroun; (2) "A New Method in Harmonic Analysis," by A. Sharp.

Electricity in Mines.—In the last batch of reports by Her Majesty's Inspectors of Mines, issued from the Home Office, Mr. Hall, the well-known inspector for the Liverpool district, on the question of lighting goes strongly in favour of electricity. Its use, he points out, is extending for illuminating pit banks and also the shaft sidings underground, though a portable and satisfactory miners' electric light is still wanting. An objection has been urged against an electric lamp on the ground that it would afford no test of the atmosphere of the mine; but this is scarcely shared by Mr. Hall, who declares that any drawback of that kind would be more than compensated for by the greater security of the lamp in other respects.

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The Electrician.

(The Oldest Electrical Journal, 1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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Last week's number of "THE ELECTRICIAN" completed Vol. XXXIV. With this week's Number is issued (Gratis) the Index to that Volume. Complaints of non-receipt should be promptly made to the Publisher.

Owing to the growth of the electrical and allied industries the demands for space in "THE ELECTRICIAN" are, for the greater part of the year, so pressing that a permanent increase in the size of the journal has become necessary. To meet the increased cost involved by this step, and by other improvements, such as heavier paper and more numerous illustrations, the price of "THE ELECTRICIAN" will, from this issue, be advanced to 6d. Hitherto this sum has been charged when the number has contained a Supplement, and, as the industries grow, these may be more frequently necessary; but the practice of charging extra for Supplement numbers as issued will be discontinued.

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THE BELT AND ROPE TRANSMISSION TRIALS OF THE SOCIÉTÉ INDUSTRIELLE.

Nearly twelve months ago, in the course of his remarks at the Institution of Electrical Engineers on Mr. CROMPTON'S Paper on "The Cost of Electrical Energy," Prof. KENNEDY announced that a series of what he hoped would be exhaustive and complete trials with regard to rope-driving was about to take place on the Continent. Reflecting that they often manage these things better abroad than we do at home, we awaited the results of these trials with no little nterest. But though thus heralded almost with a flourish of trumpets, the trials of the efficiency of belt and rope gearing, by the Commission appointed by the Société Industrielle du Nord de la France, have added little, if anything, to the stock of useful human knowledge on the subject. Ample machinery for an exhaustive inquiry was lent and assembled at the expense of numerous influential supporters of the Commission; a competent body of experimenters was gathered together; a splendid opportunity offered itself for the performance of genuine and useful research. Many questions pressed for solution; there was the great uncertainty as to the absolute efficiencies of ropes and belts,

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when driven under the most favourable conditions; there were doubts even as to what are the most favourable conditions; there were matters to be settled as to the proportions and speed and driving pitch, or length of drive, which it is advantageous to adopt; there were countless other matters equally important. But, so far as we can gather from the published Report, a translation of which will be found in our columns, not one single item in this long list occupied the attention of the Commission. The mutual congratulation, vote of thanks to the boiler stoker, and proposal to request the Council of the Society to strike a medal commemorating the trials, stand in somewhat ludicrous contrast with the meagre programme of the actual research, and with the amount of time devoted to carrying it out. What is it that this Commission set itself to do, and what has it actually achieved with all its appliances? Engineers have long known something about belt and rope driving. They have known, for example, that these two forms of flexible gear must be arranged on different lines, as to the speed and distance at which they should be run, and the intensity of stress to which they should be subjected. Yet the Commission elected to run all the ropes and belts, of every kind whatever, on pulleys of precisely the same diameter, giving cotton belts, leather belts and manilla ropes exactly the same linear velocity! This alone is sufficient to detract from the value of any results which might have been arrived at. Moreover, the length of the drive in each case does not appear to have been measured; and the diameter of the dynamo pulley would seem to be too small for the ropes, and likely to punish them on the bend. In practice, also, the working stresses in belts and ropes are not so nearly equal as was the case in these trials.

With their plant equipped and arranged, the Commission proceeded to the settlement of two matters: (1) The amount of slip between the ropes or belt and the pulleys, and (2) the ratio of the indicated power developed in the steam engine to the electrical power developed at the terminals of the dynamo. The first of these is beside the point, and the second is vague and, under the circumstances, valueless. One cannot avoid the impression, on reading the Report, that the Commission attached considerable importance to this matter of slip; that they seemed to connect it in some way with the efficiency of the gear. Else, why did they devote so large a share of their attention to it? Yet, and especially under the ideally steady conditions of working maintained in these trials, slip signifies very little indeed, and it is no sort of indication whatever of the power wasted in the rope or belt. Under the irregular conditions of actual work the amount of slipping would be both absolutely and relatively different, when taking the various kinds of belts and ropes into comparison. But, perhaps, the most extraordinary feature of these trials was the vague and uninstructive way in which the wasted power was measured. If properly measured and analysed, this quantity should enable the absolute efficiency of the rope or belt to be determined, but an analysis from the figures supplied is quite impossible. The wasted power consists of power absorbed (1) in the engine, (2) in the rope or belt, and (3) in the dynamo. No attempt has been made to find the values of the first and the third quantities, and thus the second remains indeterminate. Yet it would have been a simple matter to measure the mechanical efficiencies of the dynamo and engine. Finally, there is an imposing display of indicator diagrams and engine dimensions, all to no useful purpose. An unequalled opportunity for the attainment of accurate knowledge on a point of high mechanical engineering interest has, it seems to us, been sadly wasted. Perhaps, after all, we may do this thing better at home.

REVIEW.

Elementary Lessons in Electricity and Magnetism. By S. P. Thompson, D.Sc., F.R.S., &c. New Edition. (London: Macmillan and Co. 1895.)

This well-known work has always been far more than a book for beginners, although it has served admirably for that purpose. The earlier issues contained a large quantity of matter of interest to the advanced student, and the practical applications of the subject were not neglected. The fact that seven years ago the circulation had already exceeded 40,000 copies, shows that the work was regarded as the favourite text-book among readers approaching the subject from the pure science side, and wishing to obtain a good grounding in both the pure and applied parts of the subject.

In the present edition, which has been largely rewritten and extended, the author has endeavoured to make his book comprehensive, and quite up to date, on both the theoretical and practical side; and he has certainly succeeded to an extent which will greatly increase the already high reputation of this book. The additions include a short account of Ewing's magnetic work; a description of the newer kinds of d'Arsonval galvanometers and electrostatic voltmeters; a *résumé* of Lodge's lightning rod work; the theory of the magnetic circuit, and the idea of magnetomotive force; a description of the current balances of Lord Kelvin, wattmeters, supply meters, arc lamps and their classification, glow lamps and their mode of grouping, inductance and its measurement, alternate currents, alternators, transformers, alternate-current motors, and polyphase transmission of power. The portion dealing with direct-current dynamos is fuller than in previous editions, and some of the fundamental calculations made in the design of these machines are discussed in connection with the subject of the magnetic circuit. The last chapter contains an excellent description of the properties of electric waves, and of the more important experiments which have been made with them. There are several appendices, including some useful tables, the official specifications of the various electrical units, a large number of problems and exercises, and, lastly, an alphabetical index for purposes of reference. The book is very fully illustrated, and, as is characteristic of all Dr. Thompson's work, the style of writing is both clear and interesting.

We have merely given the barest outline of the nature of the changes introduced into the present edition. These can, perhaps, be best described by saying that the author has succeeded in his principal object, stated in a paragraph of the preface, where, after alluding to the great extension of electrical science in recent years, the writer states that "this expansion of the science, and of its practical applications, has rendered more difficult than before the task of presenting with sufficient clearness, yet with necessary brevity, an elementary exposition of the leading phenomena, and of their relations to one another."

The chief criticism we are inclined to offer is that we doubt the wisdom of attempting in a book, which is styled elementary, so complete an exposition of the subject. It is impossible, however well the book may be written, to properly discuss, in the space at the disposal of the author, such a great number of electrical matters. As a consequence some of them have to be referred to very briefly, as, for instance, in Chapter VI., where five small pages are all that are devoted to describing five methods of determining electromotive force, five methods of determining the internal resistance of cells, and six methods of determining capacity. Such a brief catalogue seems merely to supply a number of reasons for seeking information elsewhere. It is also a pity that the immediate wants of the beginner have not been more considered. In spite of the advanced character of much of the contents of this edition, there still remains a considerable fraction of the book written in a style, and dealing with subjects, admirably suited to the mere beginner; and, if the paragraphs in which these parts occur had been marked by means of an asterisk, or in some other suitable manner, the value of the book would have been much increased. It is true that the

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author is already engaged in writing a book "for beginners" on the same subject, and "adapted to the elementary stage of the South Kensington syllabus." There is no doubt that this book, when written with the free interpretation which the author will rightly give to the above description of its scope, will admirably supply the wants of the beginner. Nevertheless, at present the very success of the author has deprived the elementary reader of a book suitable for his wants, by supplying him with one styled elementary, but really advanced. The matter which such a student requires, although all contained in the present volume, is so mixed with other matter which is beyond his powers to understand, that he will probably be driven to resort to books of a much inferior stamp.

The first chapter is admirably written for students who already have a slight knowledge of the subject, but for a beginner parts of it are likely to prove most difficult. It deals with electrostatics, though for this subject the author adopts the grandmotherly title of frictional electricity. His liking for old fashions, however, ends at the title, for he presents the subject in the most modern way, introducing the ideas of lines of force and tubes of displacement in order to explain the phenomena of electric attractions and the action of the electrophorus and influence machine. Prof. J. J. Thomson has largely developed these ideas in his recently published supplementary volume; and the author of the present work, so long ago as the year 1888, used them with considerable success, to throw a new light upon the mode of action of the Wimshurst machine, in a valuable Paper which he read before the Institution of Electrical Engineers at that time. Admirable, however, as these lines of force may be in connection with the latest developments of electrical theories, it may well be doubted whether it is wise to bring them to the notice of a student wishing to obtain "elementary lessons in electricity and magnetism." In any case, if it was thought desirable to describe the phenomena of electrostatics in terms of lines of force, it would have been much preferable to commence the book with a chapter on magnetism, a subject in which numerous experiments of a simple character can be devised to convince the student of the physical reality of similar lines of force, and the general properties which they possess. In electrostatics the experimental means of exhibiting these lines are quite insufficient to give the student an intelligible idea of them; and the explanations of the phenomena in terms of them, although of great interest to the advanced student, are not so simple as those in terms of positive and negative charges.

When dealing with the subject of permeability, the properties of the hysteresis curve are briefly described in a couple of well-written paragraphs. We believe that this is the first time that these properties have been described in a text-book not written expressly for technical readers. No mention is made of it in the former edition of this work, nor anywhere else that we know of, with the exception of technical books or the Proceedings of scientific societies. This is the more remarkable when the theoretical importance of these phenomena is considered, and can only be accounted for by the comparatively recent date of the discoveries themselves.

In our opinion it is to be regretted that the author has introduced into his book calculations based upon the law of the magnetic circuit. The imperfect analogy between the electric and magnetic circuits is useful to anyone having already a good knowledge of the former, and has proved of great service to many engaged in the practical applications of electricity, since it has helped to simplify the conception of the magnetic circuit. But it is a mistake in a book dealing with the subject more from a scientific than a technical point of view, and intended for ordinary students, to compare an exact law, like that of Ohm, in which the ratio of force to flux is a constant, with an approximate law, like that of the magnetic circuit, in which the ratio of force to flux is a variable, determinable merely by experiment, and in which a number of leakage constants (or rather variables) have to be dragged in to completely account for the facts. We should be the last to deny the important services the so-called law of the magnetic circuit has rendered in simplifying the calculations necessary to predict the action of the various types of electromagnets used in the practical applications of electricity. At the same time, a scientific student would be justified in objecting to paying much reverence to a law which only seems to predict experimental results, after these same experiments have been made for the purpose of finding a number of so-called constants necessarily determined in this way before the law can be applied at all.

NOTES ON SUBMARINE CABLE WORK.

BY H. D. WILKINSON.

(*Continued from page 450, Vol. XXX.*)

The Localisation of Faults.

31. **Preliminary.**—In the former articles we have examined the machinery used and practice followed on board a cable steamer while carrying out a repair. We now propose to review some of the electrical tests for the localisation of faults and breaks, adhering to the practice and methods in common use to-day. Ships go out now to repair faults of a minuteness scarcely ever met with ten years ago, on account of their more rapid development at that time.

The covering of brass tape, by which the core of all modern cables is protected from the attacks of the submarine teredo, is a means of preventing the previously rapid development of a fault under the action of the current, because the gas evolved has no free escape, and becomes occluded on the surface of the tape. The result of this condition is that faults are of much higher resistance, although they occur in less numbers, except as regards fractures, and it may be said that finality has not been reached in the tests used to locate these small and difficult faults. Further, as regards duplicate cables, a fault, or even a total interruption of one cable, does not trouble the public, whose messages still go through by the other; but it is a matter requiring prompt action on the part of the owners, in order to keep the duplication intact; and, consequently, faults are dealt with as soon as they occur, and are oftener than ever of a very minute character. Such faults require very rapid observations on the instruments on account of their polarisation, and this action is so instantaneous in some cases as to render the results from one end quite unreliable; but, notwithstanding these difficulties, the smartness with which repairs are carried out to-day is proof that considerable practical advances have been made.

In these papers some acquaintance must necessarily be assumed with electrical apparatus. The Wheatstone bridge, galvanometer, keys, batteries, and commutators are nowadays within reach of all who have entered on any branch of electrical work, and the practical use of them is very soon acquired.

Faults are sometimes so small as not to have the slightest effect on the signals through a cable, and, indeed, would not be noticed at all if it were not for periodical tests. Other kinds of faults make their presence felt on the signals at once, and at times there are total breaks or dead-earth faults, which immediately put a stop to communication. But, however small a fault is when first detected, it will gradually open up under the action of signalling currents, even should the original cause have ceased, and on this account it is usual to proceed at once to remove such. Before the ship leaves, the nearest possible approximation of the position of a fault is made by tests from both ends, and after she arrives at the estimated position and cuts in on the cable, similar tests are made between the end on board and the shore to obtain a nearer result.

It will be seen that these tests are of great importance, as, when carried out skilfully, the ship's time at sea is lessened, and the business of the company quickly restored to its accustomed channel.

32. **The Earth Overlap Test.**—In cases where the fault makes only partial earth—that is, when it offers anything above, say, 20 to 30 ohms resistance—the observers at either end can speak to each other, arranging times for testing, and

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then compare results. A reliable test, depending on results from both ends, is that first published by Messrs. A. E. Kennelly and James Anderson in *The Electrician* of July 17, 1885 (Vol. XV., p. 177), and which has since been used with success in difficult cases. The principle of the test is to take readings on the bridge in turn at either end of the cable, the opposite end being earthed for the time, and, by adding a resistance to the end of the cable nearest the fault, to make both bridge readings equal. Whatever bridge ratios are used at one end should be used at the other, and the batteries should have approximately the same E.M.F. and resistance; the current through the fault will then be the same, and its resistance constant for the tests from both ends. The connections for testing at one end are given in Fig. 102. A plug is put in 1 (of the commutator) to connect cable to bridge for testing, and is taken out of 1 and put in 2 for earthing the cable while the other end tests.

The tests may be taken with one current only to false zero, or by reversals of current to instrument zero. If with one current the zinc current should be used by both ends, as by this the current in both tests flows through the fault in the same direction, and in such a direction as to open it up (although it flows through the cable in opposite directions). The time for earthing and testing being agreed upon, the first pair of tests is taken and compared. The end nearest the fault will test lower than the other. Now add a resistance to the lower end equal to the difference between the two results. On trying a second pair the readings will be more nearly alike than before, but may still not be equal. The added resistance is then increased by the difference of the two readings if the same end still tests the lower, or is reduced by a like amount if it tests

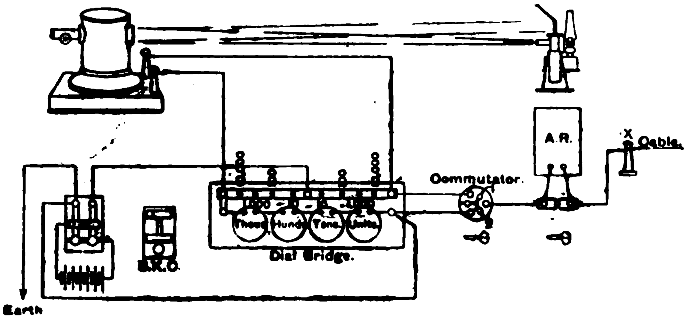

FIG. 102.

too high. More pairs are taken in this way till both ends test the same. The difference between the results at both ends when testing to earth is always less than the true amount by which the added resistance should be increased or diminished to produce equality between the readings.

Mr. Kennelly, in a communication to the Institution of Electrical Engineers (*Proceedings*, Vol. XVI., page 581), has given a formula (derived by differentiating the difference between the earth readings with respect to the added resistance), by which the approximate value of the added resistance may be determined after a pair of earth readings have been taken with a given added resistance. This is given below in a simple form.

Free the end nearest fault and test from the other, giving a balance, say, of A ohms, and let P be the sum of the line perfect and added resistance. Then the latter must be increased or reduced by the difference between the two earth readings multiplied by the following fraction :—

$$\frac{A^2}{P\left(A - \frac{P}{4}\right)}.$$

This fraction is more easily worked out when written

$$\frac{A}{P} \times \frac{A}{A - \frac{P}{4}}.$$

Another way is to take a pair of frees and increase or diminish the added resistance by the difference between the readings.

When earth readings are the same at both ends, free readings should be also equal, with the same added resistance. The free overlap is, however, not so reliable as the earth overlap, as it is more affected by low places beyond the fault. When freeing the cable it should be disconnected at the terminal X (Fig. 102). The added resistance simply makes the cable longer in order to place the fault electrically in the centre of the line. The formula is therefore the same with either earth or free overlap. Calling R the correct added resistance (proved by equal results from both ends), L the line perfect, and x the distance in ohms from end nearest the fault (Fig 103), we have

$$R + x = L - x;$$

whence $$x = \frac{L - R}{2} \text{ ohms.}$$

In the manipulation of this test it is best that the end which tests last in one pair should test first in the next. The

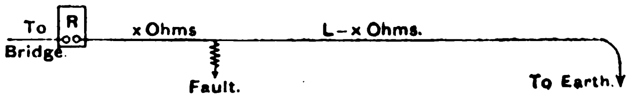

FIG. 103.

time taken in testing at each end can then be kept more nearly the same, and the fault is given less chance to alter. If this is not done, the fault may polarise and make the result too high, even with the right added resistance.

33. **Earth Overlap as a Loop.**—When testing cable in tank, or a faulty cable looped to a duplicate cable, the earth overlap may be used as a check on the ordinary loop.

The cable ends are first connected as usual to the line and earth terminals of bridge, and a reading taken. Then the cable ends are reversed, and the bridge balanced again. The end to line of bridge when the lower of these two readings is obtained is that nearest the fault, and to this end is added a resistance equal to the difference between the two readings. The ends A and B

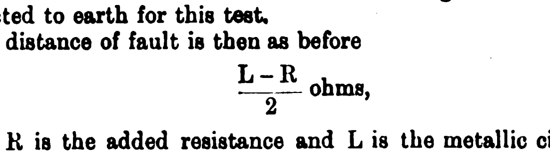

FIG. 104.

(Fig. 104) are reversed on the bridge for each reading, readjusting the added resistance after each pair until the readings are the same with either end of cable to line of bridge and the other to earth. The earth terminals of bridge and key are connected to earth for this test.

The distance of fault is then as before

$$\frac{L - R}{2} \text{ ohms,}$$

where R is the added resistance and L is the metallic circuit measured with the ends of cable to line and earth of bridge, and the earth wire taken off key. As a loop, excellent practice can be gained in using the overlap. The battery power and bridge are identically the same for each reading. Moreover, the correctness of the added resistance checks itself in one observer's hands, and the effect of differences in the time taken over each reading can be readily seen.

(To be continued.)

Telephonic Communication between Ships and the Shore.—An experiment in connection with telephonic communication between the watch ship "Heimdal" and the land was recently made in the harbour of Kiel. At the forthcoming opening of the Baltic ship canal, it is proposed that all the war vessels—German and foreign—which take part in the opening ceremonies, shall be enabled to communicate with the shore, telephone cables being attached to all the harbour buoys.

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LEICESTER ELECTRIC LIGHT AND POWER STATION.

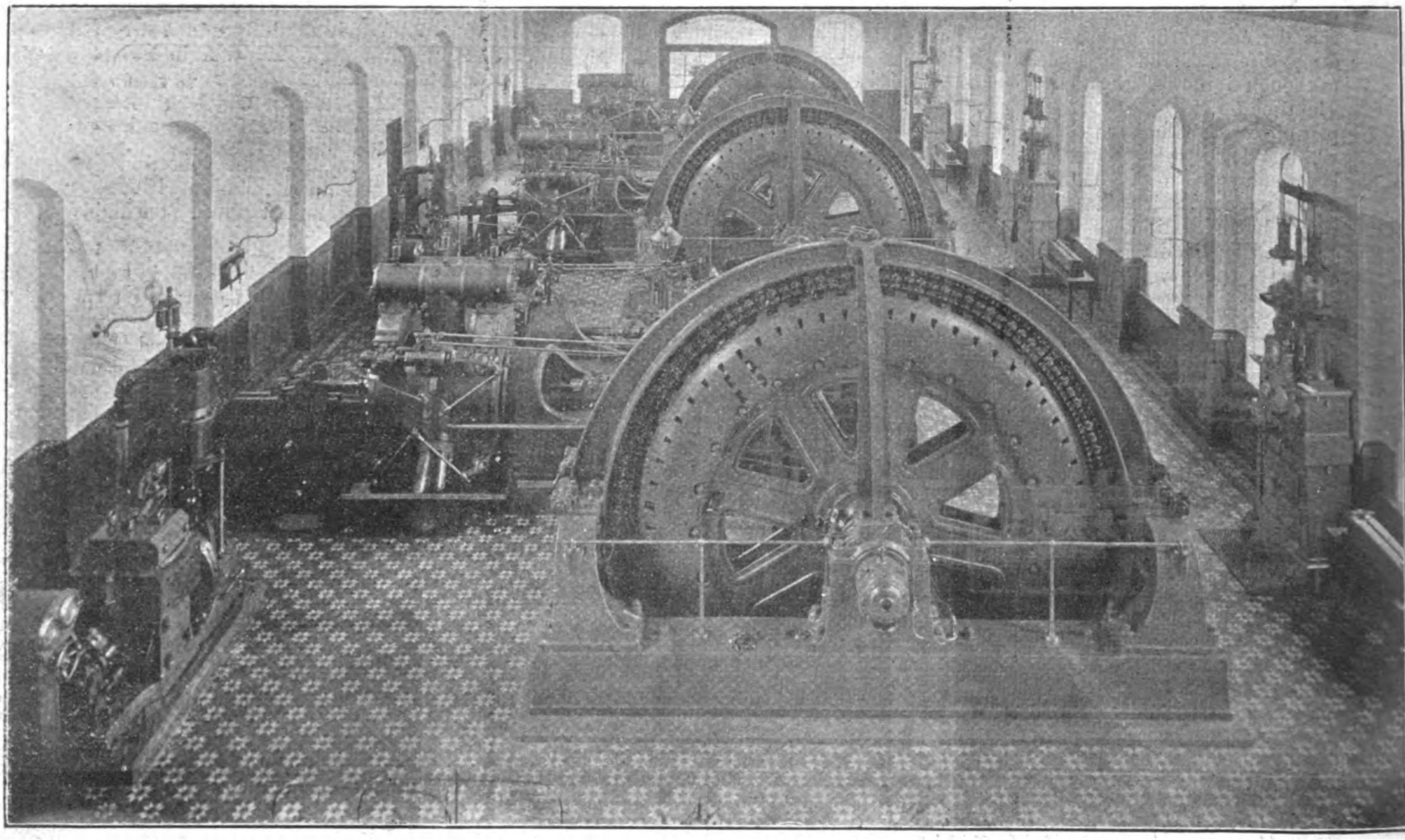
Unusual interest has perhaps been taken in the Leicester electric lighting scheme because the Corporation have carried out the work without engaging the services of an expert in the usual way, and also because it has been understood that both of the contractors for the plant—steam and electric—have made special efforts to supply the best possible machines they were capable of, and the buildings, for which Mr. Alfred Colson, the borough engineer, is responsible, probably contain, as will be seen from our illustration, the handsomest engine room of all the central stations of Great Britain.

The system is a high-pressure alternate-current one, with street sub-station transformers and a low-pressure distribution, the pressure of the feeders being 2,000 volts, and that of the low-pressure network 100 volts. In many respects the station equipment follows continental practice rather than that hitherto the custom in England. The plant is divided into three large units each of 200 kilowatts, with a smaller unit of 75 kilowatts for the light load. Compound condensing engines are coupled direct to the alternators through flexible couplings, and the revolving field-magnets act as flywheels. The steam pipe and electric conductors are all carried in a basement under the flooring formed by spaces left between the foundations of the machines and the main walls.

The flooring is formed of rolled steel joists, filled in with cement concrete, and paved with tessellated tiles. A dado of stained and varnished match boarding, with moulded cap and skirting, encircles the room. The room is lighted by double tiers of windows on both sides, except where the boiler house abuts, and one end is left plain for extensions. The roof is supported by wrought-iron principals, and is formed of pitch pine rafters and purlins filled in with diagonal match-board panels, stained and varnished. A 15-ton electric overhead traveller spans the entire width, and can be traversed from end to end of the room. The walls are faced with cement, and whitened. The general effect is extremely fine, and Mr. Colson is to congratulated on the design, by which he has realised an artistic and commodious station, with facilities for getting at any part of the plant.

The most striking features of the plant are, perhaps, the engines and the switching and regulating devices, but there are interesting details and improvements of various kinds in every part. Commencing with the boilers, there are at present four Babcock and Wilcox water-tube boilers, each of 250 actual horse-power, arranged in two batteries, with foundations for extensions amounting to 50 per cent., under the same roof. The working pressure is 120lb. per square inch, and the firing is done by hand. Gas coke from the gasworks is the cheapest fuel available, and is used at present. The feed water for the boilers is supplied from a tank, holding about 600 gallons. The exhaust steam from the exciter and pumping engines is taken into this tank and raises its temperature before it is delivered through the economisers to the boilers. The fuel economisers are also by Babcock and Wilcox and embody all the latest improvements. There are two vertical Brush three-throw pumps, direct coupled to Brush vertical steam engines. Each set is equal to the full load demand of the present plant, and the feed can be regulated to a nicety by levers which shut off the suction to each of the three rams as required. All the water and steam pipes are in duplicate, and valves are arranged so as to isolate any part. The feed water-pipes are of 3in. galvanised iron. The main steam pipe is of 6in. wrought iron, arranged in a ring with straight-through valves of the parallel slide type, and Giepel's patent steam traps. Magnesia sectional covering is used as lagging. The exhaust pipe from the condensers is of cast iron, 12in. in diameter at its largest section.

The engines, by Messrs. Hicks, Hargreaves and Co., of Bolton, are horizontal compound condensing, with Corliss gear of special design. The three large ones indicate 350 H.P. each, and have governors unusually large and powerful, which control the gear on both cylinders. The cylinders are respec-



Engine and Dynamo Room of the Leicester Municipal Central Station.

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tively of 16in. and 30in. bore with 30in. stroke. The speed is 96 revolutions per minute. Each engine has a jet condenser with circulating and air pump worked off a rocking lever on the tail rod of the low-pressure piston rod. The smaller engine is of similar design, except that Corliss gear is not fitted to the low pressure cylinder, and only the high-pressure gear is governed. The condensing water is got from the River Soar, and is discharged into a canal alongside the station. The three 200-kilowatt alternators are of the Mordey-Victoria type, and are similar in general design to those in use at the Bankside station of the City of London Electric Lighting Company. They have 120 coils in the armature, each wound on slate formers and fixed in German silver and ebonite brackets. They are set radially round a gun-metal ring bolted to a cast iron frame, which is divided into four sections, two being below the floor level. Each section is centred on end girders of cast iron, and can be readily swung back for inspection and repair of the coils. As the two halves of the armatures are connected in parallel, an equaliser is placed in one of the end girders. The field-magnets are of massive steel castings, with 60 pairs of polar projections, the over-all diameter being 12·5ft. The excitation is provided by a single central coil having two gun-metal collecting rings mounted on the shaft, which runs in large swivel bush bearings. The lubrication is effected by a continuous circulation of oil maintained by a pump worked off the shaft. The smaller alternator gives 75 kilowatts at 118 revolutions, and is similar in design to the large ones. The pressure is 2,000 volts, and the frequency 100 ∿. The exciting plant consists of two Brush-Falcon compound wound steam dynamos, each having an output of 12 kilowatts, either being capable of exciting all the alternators at the same time. Raworth's patent electric governors are fitted to these engines, and by means of a resistance in circuit the whole of the station can be regulated from one place.

As previously mentioned, one of the most interesting features of the station is the switching arrangement. There is no main switchboard, its place being supplied by a number of so-called switch pillars, which form the features of the Raworth interlocking system. Each alternator has a switch pillar containing a system of interlocked switches, which prevent the closing of the main circuit before the field circuit and synchronising circuit are closed, and also the opening of the field circuit before the main circuit is open. A synchroniser is provided for each of these pillars, and is in mechanical connection with the main switch. Conductors are taken from the four "alternator pillars" to a "dividing table," and from thence through separate switches to two "circuit pillars" containing double-pole switches, fuses, and ammeters for each of the two concentric feeders, which are laid into the limited area. Each exciter has an automatic switch pillar acting on a zero cut-out, and preventing the return of current on the exciter in case of accident to engine or dynamo, and also closing the exciter circuit when, and not until, the exciter has attained the proper pressure. There is also an "omnibus pillar" for dealing with the exciters, travelling crane motors and other circuits in the station. The travelling crane will safely lift 15 tons, and is operated by hand or by three electric motors, each controlling one of the three motions through worm gearing with rolling bearings. The switches are of the interlocked type, and are fixed in a cage below the crane.

The cables are all of the Fowler-Waring concentric make, being lead-sheathed and armoured with steel tape, excepting in the case of the high-pressure ring main in the limited area where, as the cables have been laid in 3in. iron pipes, no armouring is used. The outers of the system are earthed at the station through a switch at each of the "circuit pillars," so that each feeder may be disconnected from earth for testing. The two feeders running to No. 1 sub-station in Market street are each about 1·5 miles in length, and are 0·146 sq. in. in section. From No. 1 station the high-pressure mains are run round the limited area in a ring main 0·097 sq. in. in section, the cable, which is braided over the lead sheathing, being run in 3in. C.I. pipes. There are eight transformer stations in the ring, each with suitable switching devices, so that any section can be disconnected for testing or repairs.

The transformer stations have an internal measurement of 7ft. 6in. long, 5ft. 6in. wide, and 7ft. high, the sides and ends being segmental and rising 6in. The walls of the chambers are formed of good hard bricks in cement in two thicknesses with an inch space between. This is filled up with asphalte, which is continued under the floor and roof, thus making the whole perfectly water and gas tight. The roof is formed of rolled steel joists filled in between with cement concrete. The manholes have double doors, and iron steps are built into the inner skin of the walls. Ventilation is secured by an air inlet and outlet. The bell mouths of the tubes carrying both the high-pressure and low-pressure cables are caulked with vulcan cement, and a half-inch hole about a foot back from the wall of the chamber communicates with a ventilating flue. This arrangement allows of the escape of any gas which may find its way into the pipes. The transformers are of the Mordey-Victoria type, each being provided with a double-pole H.T. trigger switch in a C.I. lock-up box. The "secondaries" of the transformers are connected through double-pole switch fuses to omnibus bars in connection with the low-pressure network. All the transformers, switches, joint boxes and frames are earthed. The low-pressure mains have a sectional area of 0·146 square inches, and are laid direct in the ground. House connections are made by means of concentric armoured cables jointed with wiped joints protected by a T-shaped casting. The house service switch used is of a new form recently designed by the Brush Company. It includes a double-pole switch and fuse specially arranged for connecting a concentric cable service to separate house mains.

The plant has been at work since December 19th last, lamps equal to 6,000 8 c.p. being already connected. The price charged is 6d. per unit. The Corporation have organised an electric light fittings department, and have succeeded in securing the greater portion of the wiring and fitting that has been carried out in the town. The profit from this is to go towards reducing the cost of supplying electricity. No cables have yet been laid beyond the limited area, but the residential district, Stoneygate, will shortly be served. The authorised expenditure is £42,574, and of this about £33,000 has been spent up to date. The capacity of the present station plant is roughly 18,000 8 c.p., so that not more than one-third of the plant is yet utilised.

Mr. Alderman Lennard, the able and energetic chairman of the Gas Committee, to whom so much of the credit of the scheme is due, says he hopes to reduce the price to 4d. per unit as soon as the full output of the present plant is in demand. Until the Board of Trade returns for the first year's running expenses are made up, it will not be possible to form an exact opinion of the financial advantages of this scheme; but if the experience of the past three months be maintained, it would appear that the figures will come out all right. Also it would be out of place here to question the suitability of the plant, and still more so to emphasise the unfortunate experience which some of the Brush alternators have met with in London, Sheffield, and elsewhere. The Brush Company's officials are fully alive to the causes which led to their troubles and have apparently overcome them, since at Leicester the alternators and feeders are so arranged that parallel running is the normal condition, except during light load.

BELT AND ROPE TRANSMISSION TRIALS.

It was at the meetings of May 25 and June 25, 1893, in the course of an account of an investigation into belt and rope transmission (an investigation undertaken and published by M. V. Dubreuil) that the idea of making a series of comparative tests of the power absorbed by these two systems of transmission occurred to the Civil Engineering Section of the Société Industrielle du Nord de la France. M. Dubreuil, with a view to obtaining facts upon which to base his investigation, had asked the opinions of a large number of French and foreign constructors. Their answers were somewhat vague and contradictory, and they aroused amongst all a wish to have the

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matter exhaustively investigated. Thereupon M. A. Dujardin, an engine maker of Lille, who was present at these meetings, offered to supply at his own expense, for the purpose of a series of practical experiments, a 200-H.P. steam engine, to be fitted as required either with a rope or belt pulley of 4½ metres diameter. This offer was accepted, a Committee of five nominated, the number being increased to nine later on, and this Committee was authorised to apply to individuals, who although not belonging to the Société Industrielle, might be interested in the matter. This appeal was very successful, and on November 5, 1893, six gentlemen, chosen by outside adherents in general assembly, were elected by that assembly and added to the Committee appointed by the Civil Engineering Section. The committee from that time was composed of the following 15 gentlemen: M. Bonet, chief engineer of the Association of Steam Owners of the North of France; Prof. D. S. Capper, of King's College, London, and delegate of the Institution of Mechanical Engineers; M. Chapuy, mining engineer of Lille; M. de Cuyper, manager of the Van den Kerkove Works at Ghent; M. V. Dubreuil, engineer and architect of Roubaix, delegate from the Society of Civil Engineers of France, and of the Old Students' Association of the National School of Arts and Industry, president of the Civil Engineering Committee and of the Ropes and Belts Tests Committee; M. A. Dujardin, Engineer of Lille; M. Goerich, engineer, manager of the Société Alsacienne de Constructions Mécaniques of Mulhouse and Belfort; M. Gruson, chief engineer in the Ponts et Chaussées, and director of the Industrial Institute of Lille; Col. Laussedat, director of the Conservatoire des Arts et Metiers of Paris; M. Olry, mining engineer, delegate appointed by the Managing Committee of the Association of Steam Engine Owners of the North of France; M. Neu, electrical engineer, old student of the Ecole Polytechnique, Professor at the Industrial Institute of Lille and co-delegate of the Society of Civil Engineers of France; M. Schmidt, chief engineer to the Association of Steam Engine Owners of the Somme; M. Vigneron, manufacturing engineer and manager of the cotton mills of MM. Wallaert Frères, of Lille; M. Villain, engineer, of Lille; M. Witz, manufacturing engineer and science professor at Lille.

On February 5, 1894, the Committee met and adopted the following resolutions:—(1) The steam engine is to have a double flywheel or two flywheels, one for belts and the other for ropes; (2) the dynamo is to be direct-driven,* and provided with two pulleys, one for belts and one for ropes; (3) the dynamo is to be placed on a sliding bedplate to enable the tension of the ropes to be regulated at will; (4) the cotton belt is to be obtained from M. Lechat, of Ghent and Lille; the homogeneous belt from M. Domange, of Paris; the leather belt from M. Lemaire, of Tourcoing; the ropes from MM. Saint Frères, of Paris. The experiments are to be conducted by making on each occasion several alternative tests with ropes and belts. The tests being comparative, and the double flywheel enabling the Committee to work alternately with ropes and belts, it may be assumed that during the course of an experiment the mechanical efficiency will not vary, and secondly, there will be no necessity to ascertain what it amounts to.

Such, broadly, was the programme which the President of the Committee was to carry out, and to ensure success M. Dubreuil obtained the support of competent experimenters chosen from amongst the members of the Committee who were good enough to undertake the task, and of all these gentlemen who were good enough to consent to present various apparatus at the least cost in order to reduce as much as possible the expense of an installation which might have required an expenditure of 150,000fr. In the first category of supporters came M. Bonet, Profs. Neu and Paillot and MM. Loriol, Finet and Maréchal (electrical engineers) and M. Dujardin, who between them formed a staff of practical men whose competence is beyond dispute. In the second category came the Société Alsacienne, who laid down and superintended the working of a 200-H.P. dynamo, especially constructed for these trials, MM. Gabriel et Anguenault, of Paris, who supplied 1,800 incandescent lamps, M. Henneton, of Lille, who supplied 300 additional lamps; the Société Industrielle des Téléphones, who supplied the electric wiring; MM. Lazare Weiller et Cie., who furnished the heavy copper conductors; M. Sage et Grillet, who supplied the lamp-holders and accessories; M. Loriol et Finet, who superintended the general arrangement of the electric installation; and MM. Lechat, Lemaire, Domange and Saint Frères, who furnished the belts and ropes. These firms gave their services absolutely free. In addition should be mentioned the Compagnie du Chemin de Fer du Nord, who lent one of their large boilers, and MM. Dujardin et Cie., who supplied, not only the engine, the steam, and the site, but also discharged the incidental expenses of the installation. All this unhoped for support ensured the success of the experiments decided upon.

Carrying Out of the Tests.

In carrying out the experiments, the following principle was assumed as an axiom. Having given a constant resistance, and the power intended to overcome this resistance, all variation of power must be debited to the means of transmission, belt or ropes, which alone were capable of altering the *régime*. Such was the axiom assumed by the Committee, and such was the axiom practically made use of. The resistance was composed of incandescent lamps demanding a constant number of watts. The revolutions of the engine and the dynamo were counted, the dynamo being kept at a constant speed in all the trials, and indicator diagrams were taken when the load was steady.

Methods Taken to Maintain the Constancy of the Load.

One of the most important points was to maintain the load constant. This object was obtained in the following manner. Observations were taken throughout the trials to make sure that the difference of potential at the terminals of the bank of lamps, and that the current passing through the lamps was constant; in other words, that the number of watts absorbed by the lamps was the same in all cases. Measurements of difference of potential and current were made in M. Dujardin's office at a sufficient distance from the lamps and dynamos to annul any disturbing influences. The apparatus was lent by the physical laboratories of the Science Faculty and Industrial Institute of Lille.

To measure the difference of potential a Siemens and Halske torsion voltmeter was made use of. This voltmeter, which was carefully standardised, enabled one to read with great ease to ⅓rd and even to ¼th of a volt. The measurement of the current would have presented some difficulty, but as it was not necessary to know its exact value, but only to make sure that it remained constant, the operation was carried out in the following manner:—At two points about one metre apart on the main circuit two fine wires led to the terminals of a sensitive Wiedemann-d'Arsonval galvanometer. Readings were taken by Poggendorf's reflection method, and the sensitiveness of the method was such that it was found necessary to diminish the sensitiveness of the galvanometer in order to keep the spot on the scale. A switch enabled the direction of the current to be reversed, and consequently the direction of the deflection on the scale, enabling the correction of possible variations of zero due to the disturbance caused by the masses of iron in the neighbourhood of the apparatus. The difference between the two readings remained constant if the current itself remained constant.

It should be added that the trial measurements were not commenced until after everything had been in operation a certain time, that is to say, until the temperature of the wires had become as constant as possible.

Every ten minutes the constancy of the volts and amperes was verified. If the difference of potential was found to have varied, it was brought back to its normal value by adjusting the engine governor and altering the speed, the correction being completed by a regulation of the field. As soon as the volts were brought to their proper value and if a variation of the current was observed, this latter variation was corrected by switching lamps in and out on the bank, then indicator diagrams were taken.

Date of the Trials.

It was in the course of August 7, 8, 9, 1894, that the trials were carried out. Not only did the members of the Committee

* "Direct-driven" here implies, not direct-coupled, but the absence of countershaft or intermediate gear.—[ED. E.]

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take part in them, but also anyone who expressed a wish to do so. An August 9th the Committee met and drew up the following minutes, which prove the perfect regularity and success of the trials.

Trial of August 8th.

The morning of August 7th was occupied in carrying out the preliminary runs intended to initiate the assistants into their various duties, in order to ensure the subsequent complete regularity of the operations. The apparatus being new, the results might possibly have been vitiated if the actual trials had been commenced from the start. In the course of these preliminary runs it was observed that the electrical measuring instruments, which were placed in the erecting shop, were influenced by the movement in their vicinity of the masses of iron, and they were taken, therefore, into the office of M. Dujardin.

The work of carrying out the trials was allotted as follows:— (1) Boiler: This was looked after by a stoker belonging to the Compagnie du Chemin de Fer du Nord, who had instructions to keep the pressure constant at 6·75 kilogrammes (96lb. per square inch). (2) Steam engine: The taking of indicator diagrams and general superintendence was entrusted to the engineers of the Association of Steam Owners, who were under the direction of M. Bonet. (3) Dynamo: This was looked after by MM. Loriol, Finet and Maréchal of the Société Alsacienne. (4) Speed Counters on Engine and Dynamo: This duty was entrusted to the engineers belonging to the Association and of M. Dujardin's firm. (5) Lamps: These were looked after by the Société Alsacienne. (6) Electrical Measuring Instruments: The readings were taken by Profs. Neu and Paillot.

The general direction of the experiments was undertaken by M. Dubreuil, President of the Committee.

In order to ensure uniform trials the following programme was adopted for each run: (1) The plant was first run light for 30min.; (2) preliminary run, loaded, lasting 30min.; (3) then 10min. for regulation; (4) test, with 15 indicator diagrams, taken for 10min., trial lasting altogether for 140min.; (5) diagrams taken running light; (6) removal and weighing of the transmission gear.

In the evening of August 7th a test was made with ropes. No notice was taken of the first test, in which the voltage rose to 104, a further test at 94 volts being made. The trial commenced at 3:40 and ended at 6 o'clock. In the course of this trial the experimenters noticed that one of the speed counters had got out of order. During this first preliminary trial Profs. Neu and Paillot reported an absolutely steady voltage.

Trial of August 8th.

In the morning the cotton belt supplied by M. Lechat was tested. A start was made at 7:50, and the load was put on at 8:20. The actual trial lasted from 9:10 till 11:30. In the afternoon the leather belt supplied by M. Lemaire was tested. A start was made at 3:10, the load was put on at 3:40. The trial lasted from 4:30 till 6:50.

Trial of August 9th.

In the morning the leather belt supplied by M. Domange was tested. A start was made at 7:50, and the load was put on at 8:20. The trial lasted from 9:10 till 11:30. In the afternoon ropes were tested. A start was made at 2, the load came on at 2:50. The trial lasted from 3:8 till 5:30. The same constancy of voltage was obtained as in the other trial.

* To convert kilogrammes per square centimetre into pounds per square inch, multiply by 14·2. † To convert metres per second into feet per second, multiply by 3·3. ‡ 1 sq. cm. = 0·155 sq. in. § During this trial a revolution counter having omitted to count a certain number of revolutions, which is proved by the negative slip obtained, the figures in column 11 and 15 are minima. Taking the chronometer into account, these figures become respectively 162·95 and 78·49. It is to be observed, moreover, that the engine and dynamo were new, and had only been run previously for two hours, on the eve of the trials. The passive resistances were therefore considerable, as is shown, as a matter of fact, by the results of the fifth trial. ‖ During the last five trials the volts on the Siemens torsion voltmeter were 93·66 in lieu of 94·0, which gave an average of 93·88 for the power instead of 94·0 at the moments of taking the diagrams. ¶ Ten readings out of fifteen were taken at 93·75 instead of 94·0 volts; this gave an average of 93·83 for the power.

Recapitulatory Table.

	Date of trial.	Nature of trial.	Steam engine. Average ordinates in thousandths. High-pressure cylinder. Front.	Back.	Low-pressure cylinder. Front.	Back.	Indicated horse-power. H.P. cylinder. Front	Back	L.P. cylinder. Front	Back	Total I.H.P.	Time during which revolution counters were on.	Indications of revolution counter. Start.	Finish.	Av'rage revolutions of the engine per minute V.	Av'rage pressure Kilogrms. per sq. cm.*	Dynamo. Indications of revolution counter. Ratio 1/5. Start.	Finish.	Revolutions per minute v.	Ratio of the revolutions v/V	Ratio of the organs of transmission at the surfaces and lines of contact.	Linear velocity in metres per second at the circumference.† Fly-wheel	Pully	Slip % calculated according to Column 21.	Memoranda. Section of the ropes and belts in sq. cm.‡	Tension of the ropes and belts per sq. cm.	Average load.	Ratio % I.H.P./Power absorbed in lamps	Weight of the ropes and belts.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Ropes. §	1894. Aug. 7, afternoon	Manilla Ropes (Saint Frères)	16·931	18·336	20·730	21·422	37·16	40·85	40·73	42·86	161·60	hrs. min. 2 16	13·595	24·182	77·84	6·233	8·730	20·558	260·91	3·352	3·335	20·31	20·31	−0·051	10·33 sq. cm. × 5 sq. cm. = 51·65	k. 11·050 / 11·050	94·0	100/58	k. 190
Belts. ‖	Aug. 8, forenoon	Cotton Belt (Lechat)	17·106	19·022	19·700	20·360	38·14	43·00	39·33	41·35	161·91	2 31	5·226	17·163	79·05	6·287	28·165	41·306	261·08	3·303	3·329	20·65	20·49	0·780	450mm. × 9·5mm. = 42·75	12·380 / 12·47	93·88	100/87	151
	Aug. 8, afternoon	Leather Belt (Lemaire)	16·670	17·136	20·476	21·714	37·17	38·80	40·89	44·14	161·00	2 22	24·438	35·667	79·08	6·230	49·239	61·580	360·72	3·297	3·329	20·66	20·46	0·961	450mm. × 12·5mm. = 56·25	9·350 / 9·450	93·83	100/37	150
	Aug. 9, forenoon	Leather Belt (Dom'nge)	18·048	18·589	19·102	20·490	40·32	42·16	38·20	41·74	162·42	2 20	5·346	16·438	79·23	6·243	5·904	18·118	261·73	3·303	3·329	20·67	20·51	0·780	442mm. × 11mm. = 48·62	10·900 / 10·98	94·0	101/07	133
Ropes. ¶	Aug. 9, afternoon	Manilla Ropes (Saint Frères)	17·852	17·711	19·580	21·130	39·51	39·78	38·79	42·62	160·70	2 30	22·707	34·476	78·46	6·290	25·172	33·211	260·78	3·324	3·335	20·47	20·40	0·329	10·33 sq. cm. × 5 sq. cm. = 51·65	10·900 / 11·00	94·0	100/00	190

Diameter of the flywheel (5 45mm. ropes), 4·986m.; diameter of the flywheel (450mm. ropes), 4·993m.; diameter of the rope pulley, 1·495m.; diameter of the belt pulley, 1·500m.; distance between the axes, 9·200m.

For footnotes to table see preceding column.

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After the trials were finished the Commission met together under the Presidency of M. Dubreuil, when the above minutes were read and adopted. M. Bonet undertook to work out the diagrams and to furnish the Committee with his results in the shape of tables, and all the other gentlemen who had taken part in the trials were requested to send in their reports. The hearty thanks of the Committee were accorded to the various gentlemen who had given their assistance in one shape or another, and amongst others a vote of thanks was passed to the stoker for the manner in which he had kept the boiler pressure constant. M. Dubreuil stated that he would ask the Council of the Société Industrielle to strike a medal commemorating the trials which had just taken place.

The accompanying Table recapitulates the general results of these trials. If we examine this Table and neglect the results of the first trial, which did not yield anything certain, owing to one of the counters having got out of order, we shall find that for a constant resistance—

A. The ropes transmitted	160·7 H.P.	with a slip of	0·329	per cent.
B. The Lechat belt	„ 161·9 H.P.	„	0·780	per cent.
C. The Lemaire belt	„ 161·0 H.P.	„	0·961	per cent.
D. The Domange belt	„ 162·42 H.P.	„	0·780	per cent.

The diameters of the pulleys were taken at the surfaces and at the lines of contact. If we reduce these results to 100, and take into account column 27 of the Table, which shows the average load in each trial, we find that—

A. Ropes transmitted	100·0	with	0·1	slip.
B. Lechat belt „	100·87	„	0·237	„
C. Lemaire „ „	100·37	„	0·292	„
D. Domange „ „	101·07	„	0·237	„

Tension of the Belts.

During the trials the sliding base of the dynamo was not made use of for the ropes, but it was more or less employed for the belts, according to the wishes of those who supplied them who were allowed to regulate the tension whilst the trials were in full swing.

Conditions of Trial.

It is evident by the Table that the comparative linear speeds of the belts and ropes, and the pull per square centimetre demanded from the gear, were excellent and identical. Thus, for a linear speed at the point of contact with the pulley of—

20·4 metres per second (67ft.) the ropes transmitted a pull of 11 kilogrammes per square centimetre (156lb. per square inch);

20·49 metres per second (67ft. 6in.) the Lechat belt transmitted a pull of 12·47 kilogrammes per square centimetre (177lb. per square inch);

20·46 metres per second (67ft. 6in.) the Lemaire belt transmitted a pull of 9·45 kilogrammes per square centimetre (134lb. per square inch);

20·51 metres per second (67ft. 7in.) the Domange belt transmitted a pull of 10·97 kilogrammes per square centimetre (156lb. per square inch).

Constancy of Volts.

A peculiarity noticed in the course of the experiments was the steadiness of the needle of the voltmeter when rope-driving was employed, and the oscillation to the extent of one or two divisions when the driving was effected by belts. This oscillation, which at times rendered the reading difficult, corresponded exactly with the passage of the fastening. It did appear to affect the lighting. It shows, however, the necessity for good joints.

Cotton Ropes and various Belts.

Obliged to limit the number of trials, the Committee was not able to experiment on all the other materials proposed, and it decided to limit the trials to such materials as had had at least 15 to 20 years' commercial use. The Committee, however, regretted that it was not able, owing to a misunderstanding, to try M. Domange's homogeneous belt, which one of his representatives had offered from the first to place at their disposal.

Shape of the Pulley Rims.

The shape of the belt flywheel was according to the designs of the firm of Van den Kerkove, of Ghent, and those of the grooves to the designs of MM. V. Dubreuil and A. Dujardin, and were of the kind usually adopted for this kind of work.

General Working.

It should be observed that there was not a single accident during these trials. The dynamo, although new and only just out of the Belfort shops, ran as well as could possibly be desired and without interruption. Not a single lamp was burnt up or injured. The boiler, the fire of which was kept in a marvellous manner by stoker Louis Wagnez, of the Compagnie du Nord, the engine, in a word, all the mechanical apparatus worked to perfection.

Résumé.

The experiments show that ropes and belts well fitted absorb much the same amount of power. M. de Cuyper, however, applied a reservation to the figures in the recapitulatory table relating to the value of the belt slip. According to M. de Cuyper the thickness of the belts should have been taken into account in reckoning the diameters. If this be done the belts have a slip comparable with that of the ropes.

VARIATION OF INTERNAL RESISTANCE OF A VOLTAIC CELL WITH CURRENTS.*

BY HENRY S. CARHART.

It has long been known that the internal resistance of a voltaic cell, when at a constant temperature, has not a fixed and finite value, but that it is a function of the current flowing through it. The methods commonly employed to measure this resistance are not sufficiently exact to exhibit the relationship in question with satisfactory accuracy. But if the condenser method be employed,† together with certain auxiliary appliances to secure very brief and uniform closing of the circuit through different external resistances, while the potential difference between the battery terminals is measured within this short interval, then results can be obtained which plot as a smooth curve.

The resistance measured is a quantity satisfying the equation

$$r = R\frac{E - E'}{E'}, \text{ or } \frac{E}{R+r} = \frac{E'}{R} = I,$$

where r is the internal resistance, E the electromotive force of the cell, and E' the potential difference between the terminals when

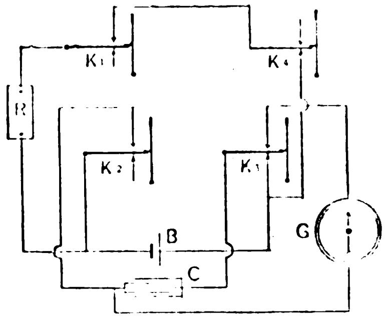

Fig. 1.

closed through an external resistance R. To determine the relation between r and I, the potential difference E' must be measured with different external resistances in succession. For this purpose, the operations of closing the circuit, charging the condenser, discharging through a ballistic galvanometer, and finally opening the circuit, must be done by some mechanical device by which all of them use be repeated in precisely the same interval of time. The disturbing influences due to absorption of the condenser and polarisation of the cell are then as nearly eliminated as possible.

For this purpose I have made use of a pendulum consisting of a long narrow frame pivoted at the top, and carrying a heavy bob at the bottom. The bob swings between two curved rails, concentric with the axis of suspension of the pendulum, and each rail supports two keys, which can be clamped on it in any desired position. A vertical lever on each key holds it closed on the lower contact; but when the pendulum sweeps over the rails it throws these levers over, and allows the spring keys to make contact on the upper point. The contacts are all platinum, and the base and pillars of the keys are hard rubber. When care is taken to adjust the

* From the *Physical Review*, Vol. II., No. 5.

† Carhart's Primary Batteries, p. 116.

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contacts properly, and to keep them free from dust, their performance is in every way satisfactory.

Fig. 1 shows the connections for the measurements in hand. Keys K_1 and K_4 are on one rail, while K_2 and K_3 are on the other. When the lever of K_1 is thrown forward while that of K_4 is up, the battery circuit is closed through the resistance R. When the lever of K_2 is thrown over while that of K_3 is up, the battery is charging the condenser C; but as soon as the lever K_3 is thrown over, the cell is disconnected from the condenser, and the latter is instantly discharged through the galvanometer G. The pendulum swings from left to right on removing a detent. If all the levers are up, it closes the battery circuit on reaching K_1, charges the condenser by throwing over lever K_2, discharges it through the galvanometer by means of K_3, and finally opens the battery circuit on passing K_4. The key levers remain forward out of the way of the pendulum bar as it swings back again to the detent. The keys can be set as close together as desired. The length of the pendulum is such that its period is a second. Hence the time during which the battery circuit remains closed can be calculated. To get the deflection proportional to the total electromotive of the cell, the levers of K_1 and K_4 are both left down. The pendulum then charges and discharges the condenser, the circuit through R remaining open.

The change of resistance with the current is exhibited in a marked degree by "dry cells." The table contains the data of a series of measurements on a Gassner cell, whose electromotive

d	d_2	R	r	I
271	258	400	21·1	0·0028
...	249	200	17·7	0·0056
...	238	100	13·9	0·0106
...	227	50	9·7	0·0203
271	223	40	8·6	0·0249
...	218	30	7·3	0·0324
...	212	20	5·56	0·0473
...	204	15	4·93	0·0607
...	194	10	3·96	0·0868
271	172	5	2·87	0·0538
...	164	4	2·59	0·1838
270	153	3	2·29	0·2289

force was 1·213 volts. The first column contains the deflections due to charging the condenser with the whole electromotive force of the cell, and it will be seen that the polarisation was inappreciable. The second column contains the deflections due to charging the condenser with the potential difference at the extremities of the cell when closed through the resistances in the third column. The fourth column contains the resulting internal resistances, and the last column the currents.

In Fig. 2 these internal resistances and the corresponding currents are plotted as co-ordinates. It cannot be objected that the relatively low resistances with the larger currents are due to polarisation; for, while it was demonstrated that polarisation did occur within the small time interval required for the pendulum to

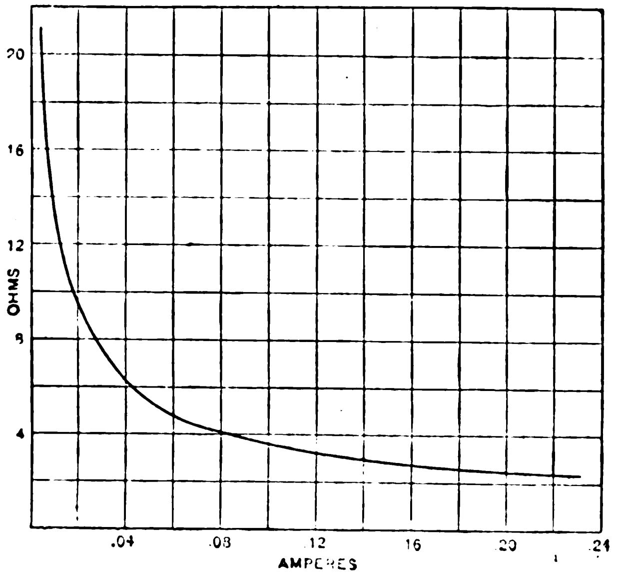


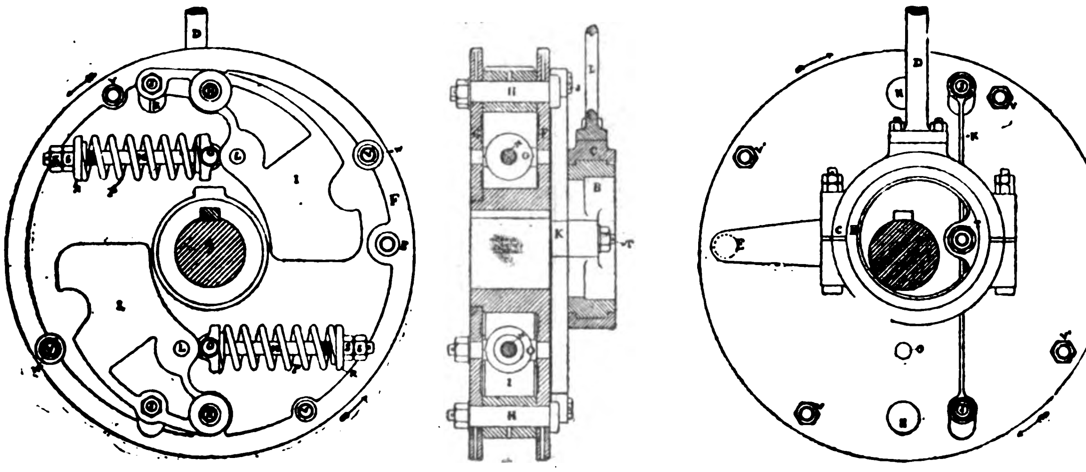
Fig. 2.

swing from K_1 to K_4, yet the effect of such polarisation is to diminish the potential difference between the terminals of the cell when on closed circuit, and this effect increases the computed internal resistance.

The Gassner cell was an old one, and its internal resistance was above the average; but other dry cells show the same characteristic curve, differing only in the relative values of r. A Daniell cell shows a similar decrease in r with increase in current, but the decrease is much smaller, and the curve is more nearly a straight line.

AUTOMATIC EXPANSION GEAR FOR HIGH-SPEED STEAM ENGINES.

The accompanying set of illustrations shows the construction of the automatic expansion valve gear employed by Messrs. J. P. Hall and Co. in their new steam-dynamo sets. It will be seen that the gear is actuated by a high-speed crank governor, the portion F of which is keyed to the shaft end, while the portion G is an annulus connected by bolts, and distance pieces V to F, leaving an intermediate space in which are contained the weights I and the springs M. The weights are pivoted at H, H, the upper one being provided with a tailpiece whereby the two weights can be connected together by the flexible bar K. Each weight has connected to it, by a stud L, an eyebolt round which is coiled the helical spring M. This eyebolt passes through a swivel lug O, pivoted and free to revolve in the discs F and G. The compression



Automatic Expansion Gear and Crank Governor.

of the springs can be adjusted to balance the tangential force of the weights within a certain variation of speed by means of the locknuts S. The flexible bar K is on the outside of the disc F, and is fixed on to the studs J on the weights. These studs pass through slots in the disc. At the centre of the bar is a forged eye that embraces a stud T on the eccentric B. The eccentric, which has a large eye to enable it to move

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relatively to the shaft has an extended ear pivoted to the disc at E. When the weights I, I move in or out, owing to variations in the speed of the engine, the flexible bar K shifts the eccentric to vary the cut-off. The governor can be used for either right or left hand by reversing the position of the parts. The cut-off is controlled by variation of travel of a single slide valve, the angle of advance varying with the load. Although this does not give ideal steam distribution, nor as perfect as in more elaborately designed expansion valves, it is possible that it answers its purpose for steam engines of small power.

THE EWING HYSTERESIS METER.

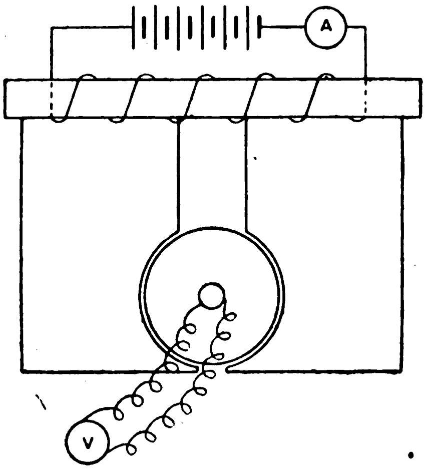
The following is an abstract of the discussion at the Institution of Electrical Engineers on Prof. Ewing's Paper on "A Magnetic Tester for Measuring Hysteresis in Sheet Iron." Speakers who have been good enough to return their proofs revised have their remarks prefaced by an asterisk. Prof. Ewing's Paper appeared in our last issue :—

*The CHAIRMAN (Sir David Salomons), after proposing a vote of thanks, said they had just heard a Paper which would have been most welcome to them three or four years ago, but it was better late than never. He was sure that those who were engaged in laboratories would find such an instrument as that described most valuable, but their appreciation of it would be as nothing compared with that of the manufacturer and engineer. He had recently seen a masterly report (by Prof. Fleming), showing the extreme importance of the quality of transformer iron, and it showed that if the shareholders in an electrical supply company got their bread when the iron was as at present, in the future they might expect to get their meat and dessert.

*Dr. J. A. FLEMING said it was impossible not to admire the ingenious and simple solution of a practical problem which Prof. Ewing had brought before them. He thought it possessed three important recommendations for a workshop method : in the first place it was independent of steadiness ; it worked with small samples, and in the next place it occupied a very short time. No doubt the apparatus had passed through many stages before it had been presented to the public, but he would like to ask Prof. Ewing why he preferred to revolve the specimen and not the magnet. At first sight it seemed the simpler thing to do to revolve the magnet. One thing easy to test in *that* form would be the effect of temperature on hysteresis. It must not be forgotten that the hysteresis losses in iron varied very considerably with temperature. In transformer tests he had found the differences of hysteresis loss in the transformer, taken quite cold and taken at 100°C., as much as 12 to 15 per cent. Then again, although this was not, of course, a suggestion for an improvement, it was an obvious variation to make the field revolve, which might be done in two or three different ways. Again, one would like to be assured that in the use of the instrument the brass clamps holding the specimens together did not have any eddy currents set up in them. It would, of course, be an important application of this instrument to assist to solve that question which had exercised the minds of many of them, whether there was a time increase in the hysteresis loss in iron by use. That had been discussed a good deal in the pages of the technical journals, and many experiments had been made on it. This loss certainly did not occur in all transformers, but it seemed that it did occur under certain circumstances in some. This could be tested by measuring the loss in portions of a transformer core at various times. If iron aged, not as port wine, by way of improvement, but by way of deterioration ; then it was not of much use to wrangle about very small differences at the core loss when large ones might be brought about by use. These were important practical questions, and any instrument which facilitated the solution of them would be of very great value. No one who had used ballistic methods in laboratories was in love with them.

*Prof. CAREY FOSTER said at first sight it occurred to one that it would be possible to deflect a magnet like that so delicately suspended by causing even a non-magnetic body, say, a piece of wood to revolve between the poles ; anything rotating between the poles acting as a fan. Another point was that time lag, or magnetic viscosity, would, he imagined, act on such an instrument like that in the same way as true hysteresis, and it was not obvious that this instrument would distinguish between the two effects.

*Prof. W. E. AYRTON said there was one thing which charmed him about this instrument, especially as it had been made by a Cambridge professor, and that was that an observer had simply to turn a handle ; the instrument, as they could see, had a slot, and if they possessed the necessary penny it achieved the desired result. Certainly if all one wanted to do in testing iron was to ascertain approximately the hysteresis, no better instrument than the one on the table could be used. If, however, one wanted to know the hysteresis for different inductions, was it quite right, as Prof. Ewing had said, to assume that the ratio of the hysteresis of different irons with different inductions was the same? He had rather implied in the Paper that it was so, but in his (Prof. Ewing's) own Paper, published with Miss Klaassen, irons which might be said to have the same hysteresis with an induction of 4,000 varied by 8 per cent. at an induction of 8,000, and by 12 per cent. at an induction of 2,000. There was another point which must not be forgotten, and that was that to the designer of a dynamo or of a transformer hysteresis was not all that he wanted to know. It might seem a roundabout way to measure the permeability if they only wanted to know the hysteresis, but if they wanted to know the permeability—and he did not see how they could make calculations unless they did—it did not seem a round about way of getting hysteresis loss by first measuring the permeability. Then came the question, Could they get the permeability of iron easily, or must they resort to the time-honoured ballistic galvanometer? In the beginning of Prof. Ewing's Paper he rather implied that they could not get the hysteresis quickly by first finding the relation of magnetism to magnetising force. That, however, if he might venture to say so, had not been quite his experience. Some years ago he wanted to see if it was not possible to make an instrument which would enable him to get the B-H curve quite quickly. His object in designing the instrument was to make something which would be acceptable to mechanical engineer students, some of whom worked in his laboratory. The mechanical engineer did not care particularly about the vagaries of a ballistic galvanometer, but appreciated dynamos and motors. So it occurred to him that the simplest plan was to make a little separately excited dynamo, and use the specimen required to be tested as the yoke of the dynamo. The sheet, or rod, to be tested was simply passed through the coil and clamped down, and formed, in fact, the yoke of the machine, which had been constructed under Mr. Mather's supervision (*see* Sketch).



There was an armature of the Paccinotti type rotated by a little motor at a fixed speed. Attached to the brushes was a voltmeter, and there they had the whole apparatus. The ammeter gave the magnetising current, and the voltmeter the corresponding induction in the iron, so that by merely altering the resistance they got in a few minutes a series of points in the B-H curve, which obviously might be obtained between any desired limits of plus and minus magnetising forces. The observation was not taken by the swing of a ballistic galvanometer, but by a perfectly steady deflection. It had the disadvantage, compared with Prof. Ewing's instrument, if they only wanted to know the hysteresis, that they had to take the area of the curve ; but if they wanted to know both the permeability and the hysteresis, then they got both easily. Of course it was not nearly so simple an instrument as the one on the table, and he repeated that, if they merely wanted to make fairly approximate measurements of hysteresis, the latter was certainly the better of the two.

*Prof. G. FORBES said that in transformer work there was no doubt hysteresis was the great thing to look after ; the permeability was good enough in a piece of iron that had little hysteresis. The instrument commended itself to them because it was a thoroughly practical instrument for testing samples that were being used in manufacture. It was essentially, he should say, not a laboratory instrument. While it was admirably adapted for the measurements they wished to make in the shops it was not, he thought Prof. Ewing would admit, the most refined instrument that could be obtained for laboratory work. He thought that Prof. Ayrton had hit upon a point as to the magnetic density. They could not very well trust to hysteresis being proportional in different specimens of irons at different densities. Owing to the enormous hysteresis variations with different samples of iron he presumed that Prof. Ewing considered it quite immaterial whether the strength of the field-magnet diminished with age, so long as it did not become really bad ; so long as it did not fall more that 50 per cent. or so, he supposed he would consider the result practically the same, because they must remember they were always comparing the sample with the standard sample, and that was rather a check on the calibration of the instrument. Dr. Fleming drew attention to the possibility of eddy currents in the brass work, and he (the speaker) would suggest that the eddy currents in the iron itself might possibly also be quite perceptible. If they were they would probably appear immediately upon considerably increasing the speed of the instrument, and if they could vary the speed very largely without altering the values so as to give very erroneous results, he thought that that source of error was probably of no importance. He did think, however, that he would prefer that explanation of eddy currents in the iron rather than the explanation Prof. Ewing gave as the reason why the straight line in Fig. 3, which covered the whole observations, did not pass through the zero. Obviously if the iron were perfectly without hysteresis there would be a certain amount of work done owing to eddy currents at the zero point; that would not be shown by the ballistic method, but would account for the deviation of the straight line from the zero point. The instrument was a perfectly beautiful one, and one for which they had been

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waiting for a long time. When he heard that Prof. Ewing was getting out such an instrument, and before he knew the method on which it was founded, he recalled the apparatus which Prof. Elihu Thomson made some years ago, and which, he believed, was being made by the General Electric Company of America. Prof. Thomson cut his sheet iron into circles and built them up into a small cylinder, mounting them on a pivot, retaining them in position by a spiral spring. He then rotated, as Dr. Fleming suggested, a field round the iron cylinder, and measured the deflections produced in the cylinder by the torsion due to hysteresis, the restraining force being the force of the spring and the deflection being proportional to the force required to overcome that.

*Mr. A. SIEMENS said he would remind them that he brought some results of hysteresis before the Institution three years ago, where the results were measured by the ballistic method; and he might say that they had still continued, and probably should continue, to use that method, although they would probably obtain some of these instruments of Prof. Ewing's. Prof. Ewing had himself said in the beginning of his Paper that specimens cut from the same plate might vary considerably, and he also said that the treatment of the specimen was of great importance. That was precisely what they had found—that if they wished to determine the hysteresis of any specimen they must not do anything with it. They dare hardly look at it, or it would change its hysteresis altogether. Prof. Ewing said that when he bent his strips into a ring in calibrating his instrument he had to anneal the ring to get back the previous state of the iron; but from experiments they had made he did not think they could get the state of the iron back again by annealing. They had had a very sad experience, and perhaps it might serve as a warning to others. They might remember that he spoke very hopefully of a cable transformer, a transformer to be made on the cable machine, where a strand of iron wire was to be made and spun round with the primary and secondary conductor. They found that it was simply impossible to make this cable transformer sufficiently good as regards hysteresis, because however good the individual wires were which were received from the manufacturers, the mere fact of laying them up in a strand, the mere manipulating of them spoiled them, and the hysteresis increased to such an extent that these cable transformers were of no use whatever. He spoke of this because he wanted to point out what he considered was the only drawback in this instrument, and that was the filing of the specimens. He was perfectly certain that if a millimetre, more or less, were filed, it would at once make the results of the readings quite different. As he said at the commencement, as a rule if very accurate scientific results were required, the ballistic method was the safest. Now Prof. Ewing had reproached that method with being slow and not easily performed. Of course, if they took the man in the street and asked him to take readings on a ballistic galvanometer, they would not succeed; but if they took people who had been educated as electrical engineers, who had passed through the electrical testing room, and who knew how to read a galvanometer, they could make those tests very quickly, and he would say that with the apparatus as arranged in his firm's works the readings of a specimen could be completed in half an hour.

Mr. S. Z. DE FERRANTI said the beauty of the instrument shown and its perfect adaptability for the purpose for which it was most generally required, namely, the testing of transformers, so much impressed itself upon his mind that he was immediately seized with a desire to know where it was made, where it was on sale, and how much it could be bought for; but this idea was rather dispelled when Prof. Ayrton came along and showed them another instrument. He immediately thought it might be necessary to have both. He thought, however, from the various remarks made by the different speakers, that the instrument which Prof. Ewing had shown, coupled with the accurate means of reproducing samples without varying the class of treatment, would serve the purpose most perfectly for everything one could want in the way of transformer work. He would suggest it would be more accurate to properly stamp the sample than to cut it, which involved a certain amount of bending.

*Mr. W. B. ESSON said he thought it was only a manufacturer who could appreciate at its true value an instrument like Prof. Ewing's. Although it was very true, as Prof. Ewing would admit, that it did not give tests of the same scientific accuracy as the ballistic method, he could conceive no instrument more adapted for rapid pass tests of bulk iron, such tests as were required in the factory.

*Mr. F. G. BAILY said he had been trying some experiments with a rotating magnet for a somewhat more scientific purpose than that of Prof. Ewing, and it was with considerable disappointment that he found that Prof. Ewing had applied the principle so satisfactorily for a useful purpose, whereas he (the speaker) had not. There were one or two points about which he should like to make inquiries. As regards the immaterial thickness and size of the plates, it was quite easy to see how the induction of the iron stayed constant, but he could not quite see how the total hysteresis in that sample stayed constant. He would like to ask Prof. Ewing whether he had considered the effect of self demagnetisation while the sample was at right angles to the poles of the magnet. When it was away from the poles, before it got to the other poles, it must demagnetise itself; it was only a short piece of iron, and there must be a certain amount of demagnetisation, and therefore the repulsion when it got to the opposite pole would be diminished, the decrease depending on the retentiveness of the iron, and he thought that was a possible explanation of the variation of the line in Fig. 3.

*Mr. A. P. TROTTER said he did not quite understand whether or not Prof. Ewing annealed the specimens. The specimens seemed to be so much smaller than those used by most people in testing iron, and he thought that the hardening of the hedges by shearing ought to be allowed for.

*Prof. EWING, in replying, said Dr. Fleming had asked why he had selected a form in which the specimen revolved rather than the magnet. The point he mentioned was a very important one, and was, in fact, very carefully considered in the early experimental stages of the instrument. At one time it had been definitely decided to use a revolving magnet and a fixed specimen. If the specimen were made to be the stable body, which indicated a deflection through the rotation of the field-magnet, then, of course, it would be necessary that the specimen should always have precisely the same amount of mechanical stability. Now, in putting specimens into a carrier it was not a little difficult to ensure that they would have always the same amount of mechanical stability. The stable part should be a thing which did not have to be handled, and the parts of which did not have to be varied. That was the principal thing, but there were several other minor considerations into which it was not necessary to go. Another point which had been raised by Dr. Fleming, and also by Profs. Carey Foster and Forbes was the influence of eddy currents and fan action on the deflection. As regards fan action, one could easily see that there was no material effect by turning the carrier round when the specimen was one of wood or vulcanite. After all, the magnet, although it had not a large amount of stability, was not so very delicately poised as they might think. As regards eddy currents, he thought he had mentioned sufficiently fully in the Paper that when the speed of the revolving sample was increased, even to the extent of about doubling it, beyond the speed necessary to get a steady reading, they did not find any appreciable increase in the amount of the deflection, and to his mind this was quite sufficient proof of the unimportance of the eddy currents, seeing that their effect would increase in proportion to the square of the speed. He should add that the brass work was made with the view of diminishing eddy currents in it as much as possible. Dr. Fleming spoke of the laboratory uses of the instrument, and he was very glad he had done so, because several others seemed to be rather under the impression that it was a workshop instrument, and nothing else. Primarily, of course, it was a workshop instrument; but he must confess that during the last two months he had found it a very interesting laboratory instrument as well, and he thought it would be found so by others. Only the other day the manager of a central station asked him to test a sample of iron taken from an actual transformer used in the station system for several years. He was distinctly unwilling to apply the ballistic method to it, on account of the time required; but in a few minutes he had cut this iron into a number of strips, put them into the machine, tested them, and found they were very bad indeed. He then had the curiosity to anneal these same specimens, and the effect was to remove just 49 per cent. of the hysteresis, leaving 51 per cent. of it. Whether this meant that that particular iron had been put into the transformer unannealed, as was probably the case, or whether the use of the transformer during the years it had been employed had had the effect of deteriorating the iron to that extraordinarily large extent, he was unable to say. That was only one question which might be cited to show that there were many questions that might be quickly and easily answered with an instrument of this sort which could scarcely have been answered in any other method of testing, except by a much larger expenditure of time and trouble, and he looked forward to making inquiries into a subject which had engaged the attention of Mr. Mordey and others—the influence of prolonged heat on iron. A point mentioned by Mr. Siemens was whether successive annealings of iron always brought the iron into the same physical condition as regards hysteresis. His own experience was that as long as the annealing was done in the same way, by holding the specimen in a gas flame for a few minutes and by cooling in the air, it did produce the same result each time, but he could quite believe that annealing in a furnace and keeping the iron hot for a long time might have a very different effect indeed as regards hysteresis from that which annealing in a small gas flame would have. Prof. Ayrton was quite right in saying that the ratio of the hysteresis at various inductions was not absolutely the same in all specimens of iron. He (Prof. Ayrton) had quoted some figures which the speaker at that moment was unable to verify, from the Paper published jointly by himself and another some years ago. The 8 per cent. alluded to, he thought, must have been between extreme cases, and not between the general mean and any individual case. The general mean table of figures which he had given that night was an embodiment of a much larger number of tests than those mentioned in the Paper referred to by Prof. Ayrton. It included a large number of somewhat recent tests, and referred more particularly to transformer iron, and not to other sorts of iron. Again, Prof. Ayrton had said that the hysteresis was not all that was wanted. Now, as regards transformer work, he ventured to think it was hysteresis that was wanted, and practically nothing else. It was true that there was no very precise relation between hysteresis and permeability beyond the fact that if they had a sample with very little hysteresis they might safely take its permeability for granted: that expressed the general position of the transformer maker. Prof. Ayrton described a convenient instrument of his own and Mr. Mathers, which might very possibly facilitate the testing of iron if one wished to get the B-H curve and measure its area in a manner similar to the ballistic. Prof. Ayrton said that if they took the B-H curve the thing was done. It was not done at all. When they got the B-H curve, after a good deal of solid work, they then had to take the results home and reduce them to absolute values, draw the curve, and measure the area. That method did not commend itself if the information that was really wanted could be got by turning a handle. He was very much interested in Prof. Forbes's notice of Prof. Elihu Thomson's instrument, which seemed to be of a very similar character to the experimental apparatus used with such remarkable success by Mr. Baily in establishing his very important discovery regarding the disappearance of hysteresis in a revolving field at very high inductions. Mr. Siemens raised a very important point in saying he would hardly dare look at a specimen without altering its hysteresis. It was perfectly true that it was most difficult to deal with iron in any way without producing some effect, sometimes a large effect, on its hysteresis. He thought probably anyone who wanted to use this instrument would punch his specimens to the exact size he wanted, and treat them in the same way as

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transformer stampings were themselves treated. But Mr. Siemens seemed to exaggerate the difficulty of preparing the samples. Many of those samples were not annealed after being cut, and were not materially deformed in cutting. The samples which had to be tested should as far as possible be tested in the same state as the stampings they were intended to represent, and should be subjected to the same treatment.

PARLIAMENTARY INTELLIGENCE.

SELECT COMMITTEE ON THE TELEPHONE SERVICE.

The Select Committee resumed its sittings after the Easter recess on Friday, Mr. Arnold Morley, the Postmaster-General, presiding. At the outset of the proceedings the Chairman announced that the Committee had decided to postpone taking expert evidence until after the general evidence had been given.

Mr. W. H. DICKINSON, Deputy Chairman of the London County Council, gave further evidence as to the views of that body in regard to the Agreement between the Telephone Company and the Government. After lengthy observations bearing on the Agreement and therefore strictly speaking outside the scope of the Inquiry the WITNESS proceeded to complain that the telephone system in London was certainly not good, which was admitted some time ago by the Chairman of the Company himself, though no doubt since then it had improved. Complaints had been very generally made about it, and he handed in a letter recently received from the Vestry Clerk of Battersea. The result was that the telephone system was not taken up in London to anything like the extent that it was taken up abroad. In London there was only one subscriber to 540 of the population; in Edinburgh, 1 to 240; in Amsterdam, 1 to 237; in Rotterdam, 1 to 214; in Brussels, 1 to 192; in Paris, 1 to 187; Rome, 1 to 180; Vienna, 1 to 177; Dresden, 1 to 84; Copenhagen, 1 to 83; Berlin, 1 to 66: Christiania, 1 to 36; Zurich, 1 to 33; Stockholm, 1 to 22; in fact, London stood well ahead of the principal towns of Europe in deficiency of telephonic accommodation.

The CHAIRMAN: Do you think that is at all due to the fact that London has a far better telegraphic and postal service?

The WITNESS said it was due to two facts—first, that the telephone service was not so good in London, and also that it was more expensive. In London the charges were £20 subscription per year, or £17. 10s. for a five years' agreement, and with this he proceeded to compare the charges in other Continental towns, but

The CHAIRMAN said that information was already before the Committee.

Sir J. GOLDSMID asked what were the charges in American towns.

The WITNESS said that in the American towns they were much more expensive. In New York, he believed, the charge was £30, and in Chicago, too, it was very high. In order to ascertain for how little it could be done in London, the Committee of the Council had obtained separate reports from Mr. Binnie, their engineer, and also from Mr. Newland, a telephonic engineer, and Mr. Bennett. Mr. Binnie's report was that a service could be supplied to 10,000 subscribers in London at a capital expenditure of something under £400,000, the annual charge on which, including the redemption of capital, would be covered by a charge of £10 to each subscriber. Mr. Newland's report was that the capital expenditure would be £366,000, representing an annual charge of £75,398, which would work out at less than £10 a year. Mr. Bennett's report made the annual charge, including redemption, renewal, depreciation, and royalties, £76,793. That was intended to cover the area of the County of London—not outside.

The CHAIRMAN: That would be a much smaller area than the National Company now supply.

The WITNESS: Yes; it was within what was called the London district, extending to Kingston. The Council having arrived at that point, therefore thought that London ought to be served with telephones at £10 a year subscription.

The CHAIRMAN: I suppose you are aware that a large portion of London is telephoned at £10 a year now; that is, that private houses on a five-years agreement get their telephones at £10 a year?

The WITNESS said that he was under the impression that that was only where the subscriber had an instrument of his own. Having investigated the accounts of the Telephone Company, the Committee came to the conclusion that the reason, to a great extent, why the charges were so high was the very large capital of the Company. On December 31, 1894, it was £4,419,455. The proportion of gross revenue from rentals had very much changed of late years. In 1889, when the capital was £864,000, the gross rentals amounted to 40 per cent. of the capital expenditure; in 1893 they were only 15 per cent. In the United Company, in 1887, the rentals were 44 per cent. of the capital expenditure in London, the United Company having been almost exclusively confined to London, but after the amalgamation the rentals only represented 15 per cent. of the capital expenditure. He compared that with Christiania, where, with a charge of £4. 8s. 11d. per annum, their gross rentals amounted to 26 per cent. of the capital. London was placed in a much worse position by the amalgamation; if the United Telephone Company had gone on working as it was then, London might have expected some diminution in charges. The year before they amalgamated the total profit of the Company was £94,264, which, on their nominal capital of £900,000, was 14 per cent.; but as the National Company paid £1,484,000 for that £900,000 worth of shares, it was now represented as a capital of £1,484,000, paying a dividend of something under 5 per cent. Therefore, instead of two companies doing good business, they had an enormous Company paying a dividend of only 5 per cent., which was not likely to give any reduction in its charges. The only way to bring about a reduction of charges was again to place the National Telephone Company under some kind of competition, but the effect of the agreement was to do away with competition.

The CHAIRMAN: Whereas competition in the past has brought the National Telephone Company into a position which necessitates their making heavy charges, you would reintroduce competition in order to reduce them.

The WITNESS said it depended upon what the position of the Company would be in 1911, and competition would undoubtedly result in the Government being able to take over the telephone system at a sum which would not be exorbitant.

The CHAIRMAN: Or rather two telephone systems.

The WITNESS said there would be nothing to oblige the Government to take them over unless the people wanted better accommodation, and that would be given by taking over one system. He contended that if the National Telephone Company was to go on with the benefit of the Agreement, any other authority who said they were ready to do it at no unreasonable expenditure should have the permission of the Post Office to carry out a telephone system.

Replying to Sir James Fergusson, the WITNESS stated that in the event of municipal licenses being granted the municipal exchanges should be placed in connection with the National Telephone Company's exchanges in different towns, and he quite agreed that the Company should receive some payment, but the question of terminal charges should be left to agreement.

In reply to Mr. Snape, as to the service which would be rendered on the estimates which the Council had obtained, the WITNESS stated that the service would be within a restricted area, and though it was probable that they would take in places like Kingston and Epsom, they would have to make a higher charge for those places, and treat them as if they were on the trunk lines. The amount of telephonic business done inside the County of London was vastly large in proportion to that done in the outlying places of the metropolis. In the estimates way-leaves had been taken into consideration, but a good deal of the wires would be underground, and no way leaves would then be paid. An entire underground system, he understood, would be much more expensive.

Mr. SNAPE asked how it was that a company started in Manchester could work at £5, and the most favourable estimate the Witness could produce for London was £10.

The WITNESS said the question of way leaves in London was a serious matter, and altogether it would be more expensive.

Sir JAMES FERGUSSON said he did not know how Mr. Snape got at the figure of £5 for Manchester. He had just come from that town, and they told him there that the charge was £10.

The WITNESS said that the charge of £5 was that of the Mutual Company. In further reply to Mr. Snape, he stated that the more powers the National Telephone Company got the more expensive it would be to buy them in the end. He was quite agreeable to other Corporations outside London having powers to provide telephonic communication.

Mr. RANDALL: What you contemplate and desire is that the London County Council should have a telephone system in London?

The WITNESS said that he was not at liberty to say that the Council desired, but it was his own personal opinion that it would be desirable, if anything was to be done to prevent a monopoly, to have competition from municipal authorities. Within the four-mile radius from Charing-cross there were 7,000 subscribers, and 95 per cent. of the metropolitan subscribers were within the six-mile radius.

Sir JULIAN GOLDSMID pressed the Witness as to whether he represented himself or the Council when he expressed the wish to have municipal telephones.

The WITNESS said the Council had not come to that conclusion. The Council were not the road authority in London, and would, therefore, have to get permission to break up the roads as well as to fix wires to private houses. If municipal licences were granted to twenty places he did not think it would be more difficult for the Government to take over the telephones; they would have to make 21 contracts instead of one, and for that reason they would do it cheaper.

Replying to Sir C. Cameron, the WITNESS said that the system of the National Telephone Company had not been so skilfully laid out as a new system could be laid out; and, assuming a private company or the municipality laid out London for telephone purposes with careful design, when the Government came to take over the system it would make a better bargain by taking over the new company. In fact, that was what he meant by saying competition would be useful. He was in favour of the Government taking over the telephones, but he did not think that question had been considered by the Council. He thought the competition between the telephone and the telegraph was keener in London than elsewhere. The idea had not occurred to him of the possibility of the Government taking over the telephone service for London without waiting till they took over the service for the entire country. He believed all the three estimates he had quoted were based on different systems, but they contemplated absolutely the newest instruments and twin wires.

Sir C. CAMERON: You would give them the newest system of wiring, the newest transmitters, and probably time-meters, to allow a man to pay a certain fundamental charge, and then pay so much for every five minutes he used the instrument.

The WITNESS said he could not say if that would be so. Competition in Birmingham, Manchester, Liverpool, and London would compel each company to give the greatest facilities and accommodation that could be obtained. Assuming the Post Office adopted the policy of encouraging competition, with a guarantee against buying up the companies, he thought that might meet the purpose.

In reply to Mr. John Ellis, the WITNESS stated that the County Council had not received any evidence as to the inadequacy or inefficiency of the service before arriving at its conclusions, but it was the general feeling that it was inadequate

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Mr. JOHN ELLIS: In Parliamentary Committees we require something a little more definite than that.

Replying to the Solicitor-General, the WITNESS said that he contemplated that municipal licenses should be granted for a term of years and not permanently, and he thought it advisable that they should be terminable at the same date as the Agreement with the National Telephone Company. Even if the licence was granted, the County Council would have to go to Parliament for statutory powers.

Sir E. CARBUTT, as a member of the Council of the London Chamber of Commerce and of the Special Committee appointed to consider the telephone question, said that the Chamber consisted of 6,000 members, and though at the present time Sir Albert Rollit, M.P., who was President of the Chamber, happened to be a Director of the Telephone Company, he had taken no part in the discussions on the question. The gentlemen who formed the Committee were, besides himself, Mr. Emile Garcke (Chairman of Committee), Chairman of the Electrical and Allied Trades Section of the Chamber, Managing Director Electric and General Investment Company; Major S. Flood-Page. Director of the Edison and Swan United Electric Light Company (Limited); Major-General C. E. Webber, C.B., Chelsea Electric Light Company, Past President of the Institution of Electrical Engineers; Mr. A. R. Bennett, New Telephone Company (Limited); Mr. James Chambers, Vice-President of the Chamber; Mr. Henry Clarke, L.C.C., Messrs. Mander Bros., Gracechurch-street, E.C.; Mr. R. E. Crompton, President of the Institution of Electrical Engineers; Mr. W. E. L. Gaine, General Manager, National Telephone Company; Mr. David Howard, Messrs. Howards and Sons, Stratford, E. The resolutions at which the Committee had arrived were as follows:—

1. *Acquisition of Telephones by the Government.*—"That this Chamber, whilst favouring private enterprise, is of opinion that if greater development of the telephone service which the commercial community demands can be better secured by the State acquiring and working the whole system of telephones, then this Chamber would approve the adoption of such a course."

2. *Validity of Telephone Agreement.*—"That the late Chancellor of the Exchequer and the present Chancellor of the Exchequer having in their places in Parliament stated that the Agreement between Her Majesty's Post Office and the National Telephone Company was a binding agreement, it would be useless and a waste of time on the part of this Committee reopening the question at present."

3. *Competing Systems.*—"That properly controlled competition should be encouraged providing that intercommunication between different systems covering the same area can be satisfactorily arranged and subject to the Post Office authorities deciding after due and adequate inquiry that the public can be better and more economically served than by the existing arrangements."

4. *Standard Regulations.*—"That in the opinion of this Chamber it is desirable that standard regulations should be drawn up by a Government Department for the guidance of Local Authorities in determining the conditions to be imposed by them as a preliminary to their consent being given to telephone companies obtaining statutory powers."

5. *Varying Rates for Limited Services.*—"That the desirability of developing the principle of varying rates for limited services should be emphasised by the evidence before the Select Committee."

6. *Unprofitable Areas.*—"That in granting licences precaution should be taken to avoid the neglect of telephone service in relatively unprofitable areas."

He urged that the service should be so extended by the granting of powers in restricted areas, that in the residential districts, where people could not afford to keep servants to go out and do their errands, they should be connected with the shopkeepers and pay 3d. a day, or 2s. a week, for the use of the telephone. At the present time a tradesman had to send his cart round and wait for orders, and there was a large loss of time. Then in the agricultural districts a number of farms might be connected with a central creamery, and it was estimated that 20 farms might be so connected at a cost of £100. In the grant of new licences precautions should be taken against the profitable areas alone being occupied and the unprofitable areas being left without a service; but, of course, such conditions could not now be arbitrarily imposed upon the National Company, which had its licence for 17 years. He did not suggest that the persons living within the "profitable" areas should pay extra so that those in the "unprofitable" areas should get the benefit of the service; but upon being pressed by Mr. Ellis said he did not see how it could be done otherwise. What they proposed was to leave it to the Postmaster-General when a company applied for a certain district to say that both the profitable and unprofitable areas of that district should be supplied.

Replying to Mr. Randall, he said that, as far at he knew, the Chamber of Commerce had never applied to the National Company to reduce its rates. They wished also to adopt the principle adopted in the Light Railways Bill of avoiding going for an Act of Parliament or a Provisional Order, giving the County Councils power to arrange the matter. Of course, the question would ultimately rest with the Postmaster-General and the Board of Trade. He would not like to give an opinion as to whether the charges made by the trunk lines were excessive.

In reply to the Solicitor-General he said that by the resolution as to varying rates it was contemplated that in the same area there might be different grades of subscribers, so that one man might be able to telephone within a distance of one mile and another within a distance of two miles; one set of subscribers in a suburb like Balham might be able to telephone to the local butcher, and another set might be able to telephone to London.

The SOLICITOR-GENERAL: Have you considered at all all the inconveniences which would arise in the administration of the service under those conditions?

The WITNESS said that it was present to their minds that there would be inconveniences, but they did not discuss them. He admitted that there would be very serious inconveniences. In their third resolution they thoroughly appreciated the difficulty which would arise in competition as to intercommunication between different systems, and they discussed that question over and over again, but they had not been able to solve the difficulty.

The CHAIRMAN asked, with reference to the question of profitable and unprofitable areas, whether the Witness was aware of applications having been made to the National Telephone Company to provide telephones, and of those applications having been refused in consequence of the area being unprofitable.

The WITNESS said he had no knowledge of any, and it was only with reference to future schemes that that resolution was put in.

The CHAIRMAN: Would that not result in a new company being seriously handicapped in its competition with the National Telephone Company?

The WITNESS: Not more so than the National Telephone Company is handicapped when it has an unprofitable area. With a smaller capital no doubt even a new company would be able to compete with the National Telephone Company.

The CHAIRMAN: You think the advantage derived from having a smaller capital would compensate for the disadvantage of having an unprofitable area?

The WITNESS: I think it would.

Major FLOOD-PAGE, a member of the Special Committee of the Chamber of Commerce, also gave evidence stating that there was a great deal of divergence of opinion among the members of the Committee, and the resolutions agreed to were a compromise. There was very little difference of opinion on the fourth resolution, but the subjects involved in the others were matters of hard discussion. The governing principle of the first resolution was that they felt that everything should be done for the development of the telephone by the State, which held the monopoly. The telephone had developed enormously in the last 16 years, but when they compared the progress it had made in other countries we were far behind many other parts of Europe in the application of electricity. During the next 16 years no doubt it would increase immensely, and the commercial community, including the small traders, would derive advantage from it; and the view of the Committee was that if the development could be better secured by the State doing it, then they would approve of the State doing it.

The CHAIRMAN said that he understood that the Committee had not expressed any decided view in favour of competition, but that its approval of competition would be subject to the two considerations stated in the resolution.

The WITNESS stated that that was a matter of great controversy, of which the resolution was the outcome. If the Post Office, after due and adequate inquiry that the public could be more economically and adequately served by competition under control, which should guarantee satisfaction, they would entirely approve of it; but if that could not be obtained they would leave it where it is. They thought it of very great importance that standard regulations for the guidance of Local Authorities should be drawn up so that there might be a uniform system all over the country. In considering the question they had assumed that the Agreement between the Company and the Government was an existing and binding one, and he did not suggest that the standard regulations should be arbitrarily imposed upon the National Telephone Company, which at present had its licence for 17 years. All the suggestions were alternatives to the Government themselves acquiring the telephones. As to the question of varying rates it was a matter of notoriety that there were at present varying rates; there were something like ten or a dozen places in London where they had a different rate for local service, and if there was competition that system could be very much extended.

The CHAIRMAN: But would you suggest, even without competition, the National Telephone Company might be induced to extend the service in that direction?

The WITNESS said that it was a matter of common knowledge that nearly the whole of the south of London was dealt with in that way. He contemplated that the telephone would in the future be considered as much a necessity as gas, and therefore he thought if an area was handed over to an Authority or Company, it should not be allowed to pick out the profitable portions and leave the unprofitable portions unserved.

The CHAIRMAN: Do you mean that there should be a uniform system of telephones supplied to every applicant at a uniform price at his own house, or that facilities should be given in the shape of a call station within easy reach?

The WITNESS said it was not for him to say in what shape the facilities should be given, but they contended that some facility should be given to a man to use that for which he was called upon to pay. They also considered that no one should be permitted to take out a licence, and then to drop it, but should come under an obligation to carry it out. The community had suffered very much from that in connection with the electric light.

Replying to Mr. Snape, the WITNESS said there should be means of intercommunication between different systems covering the same area, and means of getting on to the trunk wires, but they did not lay down any plans as to how that was to be carried out.

Mr. H. M. BATES, principal clerk in the office of the Commissioners of Sewers, also gave evidence, complaining, from his own experience, that the service in London was very inadequate and defective; the general opinion was that the single-wire system was radically wrong, and that the defects were caused to a great extent by circumstances over which the Exchange people had no control. To show the view held by the Commissioners of Sewers, he stated that in 1893 they had before them an application to consent to a proposal to apply to the Postmaster-General to establish a

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first-class double telephone service, and they resolved to allow certain tubes belonging to the City of London Electric Lighting Company to be used on condition that double wires, and all the latest improvements should be supplied at £8 per annum, and the negotiations with the Electric Lighting Company for the use of the tubes were still pending. On the 26th of last March the Streets Committee passed a resolution affirming that the provision now made for the telephone service in the City of London was inadequate, and that telephones should be supplied at a rental not exceeding £10 per annum. They arrived at that price after comparing the charges made in the United Kingdom and in foreign countries, but it was not based on any actual investigation.

Replying to Sir Charles Cameron, he said the Commissioners had not expressed any opinion on the question of applying for powers themselves, or on the question of competition. Their only interest was to get a service as good and cheap as possible.

In reply to the Chairman, he said that the use of the tubes could not be granted without the sanction of the Board of Trade. He could not express any opinion as to whether they were laid in the right direction for telephone purposes, or whether the tubes themselves were suitable for that purpose.

The Committee held another sitting on Tuesday, Mr. Arnold Morley again presiding.

Mr. BERRIDGE, a member of the Streets Committee of the Commissioners of Sewers, was examined with reference to his experience as regarded the efficiency of the service. In reply to the Chairman, he complained that it was very inefficient, as the lines were frequently blocked, and at other times they could hear other people speaking. His own instrument was three-quarters of a mile from the exchange.

The CHAIRMAN: Did you learn from the Company that there was a difficulty in getting a junction wire?

The WITNESS replied in the negative; he was simply told that the line was engaged. Up to last year he paid £20, but he had now got a five years' agreement at £17. 10s. a year. If he wanted an additional wire to his private house, they would charge £12 per year extra. It was his opinion that the charges were excessive; they paid the same rate now as they did 12 years ago, notwithstanding all the improvements. The New Telephone Company supplied at £13 a year.

The CHAIRMAN: They did not actually supply it.

The WITNESS: No, because the National Telephone Company, in their wisdom, bought them up.

The CHAIRMAN asked if he was aware that the larger the number of subscribers the greater was the cost to the Company, and therefore that they were obliged to charge more?

The WITNESS said he thought the greater the number of subscribers the greater the profit, for if a man increased his business the greater the profit. He had no evidence to give on behalf of the Commissioners of Sewers, except that they were very anxious to have a good service at a reasonable rate, and that they had passed a resolution that they thought £10 would be a reasonable rate, in connection with allowing the use of the tubes of the Electric Lighting Company. He was not aware whether those tubes were suitable for telephone purposes, or whether their position or direction was suitable for exchange purposes.

The CHAIRMAN: Are the Commissioners of Sewers contemplating a system of their own, and asking for a licence?

The WITNESS said they did not, but they certainly thought they should have a right to apply for one. At any rate, he considered they should have an absolute veto as to the use of the streets, but he preferred that the Government should take over the whole concern.

The CHAIRMAN: Would you contemplate with satisfaction the City of London taking over a licence for the City and the London County Council having another licence within their jurisdiction?

The WITNESS said he would. He did not think there would be any danger in having different systems inside and outside the city, because arrangements could be made as the railway companies did for the use of each other's lines.

Replying to Sir James Fergusson, the WITNESS stated that he had not had any experience of a superior system of telephoning, and admitted that the interruptions which he had spoken of might be incidental to any possible system in a crowded city. They experienced great interruption a few years ago, when they were without the telephone for a month or two. That was occasioned by a snowstorm, and would be incidental to any overhead system.

Replying to Mr. Benn as to whether the New Telephone Company did not in a very short time secure a considerable number of subscribers, the WITNESS said that it did, of whom he was one. He would be prepared to put up with the inconvenience attending competing systems to get cheaper communication. People would not pay £20 a year for what they could get for £15. The New Telephone Company offered a better system of double wires, and he considered it a grievance that that better system at a lower price was lost by the amalgamation. If the City were to join hands with the London County Council to have, independent of the trunk-wire system, a local system for London, he thought the citizens would willingly put up with the inconvenience of two systems in order to secure a good local system with double wires.

By Mr. John Ellis: The Commissioners of Sewers had not informed themselves as to the number of subscribers within their area, nor of the number of complaints within any given time of the imperfections of the service. From his own experience the complaints might be numbered by scores, if not by hundreds, but he did not know if those complaints had been lodged with the Company.

In reply to Sir James Fergusson, he admitted that there might be difficulty in regard to competing systems in the City area by the multiplication of wires and the taking up of the streets, but said he supposed nearly all new wires would be underground. The City of London had at present nearly as many wires under the streets as they could stand, but he did not consider that an insuperable obstacle.

Mr. JOHN ARCHIBALD DOW, a coal master of Glasgow, said that he had had experience of the telephone in Glasgow for nearly 11 years. The service supplied by the National Telephone Company there was a good one; although there was an occasional breakdown, taking it all over, through and through, it was a very good service. Having the service outside the municipal boundaries was a great advantage, because it enabled them to communicate directly between the business office and the collieries. He did not think it would be an advantage for the Corporation to carry on the business of telephoning within the City, because they might have the pleasure of paying a double rent. If he wished to speak to Greenock, Paisley, or Hamilton through the circuits which the Corporation had put up for themselves, it would be one eternal nuisance, and if any mistake were made they would not know whom to complain to. He regarded the municipalisation of the telephones as a retrograde movement, as it would make a shuttlecock of the customers who corresponded outside, and he would rather see them go into the hands of the Government altogether. In Glasgow the charge was £10; as he had 10 or 12 instruments he paid fully £100 a year, and considered that he got good value for his money. Unfortunately he had no shares in the Company.

In reply to Mr. Benn, he said he came before the Committee at the request of the Telephone Company. He did not think the popular feeling in Glasgow was in favour of municipalisation. The evils of a monopoly could be avoided by fixing a maximum rate.

Replying to Sir James Fergusson, he said that his collieries were distant from Glasgow 10 or 15 miles, and although they occasionally had to wait till the lines were clear, it was for seldom more than five minutes. Occasionally it made him a little angry, and although he had a very hasty temper as a rule, he had never gone so far as to throw the instrument into the street.

Mr. ROBERT CAIRD, superintendent of the Glasgow Omnibus Company, said that they had 32 instruments in operation in connection with the National Telephone Company, 90 per cent. of which were inside and 10 per cent outside the municipal area. The effect of the restriction of telephonic enterprise within the city limits would have a very bad effect upon their business, as it would cut them off, and they would have no communication with their outside offices. The work was very well done by the present Company, and he did not see why the Corporation should take it in hand at all. They had occasional difficulties; they called up all their offices at eight o'clock in the morning to find out if the wires were all right, and if not they had found the Company very prompt in remedying any defect.

Mr. Benn cross-examined the witness as to the friction which had existed between the Corporation and his Company in relation to the Corporation having the tramways in competition with the omnibuses; but the WITNESS asserted that his evidence was entirely uncoloured by any differences between them, and that he had no desire to thwart the action of the Corporation.

In reply to the Chairman, he said that if the result of the Corporation having a system of their own, and having entire control of the streets, was to drive the National Telephone Company out of Glasgow, he would not like that at all, and considered that it would be detrimental to the interests of Glasgow.

Mr. J. P. WALDIE, colliery owner, of Edinburgh, who had been a subscriber to the National Telephone Company since it started 18 years ago, said he paid £142 a year for the service. His experience of its working in Edinburgh was very satisfactory, though there were occasional difficulties and breakdowns, but complaints had been met fairly promptly. He was also opposed to the suggested system of municipal licences.

Mr. A. RIACH, a journalist, and editor of the Edinburgh *Evening Despatch* concurred in this evidence. In reply to Mr. Lawson, he said he was at first inclined to favour municipalisation as a means towards nationalisation, but having more fully considered the matter, he could not see how it would be effectual, even with a very wide area. Certainly, if confined within the boundaries of Edinburgh and Glasgow, he did not see how it would work at all. Replying to Mr. Benn, he said he doubted very much whether the ratepayers would view with satisfaction the municipalisation of the telephones, as they looked upon the acquisition by the Corporation of the electric lighting as rather a hardship. The poorer portion of the population would certainly be averse to it, as they looked upon the telephone as a luxury which should be paid for by those who desired it.

Mr. A. H. MONCUR, ex-Provost of Dundee and Deputy Chairman of the Harbour Trust, said he was thoroughly conversant with the commercial requirements of Dundee and the neighbourhood, and had been for 10 years a subscriber to the telephone. He objected to the nationalisation of the system, as he considered that where there was an efficient service, as there was in Dundee, it should be left alone. He was chairman of the local telephone company previous to its amalgamation with the National Company.

The CHAIRMAN: How do you compare the telephone service now with what it was when there was competition in Dundee?

The WITNESS said he considered it was better, for the reason that under the competitive system the town was divided, one-half being upon the local system and the other upon the National system; consequently, if they wished to be in communication with the whole town they had to get an instrument from each Company, and, after all, the service was not so efficient as at present. The Company now charged £8. 10s. for the first instrument, with a deduction of 15 per cent. if more instruments were taken. The National Company, before competition arose, charged £20, and the local company started at £10. The result of the competition was that the National Company brought down their charges to £5, and the local company had to follow, their lowest price having been £5. 10s. A sub-

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scriber who wished to be in communication with all other subscribers had to pay £10. 10s. for a service not so good as they now got for £8. 10s. His opinion of the effect of competition was not favourable, except in the way of bringing down prices. The local company paid good dividends, beginning at 9 per cent., but the last dividend was only 5 per cent. Just before the amalgamation took place the Company were contemplating raising another £5,000 capital, the original capital having been £5,000. When the National Company took over the local company they reconstructed the system to a large extent throughout Dundee. As to the future of the telephone system, he thought it should be nationalised; but, short of that, he would prefer to see it in the hands of a strong company. He was distinctly against the system of municipalisation.

In reply to Mr. Benn the Witness stated that the National Company bought up the local company at 40 per cent. premium, and the purchase agreement provided that the citizens of Dundee should not be charged more than £10. But for that arrangement he scarcely thought Dundee would be so cheaply served as at present. While in other towns competition might be adopted to secure the same advantage, he did not think a municipality should engage in the competition, but that it should be done by a private company.

By the Chairman: The competition was started in Dundee by the local company because the National Company would not lessen its rates, but since the amalgamation the Company had, of their own accord, gone below the £10 agreed upon, and now charged only £8. 10s.

Mr. JAS. CROMBIE, a merchant and shipowner of Aberdeen, who had been a subscriber to the National Company since its commencement, said he thought the system in Aberdeen was a very good one, and that temporary difficulties were promptly attended to and redressed. The Company had had difficulties with the Corporation with regard to way-leaves. He used the telephone in connection with his business eight miles outside Aberdeen, and since the twin-wire system had been introduced there had been a vast improvement in the service. The charge in Aberdeen was formerly £15, but it had been brought down to £10 by threatened competition. He considered that a competing system in the same area would lead to absolute confusion. He would rather pay a moderate charge for a good service than a less charge for a competitive service. He disagreed altogether with the evidence which Treasurer Blissett had given to the Committee in favour of municipal licences, and was certain that the people of Aberdeen would agree with him rather than with Mr. Blissett.

The Committee then adjourned until to-day (Friday).

LIGHT RAILWAYS BILL.

On Thursday, last week, the President of the Board of Trade moved for leave to bring in the long-promised Bill to facilitate the construction of Light Railways in Great Britain. The following is an abstract of *The Times* report:—

Mr. BRYCE said that frequently in past Sessions, and also in this Session, the House had had its attention called to the absence of facilities for the conveyance of agricultural produce from the agricultural districts to the markets of the country. He did not say that the measure would go very far in relieving the depression in agriculture, which was due to causes operating over the whole world, and many of which were quite irremovable by Parliament. He made no such claim, and he produced the measure as nothing more than a palliative of some evils. After reciting the events which had led up to the introduction of the Bill, Mr. Bryce said he would shortly state what were the provisions of the Bill, the provisions of which were, he said, based upon the recommendations of the Committee. Those recommendations went mainly to two points—namely, the cheapening of Parliamentary procedure and the relaxing of the requirements which it had been the custom of the Board of Trade to impose, in some cases under the absolute direction of Parliament, and in other cases under a sense of duty which had become practically imperative as regarded both the construction and the working of railways. As to procedure, the Bill proposed to commit the authorisation of light railways to County Councils, including in that designation county boroughs. If a County Council considered that a *prima facie* case was made out, then it was to appoint a Committee to inquire into the matter. The promoters were to make out their case, to state the area through which they would pass, and to show that they had consulted all the Local Authorities; thereupon the Committee was to prepare a draft Order, and that was to be sent to the Board of Trade, which was to consider it with a view to three points in particular. The first was the magnitude of the undertaking, so as to secure that under these exceptional provisions no railway should be carried out which ought to be subject to the judgment of Parliament. Secondly, the Board of Trade would consider the proposals from the point of view of the safety of the public. Thirdly, the Board of Trade would be charged with the duty of protecting landowners, and any landowner who thought that his land ought not to be taken compulsorily would have *locus standi* before the Board of Trade, in asking that the Order for the taking of his land should be varied. In making these proposals the Government was, of course, asking Parliament to part with a certain measure of its power; but he submitted that the time had come when in a matter of this kind Parliament might endeavour to effect the enormous saving which would unquestionably be the result of these provisions. As to the question of construction, with regard to these small lines the Board of Trade might be a little more tolerant of level crossings, might dispense with the present elaborate station arrangements, and in many ways might materially diminish the whole cost of construction and working, if only the necessary authorisation from Parliament were given. It had been stated that the Board of Trade was too severe. The department had felt bound to consider the safety of the public as its first charge until Parliament, as the organ of public opinion, authorised it to relax its requirements. But the evidence supplied had convinced the Board of Trade and the Committee that it was possible to dispense with a great many of those requirements in this case without any increased danger to the public or to the traffic. The same remarks applied also to the working of the lines. It had been suggested that public aid should be given to these enterprises from the national exchequer. He did not think the Government would be justified, in the present condition of the public revenue and of public opinion in regard to this question, in proposing a measure so novel and open to so many serious objections of policy. It had never been the policy of this country to subsidise railways, and Parliament would be making a serious new departure in taking such a step. The result of that policy in various foreign countries was well known. It had also been suggested that the making of these railways ought to be aided out of the local rates, and three members of the Committee signed a separate report in which they made that suggestion. There was, no doubt, much to be said for this suggestion; and he did not suppose that the Local Authorities, seeing how strong an interest they had in avoiding any unnecessary expense, would be imprudent in using the power if it were conferred on them. But, at the same time, he must feel that very great objections would be taken in the House to the conferring of such a power. Expressions of opinion had reached him from many quarters which made him feel that if the Government proposed to give to the County Councils the power of subsidising these undertakings, some persons would fear that they would remain ultimately as a charge on the rates, and the measure would meet with a great deal of opposition from which he hoped it would escape. They were, to a certain extent, in a stage of experiment. It might turn out ultimately that the making of these lines would be so great and clear a public benefit that either the national Exchequer or Local Authorities might be authorised to give them some aid or assistance. All he could say now was that the case did not seem to justify the trial of that experiment at present. Apart from what might be done by private enterprise, the formation of companies, and the public spirit of landowners, who, he believed, would in many cases feel that so great a benefit would be conferred upon their districts and properties by the construction of these lines that they would give the land necessary at a very low price, or perhaps for nothing at all—even apart from that, he believed it would be worth the while of many of the great railway companies to construct these lines.

Mr. CHAPLIN said agricultural depression undoubtedly existed in Ireland, but it was nothing like so severe, as he had reason to believe, as it was in numerous parts of Great Britain at the present time. Although State aid in the construction of light railways had been given in Ireland, the President of the Board of Trade said it would be too novel a precedent altogether and one which the Government could not possibly adopt. One thing, however, he was glad to hear, and that was that there was no possibility of any cost in connection with the light railways falling on the rates. The condition of agriculture was so bad at the present time that agriculturists could not bear the slightest addition to the burdens which already fell upon them.

Col. KENYON-SLANEY observed that this measure did not fulfil the idea of hon. members representing agricultural constituencies of every possible step that could be taken to relieve distress, and it would be regarded as a poor and paltry measure indeed. The Government were depending on a broken reed. They were depending on the generosity of a class of the population from whom they had taken away the power to be generous. They were depending on the business like capabilities of another class whose interests would go in the very opposite direction to that in which they hoped to enlist them.

Mr. STRACHEY submitted that those who represented English constituencies had a right to claim that so long as public money was given for the purpose of benefiting agriculture in Ireland and in Scotland the same policy should be pursued as regards England.

Capt. BETHELL said that it was possible that these lines of light railways might be of some use in certain parts of the country, but he doubted whether the power to make them would be generally put into force.

Mr. CROSFIELD had recently visited Holland, and he had come to the conclusion that the extreme prosperity of that country was due to its network of steam tramways.

Mr. TOMLINSON suggested that where there were tramways running along the roads the Board of Trade might require the proprietors to give certain facilities for bringing down agricultural produce as well as passengers. He did not believe that the agricultural districts could carry out a system of light railways or tramways without aid from the Government.

Mr. J. A. PEASE said that the case of Ireland was not a precedent. The position of Ireland was different from the condition of affairs which existed in agricultural districts at the present time here. When it was considered necessary to apply to the Exchequer for aid to make railways in Ireland it was to save thousands of the Irish people from starvation in the congested districts. The Government had, therefore, done well to refuse any national funds for the purpose of the Bill in this country. Distress and depression existed in other industries besides that of agriculture, and, if agriculture received this aid, in all probability other industries would claim it likewise.

Mr. T. H. BOLTON said it seemed to him that it was a Bill that would do no very great harm, and certainly it would do very little good.

Sir M. HICKS-BEACH said the principles of the Bill were good and useful; but he feared that the measure would not have the effect which they all desired. He thought that the financial question was at the bottom of the whole subject. Landowners had made these railways largely in the past. They had made branches at great cost to themselves, which the railway companies had starved, and had afterwards purchased at half the original cost. That did not hold out any hope that the railway companies would go to the expense of constructing these railways themselves. The landowners could not afford, in the present condition of agriculture, to do it. They had been penalised by the legislation of last year; they had suffered

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from the general depression; and it was impossible, under present circumstances, for the English landowners to do what they had done in the past. They were driven to the conclusion that though, in some more favoured districts, the making of light railways might be promoted by the legislation now proposed, yet, where they were most wanted, and where agriculture was most depressed, this Bill would not secure their construction. He was very sorry that the Government had put their foot down against any policy of assistance by the State. He entirely differed from the view that the assistance given in Ireland was to save hundreds of thousands of people from starvation. The assistance was not given for that reason at all. In some districts where it was given in Ireland no question of starvation arose. The light railways were given to Ireland to relieve the general agricultural depression in that country, and what was good for Ireland in this respect ought, if wanted, to be good for England too. In saying what he had said he did not, however, forget the dangers of extravagance and jobbery in such matters. The Irish example had taught them a good deal in this matter. He should be glad to aid its passing; but he hoped that from that night forward they would hear no more about the Bill as a remedy for agricultural depression.

Leave was given to bring in the Bill, and it was brought up by the President of the Board of Trade and read a first time.

CORRESPONDENCE.

THE EWING HYSTERESIS TESTER.

TO THE EDITOR OF THE ELECTRICIAN.

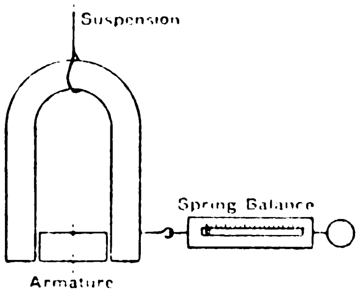
Sir: To the inexperienced student who begins to try experiments, it often seems as if all the actions of Nature were in conflict, and nothing succeeded; it is occasionally the case that the patient student is rewarded by unexpected facilities, and when there is genius to combine them, results are attained by simple means which previously could only be arrived at by complicated processes, and very stably too, that is, without the accuracy of these results being liable to be upset by minute variations in some of the conditions. This seems to be so in the case of the beautiful instrument Prof. Ewing has created—to rank it as an invention seems hardly just. By putting it in a practical form, whatever may be his pecuniary reward, he has made not only the electrical world, but the whole world, his debtor. For if I am not mistaken, the use of this instrument will so aid and forward the development of alternating current and phase plant, that we shall before long be attaining results of great commercial importance which are not within the reach of continuous currents. It has been the want of an instrument of this kind, which could be easily and quickly applied by iron and electrical manufacturers, which has caused much of the uncertainty regarding alternating current results, which has only slowly been lessened by the laborious tests which have hitherto been the only ones available.

My object in writing is not, however, so much to add to the chorus of eulogy with which Prof. Ewing's instrument was greeted, as to mention some experiments of my own, which do something towards confirming the result which Prof. Ewing himself says was unexpected, viz., that the readings of the instrument were little affected by comparatively considerable variations in the number of sample sheets used, that is, in the cross-section of the iron tested.

Supposing we take the armature of an ordinary continuous-current dynamo and place it symmetrically between the poles, there will be no resultant attraction. But, supposing the poles to be vertical, the attraction will be increased towards the top, if the armature is raised owing to the shortening of the two air-gaps at the top, and the lengthening of these at the bottom. The converse will be the case if the armature is lowered.

What, however, will happen if the axis of the armature is kept in the same plane, but the armature is moved horizontally to one side or the other? Except for a slight difference in the leakage lines, the reluctance of the magnetic circuit will not be altered, and the difference in the relative attraction of the two poles on the armature should be slight. Finding nothing on the subject in any of the books, I wrote to Prof. Silvanus Thompson, with a statement of the problem, on January 13th last, and he agreed that it had not hitherto been definitely solved.

In writing, I mentioned the following experiment bearing on the question. A U-shaped horse-shoe steel magnet, 5in. high, 1¾in. between the poles, the steel section being ¾in. by ⅝in., or, say, ½ square inch, was suspended with the poles downwards, and to one leg a small spring balance was attached. Under ordinary circumstances the magnet lifts 4lb. easily; 45 strips of armature iron, 30mm. thick and ¾in. broad and 1½in. long, were next cut, and piled up in a heap 1½in. high, the whole being tightly tied together. The bundle was now fixed between the poles of the magnet, with the laminations horizontal and touching one side, thus leaving



¼in. air-gap between the ends of the sheets and the other pole. A series of trials showed that a pull of 4oz. only was needed to detach the magnet from the armature. The 45 sheets were now removed, and one sheet only substituted for them. That is, the section of the armature was reduced to $\frac{1}{45}$th. Under these conditions the pull required to detach the pole from the single sheet was 8oz. to 10oz., or double what it was before with 45 sheets.

Although on consideration one sees why it should be so, I must confess this result was unexpected at the moment. The actions involved, however, seem analogous to those of which Prof. Ewing has availed himself with such success. In his case the greater coercive force with the fewer sheets increases the hysteresis as the section of the iron is diminished, and so secures a balance over a certain range.

As regards the use of straight samples *versus* discs. I am quite confident that Prof. Ewing's method is by far the most advantageous for manufacturers, as, owing to the fact that great exactness in the action of the samples is not of great importance, the samples can be cut with a pair of shears from sheets when sampling them. This would be far less trouble than taking the sheets to a press, and the small slip taken from the edge makes much less waste than if a circle is taken out. More sheets can therefore be sampled in a given time for less waste if straight pieces are used, and this, as Prof. Ewing has stated, is of far greater importance to dynamo and transformer builders than very exact results with a few sheets. If draughts are found to affect the readings, it would be very easy to shield this part of the instrument with a xylonite screen passing through the air-gaps.—Yours, &c.,

April 24, 1895. G. L. Addenbrooke.

EXPERIMENTS ON THE SHAPES OF RAIL GROOVES FOR TRAMWAY CURVES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of the 26th there appears a Note, quoted from the *Engineer*, on "Grooved Rails for Electric Railways." The experimental research there described is very interesting, but unfortunately no results are given, and although the shape of groove obtained might be predicted by those who have really studied the subject, yet it would be valuable to have the result depicted in graphic form. Cannot photographs of the impression be published?

From the heading of the Note it might be supposed that an electrically-driven car required rails differing from those used when the wheels are driven by other mechanical power; this, of course, is not so. The employment of electricity has, however, brought a fresh class of mind to bear upon this as well as upon numerous other subjects, and it is satisfactory to see that further attention is being given to so important a detail.

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In the experiment described, the result would have been just the same if, instead of turning the leading axle, the frame had been pulled or pushed forward, because the frame carrying the wheels was rigidly attached to the stiff radial board, and it is doubtful if the groove produced will correctly indicate what would occur in practice. It would be well to repeat the experiment, pivoting the frame to the radial bar, not in the centre, but over the leading axle. What would then happen might also be predicted, and would approximate more nearly to theoretical requirements, but would give a result somewhat difficult for practical construction.

In dealing with curves the difficulty arises chiefly in entering and leaving them. The omission to realise this has led to many mechanical devices for radial axles, &c., that have not proved satisfactory in practice. The experiments to be really valuable should show the action of the flanges of the car wheels upon the rails when entering and leaving a curve, and also when changing from right to left on a double curve.

It is to be hoped that the investigation will be continued, and the result published.—Yours, &c.,

April 30, 1895. M. Holroyd Smith.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NOW READY.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Although about 100 pages are added to the book, no addition is made to the price, which is 7s. 6d., post free 8s. 3d., abroad 9s.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices:—*

Laboratory Notes and Forms.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A Large-Sheet Table, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 2s.—each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"Electro-Chemistry."—This useful work, by Dr. G. Gore, is still on sale, the price being 2s., post free.

"The Work of Hertz."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. net., is now ready.

"The Electrician."—A special notice concerning certain changes in the price, &c., of this journal (commencing with the new volume this day) will be found on page 10.

Tenders Invited.—The Brighton Corporation invite tenders for the supply and erection of boilers at the Corporation Electricity Works, North-road. The Corporation also invite tenders for the supply of india-rubber lead-covered armoured cables. Specifications and particulars may be obtained at the office of the town clerk, Mr. F. J. Tillstone, and tenders, addressed to him, must be in by May 13th.

Tenders Invited.—The Brighton Corporation also invite tenders for the supply and erection of arc lamps, switches, &c. Specifications and particulars may be obtained of the town clerk, Mr. F. J. Tillstone, and tenders, addressed to him, must be in by May 27th.

——— The Corporation of Birkenhead invite tenders for the supply and erection of apparatus and plant for their electric supply works. Some further particulars will be found in our advertisement columns. The requirements include boilers, engines, dynamos, a battery of storage cells, instruments, cables, street boxes, &c. Plans will be ready after the 8th inst., and all further information can be obtained at the office of Mr. Alfred Gill, town clerk, Town Hall, Birkenhead; or at the office of Mr. J. N. Shoolbred, C.E., 47, Victoria-street, London, S.W. The contract is in five sections, which can be tendered for separately. Tenders must be in by 12 noon of the 23rd inst.

——— The Vestry of Shoreditch (London, E.C.) invite tenders for the erection of a dust destructor, furnaces, boilers, &c., capable of dealing with 20,000 tons of refuse per annum, and of producing the quantity of steam specified in the conditions required for electric lighting and other purposes. Specification and sketch-plan and other information can be obtained from Messrs. Kincaid, Waller and Manville, the engineers to the Vestry, 29, Great George-street, Westminster, S.W., and tenders must be sent in to Mr. H. Mansfield Robinson, solicitor and Vestry clerk, by 4 p.m. on Monday, May 20th.

——— The Corporation of Tunbridge Wells require tenders for the wiring of the municipal buildings. Tenders by the 28th instant.

——— The Manchester Corporation invite tenders for the supply, delivery and erection of electric lighting machinery required for the lighting of the new Foreign Animals Wharf, at Mode Wheel. Tenders have to be in by 9 a.m. of the 13th inst.

——— The Derby Town Council have accepted the tender of Mr. E. Danks, Oldbury, for three mild steel boilers for the electricity works, at the sum of £1,570.

Tenders Accepted.—The Electric Lighting Committee of the Hull Corporation have accepted the tender of Messrs. Amos and Smith, for the new boilers at the electric lighting works for the sum of £574, and the tender of the same firm for steam pipes for £146. Messrs. J. G. Statter and Co.'s tender for instruments has been accepted for the sum of £78. 10s., Messrs. Crompton and Co. being next lowest at £98, and the amount of the tender of Messrs. Siemens Bros. and Co. was £115.

——— The Birkenhead Town Council have accepted the tender of Messrs. Holme and Greene, of Liverpool, for the erection of the new chimney at the proposed central electricity station for £850.

Personal.—Mr. S. Crichton Hannah, who has been with Messrs. B. Verity and Sons for over 20 years as designer, has taken premises at 5, John-street, Adelphi, London, W.C., and is prepared to supply designs and working drawings for electric fittings, &c., for the trade.

Agency.—Messrs. J. C. Lyell and Co., of 55, Victoria-street, London, S.W., have been appointed sole agents for London, Birmingham, and the South of England, for the Svea incandescent lamps manufactured by the De Laval Glöd Lamp Company, of Stockholm. The agents for Manchester are Messrs. George Thomas and Co., of 72a, Deansgate; for Glasgow, Mr. Hugh Loudon, 12, Dixon-street, and for Belfast Mr. John Hind, jun.

Award.—Messrs. Crossley Brothers (Limited), of Openshaw, Manchester, have received a cable from their Australian agents announcing the receipt of the first award for their well-known oil engines at the Hobart Town Exhibition, Tasmania.

Dividends.—A dividend of 10s. in the £ is payable in the separate estate of Octavius Buss (of Young and Buss, electric bell makers), at the office of Mr. H. W. Figg, 37, Upper Thames-street, London, E.C., on any Wednesday or Thursday, after May 1st.

Dissolution of Partnership.—The partnership between A. B. Gregson and G. E. Newboult, trading at 12, Swaine-street, Bradford, as electricians and engineers, under the style of Gregson and Newboult, has been dissolved. Debts will be paid by A. B. Gregson, who continues the business.

Liquidations.—Mr. T. D. Pillans, 11, Sheen-park, Richmond, Surrey, has been appointed liquidator in the voluntary winding-up of the European Sims-Edison Electrical Torpedo Company (Limited).

——— A meeting is to be held at 107, Cannon-street, London, E.C., on May 27th, at 5:30 p.m., to receive an account of the winding-up of J. R. Powditch and Co. (Limited), electrical engineers and contractors.

——— Under the winding-up order recently made against Martiny (Limited), meetings of creditors and shareholders were held on Wednesday last; but as a quorum could not be formed, the meetings were adjourned. No statement of affairs has yet been filed.

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BANKRUPTCIES.—A summary of the statement of affairs in the bankruptcy of W. J. Kelly has been issued, which shows liabilities £2,751. 13s. 5d., assets nil. The debtor states that, having for 14 months prior to July, 1892, been secretary of Poole and White (Limited), he was in that month appointed receiver of the Company's business at the instance of Second Debenture holders, but that in February last he was superseded by a receiver appointed on behalf of the First Debenture holders. With the exception of £2. 17s. 6d., he denies personal liability for any of the debts scheduled in the statement. The public examination of the bankrupt takes place this day (Friday), at 11 o'clock a.m., at Bankruptcy-buildings, Carey-street, W.C. The following is the list of principal creditors :—

Abel and Imray	£11	7	0
Edison and Swan United Electric Light Company	457	16	0
The Electrician	82	15	9
Electrical Review	68	8	0
General Electric Company	171	7	2
L. Hervé	109	10	5
International Electric Company	47	1	2
F. Kusterer	34	7	1
Minton, Hollings and Co.	25	0	0
Nalder and Harrison Construction Syndicate	21	14	6
R. Orwin	57	12	8
T. Sanders, Birmingham	66	13	0
Taylor, Tunnicliff and Co., Hanley	48	0	4
Binney and Co., Ilford	27	11	10
Gaskell and Grocott, Longport	549	19	2
W. T. Glover and Co., Manchester	157	0	0
Mills, Walker and Co., Stourbridge	36	1	3
Orme, Evans and Co., Wolverhampton	52	16	1
Golding and Sharpe	548	15	0

Rest of London.

——— At the meeting of creditors of E. H. Berry, trading as Berry and Pope, electrical engineers, Burnley, Lancs., Mr. H. Lloyd Price, 79, Mosley-street, Manchester, was appointed trustee, with a committee of inspection.

——— The first statutory meeting of creditors in the failure of J. Torr Todman was held before Mr. A. H. Wildy, official receiver, on Tuesday. No accounts had been filed, but the debts were stated to amount to £700. No proposal was before the meeting, but it was intimated that an offer of 7s. 6d. in the £ would be brought forward, and the meeting was adjourned for three weeks to allow the debtor to formally submit the offer to his creditors.

VAL D'AOSTA ELECTRO-METALLURGICAL WORKS AND MINES.—We hear that the syndicate who own these important works in Italy have decided to offer them for sale by public auction at the London Auction Mart. The works premises cover some 12 acres, and are equipped with 300-H.P. turbines, dynamos, and other plant. With skilled labour at 2fr. per day, water power at £10 per 100 H.P. per annum, a paternal Government which protects its manufacturers by import duties, and other advantages—of climate, &c., it is probable that a spirited competition will take place at the sale, which is expected to take place during the current month.

"D. P." ACCUMULATORS.—As our readers are aware, up to the present time this accumulator has been exploited by Messrs. Drake and Gorham, of 66, Victoria-street, S.W., who some years back appointed Messrs. Johnson and Phillips as sole manufacturers for the United Kingdom. Owing to the success which the battery has attained it has now been decided to form a separate company, who take over the whole of the battery business from May 1st. This Company is styled the D. P. Battery Company, and the London branch has been established at 66, Victoria-street, S.W., where all inquiries should be addressed. The works are for the present at Old Charlton, Kent. The new Company will retain the services of Messrs. Drake and Gorham, who have both in the past been connected with the E.P.S. Company and with the Elwell-Parker battery, so that these gentlemen bring an exceptional experience in battery work to the service of the new concern. Mr. Claude Johnson, of Messrs. Johnson and Phillips, has undertaken the management of the works at Charlton, where considerable additions to the existing plant are under consideration. The business in the battery has already assumed large proportions, and doubtless this consolidation of interests will obviate any possible jealousy on the part of the trade, and should lead to further demands for an accumulator which, since its first public appearance at the St. Pancras Vestry Exhibition in 1891, has gradually won its way with the trade, and proved itself worthy of a good share of patronage from battery users throughout the kingdom.

SCHUCKERT AND CO. (NUREMBURG).—This firm has issued an album containing particulars and illustrations of the central stations erected by the firm from 1887 to date. Most of these stations are for low-tension continuous currents, and work with the slow-speed dynamos coupled direct to marine type engines, so generally adopted in Germany. Hamburg, Hanover, Altona, Christiania, Aix-la-Chapelle. The distribution is throughout on the three-wire system. There are about 35 stations in all, whose output ranges from 3,750 kilowatts to 50 kilowatts.

THE EDISON SCREW LAMP SOCKET PATENT.—In reference to a Note which appeared in our last issue, Mr. Gover, secretary of the Edison-Swan Company, writes :—"The paragraph in to-day's *Electrician*, stating that 'to-day expires the Edison Screw Lamp Socket Patent No. 1802 of 1881,' I suppose is intended to mean that the period of 14 years for which the patent was granted ends to-day. As a matter of fact, this patent came to an end in 1885, no renewal fees having been paid upon it, showing that it was not considered to be a patent of importance, as your present paragraph might lead some people to suppose."

EPSTEIN BATTERIES.—We learn that the Notting Hill Electric Lighting Company have placed an order with the Epstein Electrical Accumulator Company for two new batteries of large capacity, to be put in at their supply station, Bulmer-place, Notting Hill Gate, London, W.

ELECTRIC COOKING AND HEATING APPARATUS.—The Electrical Company (Limited), 122 and 124, Charing Cross-road, London, W.C., send their latest catalogue of cooking and heating apparatus, comprising hot plates, plate warmers, boilers, fitted with either the discs or rings, pans and the saucepans, frying pans, tea and coffee cans, grills, flat irons, cooking stoves, and a toy kitchener, &c. The catalogue is fully illustrated, the concluding plate showing a *fin-de-siècle* kitchen at the Chicago Exhibition.

NEW EDITION.—A new and enlarged edition of Mr. W. Perren Maycock's "First Book of Electricity and Magnetism" will shortly be published by Messrs. Whittaker and Co.

ACTON.—A short time back it was agreed by the District Council to transfer their provisional electric lighting Order to Messrs. New and Mayne on condition that certain stipulations as to a sliding scale, &c., were agreed to by that firm. At the last meeting of the Council Messrs. New and Mayne's acceptance of the conditions was notified. Upon this a discussion ensued on a motion by Mr. Buxton "That the sale of the Provisional Order should be rescinded." After much discussion an amendment, "That the transfer of the Order should be postponed until the opinion of the parochial electors had been ascertained" was agreed to.

ADELAIDE (SOUTH AUSTRALIA).—The question of lighting this city by electricity is being actively discussed, and Messrs. R. W. Thomson and Co., of Leigh-street, have submitted tenders for lighting portions of the city. By last reports the Mayor has been requested to call a meeting of ratepayers to consider the whole question, and to submit full details of such schemes or proposals as have been already discussed by the Corporation.

BEDFORD.—The Electric Lighting Committee have presented a report preliminary to that which is to be published in July next. From the summary it would appear that the amount paid to date on account of the electricity works is £10,644. 2s. 8d., and the amount owing £2,138. 14s. 10d. The original sum borrowed (£12,000) has, therefore, been exceeded by about £800. The Committee report that they have every reason to be satisfied with the way in which the work has been done by the various contractors, including Messrs. Johnson and Phillips (machinery), the Telegraph Manufacturing Company (mains, &c.), Messrs Grafton and Co. (travelling crane), Mr. T. H. Coleman (building and shaft), and Mr. F. H. Medhurst (consulting work), and that the installation has been most successfully carried on by the staff at the works, under the superintendence of Mr. W. Hope-Johnstone, the engineer, who has sole charge of the works. The light has given general satisfaction, as is evidenced by the increasing demand. The supply of current from December 5, 1894, to March 31st last will recoup the Council for all working expenses and materials supplied during this period, and provide a small balance, which the Committee consider a satisfactory result. The Committee submitted estimates prepared by the engineer for extending the lighting area, and recommended that application be made to the Local Government Board for borrowing the amount required to carry out the complete scheme. About £13,000 has already been expended, and a further £26,764 would be required. Mr. Richards (the Chairman of the Committee), replying on the discussion which followed, said that when St. Pancras started its electric lighting there was no Vestry so much abused, but it was a grand example to work up to. He felt that the Bedford Council's electric lighting undertaking was bound to grow into a brilliant success. The proposal to obtain borrowing powers on £26,000 was unanimously agreed to. A proposal from the captain of the fire brigade that electric fire alarms should be placed in the principal streets was referred back for further consideration.

BELFAST.—The Electric Light Committee of the Corporation considered at their last meeting the question of supplying electric current for heating and power purposes during day hours on a reduced scale of charges, and it decided that current for these purposes be supplied at 4d. per unit, with discounts. The charge for lighting is 7d. per unit.

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Birkenhead.—In its report for the year the Finance Committee of the Town Council asked for a sum of £1,500 for the purpose of lighting the Town Hall by electricity. The Committee recommend that the light should be permanently installed, "as the rooms of the Town Hall are used for high-class entertainments, and are universally admitted to be much cooler and pleasanter when lighted by electricity than when lighted by gas. This form of illumination is recommended as better for the health of the Corporation officials," and the work of installation has to be completed by September. After discussion the suggestion of the Committee was modified, and £750 voted for electric lighting. Mr. Alderman Deakin stated at the last meeting of the Town Council that Mr. Shoolbred's plans and specifications for their electric lighting scheme had already been placed before the Imperial authorities, and he hoped, if advertisements for tenders in connection with the work were approved by the Council, that he would be able to have the generating station ready for the supply of current for the coming winter. At its meeting on Wednesday, the advertisements for tenders were approved, and yppear in another column of this issue.

Birmingham.—It will be remembered that a few weeks back a heated discussion took place as to the allocation of the tenders for supplying electric plant and apparatus for lighting, power, and teaching purposes at the Municipal Technical School. The contract was finally given to Messrs. D. and G. Graham, of Glasgow. As the members of this firm have now applied for the sequestration of their estates, the whole matter of these tenders will probably have to be again considered by the City Council. The total amount of the contract given to Messrs. Graham was £6,080. 14s. 2d.

Burglary.—The recent burglary on the premises of the Brush Electrical Engineering Company in Queen Victoria-street, London, was perpetrated by a clerk named Eve, who succeeded in forcing a cash-box and stealing therefrom £207. 10s. The prisoner, when caught at Aberdeen, had succeeded in disposing of nearly the whole of the money. He had previously served eight months' hard labour for forgery, and was committed for trial.

Bury St. Edmunds.—We are notified that a syndicate has been formed for the purpose of supplying business premises in the neighbourhood of Abbeygate-street with electric current. Messrs. W. J. Crampton and Co., of Cambridge and Great Yarmouth, have been entrusted with the necessary installation work.

Derby.—At the last meeting of the Town Council the Electric Lighting Committee obtained permission to apply to the Local Government Board for sanction to borrow £5,000 for electric lighting purposes. Alderman Leech said the undertaking was in a prosperous condition, and he expected to be shortly in a position to present a satisfactory balance sheet.

Ealing.—Messrs. Bramwell and Harris, having accepted the terms offered by the District Council, have been duly appointed consulting engineers to the electric lighting works.

Edinburgh.—The Electric Lighting Committee of the Town Council has considered several requests for the extension of the electric lighting to thoroughfares not already mained, and has granted the applications. A request from Surgeons' Hall for private lighting is to be inquired into, and a report presented.

The Falls of Foyers.—At the meeting of the Inverness County Road Board on Wednesday a motion was carried that the proposal of the British Aluminium Company, relative to the submersion of certain roads in Stratherrick, and the alteration of other roads in connection with the proposed diversion of the Falls of Foyers, was approved on the condition that the company maintain the road for two years. The matter was to come before the County Council for final decision yesterday (Thursday).

Fife.—At a meeting of the County Road Board on Tuesday, the Sub-Committee's report on telephones was submitted, and it was agreed to give powers to the Committee to make a fair and reasonable agreement with the Telephone Company on the basis of 2s. 6d. per mile of wire for way-leave and as much accommodation as possible from the Company in the way of free telephone instruments at several of the police offices in the county.

Fulham.—The Vestry at their last meeting decided to appoint a special committee to consider and report as to the advisability of applying for a Provisional Order to supply electric light in the district, and also as to the construction of a refuse destructor in connection with the scheme.

Hampstead.—In reference to the proposal made by the London and Hampstead Battery Company, suggesting a scheme for dividing the work of electric lighting in this parish between the Company and the Vestry, the latter body have decided not to entertain the proposal, as they do not consider it advantageous either to the Vestry or to the parish. The question of the Company's rights in the matter is under consideration by the Lighting Committee. The Committee have given Messrs. W. T. Glover and Co. an order for the necessary cables, jointing boxes, &c., required for the extensions recently sanctioned by the Vestry.

Hanley.—At a special meeting of the Town Council on Tuesday the minutes of the Electric Lighting Sub-Committee were considered. A plan of the proposed extension of the electricity works had been submitted by the borough engineer and the electrical engineer to the Corporation (Mr. G. H. Cottam). It was stated that the demand for current in the centre of the town would necessitate the putting down of a new high-tension cable of double the existing capacity between the works and the Town Hall, estimated to cost £5,508. The extension of the generating station and mains would necessitate an expenditure of £5,900, making, with other items, a total estimate for the extensions of £19,000, and an extra sum of £1,000 was added for contingencies. The total expenditure for the scheme to date is £47,000. The Committee recommended that application be made to the Local Government Board for sanction to borrow a further sum of £20,000, repayable in 25 years. The minutes were unanimously confirmed, and several members expressed their satisfaction at the success of the municipal electric lighting undertaking.

Huddersfield.—The official accounts of the electric lighting department of the Huddersfield Corporation to December 31st last are just issued. The total amount borrowed to date at 3½ per cent. interest is, for building (repayable in 30 years) £10,800, and for general purposes (repayable in 15 years) £33,200, leaving the department with further borrowing powers to the extent of £6,000. The capital account shows a total expenditure of £46,041. 9s. 4d. The sale of current for the year realised £3,214. 8s. 4d., including £173. 15s. for public lighting. Receipts from meter rents amounted to £232. 8s. 2d., and by sale and repairs of lamps and apparatus £133. 12s. 1d., making a total of £3,580. 8s. 7d. The total expenditure for the year has been £2,184. 5s. 5d., leaving £1,376. 3s. 2d. to be carried to the net revenue account, and £20 as provision for bad and doubtful debts. The total deficiency to December 31, 1894, is £2,065. 4s. 9d., against a deficiency of £2,547. 7s. 9d. at December 31, 1893. The total number of units generated during the past year was 265,146, of which 156,169 were sold, 9,487 were used at the works, and 99,490 are unaccounted for.

Hull.—Col. C. H. Luard, R.E , Local Government Board Inspector, recently held an official inquiry into an application by the Corporation for sanction to borrow £2,800 for electric lighting extensions.

Kingswood (Bristol).—An agreement has been sealed by the Urban District Council as to the terms upon which the local tramway company, which is adopting electric power on its lines, are to pay annually for the right to erect poles for their overhead wires.

Leicester.—Exception is taken by many writers to the loca Press to the action of the officials of the Corporation in soliciting orders for installation work. One firm of electrical engineers, in a communication to the *Leicester Post* of the 29th ult., points out that the gas department of the Corporation are making nearly £27,000 profit per annum, and urge that touting for installation orders is, at least under these circumstances, inadmissible and undignified, and calculated to do great injury to local firms engaged in the supply of fittings and apparatus for electric lighting. Perhaps the most serious point is the complaint that the Corporation officials, in their anxiety to obtain business, claim that their workmanship is superior to that of private firms. The difficulty of obtaining business where official competition has to be overcome is notoriously great; but if, in addition to the perhaps not unreasonable preference of the citizens to entrust their work to the Local Authorities, the element of misstatement is introduced, the lot of the local tradesmen will, indeed, be a hard one. So far as Leicester is concerned, the regulations and tests imposed by the authorities, which are described as exceptionally severe, are safeguards against common goods or bad workmanship. The letter referred to concludes:—

"The papers containing the report of the opening of the new electric light station this week state that the profit made on the fixing department is going towards the loss on the present supply of current. Sir, we contend this is not fair. If the Corporation are going in the future to reap the benefit of profit by supplying the current for the light, we consider they ought to bear the loss now, and not try and cover it by obtaining the work from electrical engineers in the town. The loss they are now making on supplying the current, or the gain they will make in the fitting department in the future, will certainly not make any appreciable difference in the rates, but the electrical trade would feel the benefit if they had all the fixing to do. We are informed that the competition has not however, stopped at installations from the town mains, but they have now commenced supplying and fixing private electric light installations. We should like to know where the competition of Leicester Corporation with us will end. Do they intend to fix any electrical apparatus as telephones, &c.? It is most unfair that any one trade which promised to become fairly established here (manufacturing as well as fixing), should be singled out to compete with the rates they have to help to pay. It would be interesting to know where the capital for providing the stock and material for installations is obtained from; whether it is from the rates or from money granted for the supply station; also whether the interest on this amount and the time of the officers touting for electric light orders is deducted from the profits."

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LIVERPOOL.—It is stated that the result of the inquiries, made by Sir Frederick Bramwell and Mr. Barrow, into the financial and general position of the Liverpool Electric Supply Company, have so far proved perfectly satisfactory. The work of inquiry is not yet completed, but it is expected that the report will be shortly issued to the Corporation, who will discuss the matter at an early meeting. The purchase is stated to be contingent on the extension of the city boundaries being carried out, as a portion of the Company's plant is situated both within and without the city's present boundaries.

MADRAS.—Recently the officials of the Madras Tramways Company made trial trips with the newly-equipped electric cars. The preliminary trips were very successful, but subsequently on two occasions a hitch occurred, each time at the same spot. A visit has been paid to the works by the Governor (Lord Wenlock), when Mr. O'Shaughnessy, the chief engineer to the Company, conducted the party over the power station, and Mr. Gadsby, the Company's electrician, showed the brilliant effect of the electric lighting installation carried out by the Company.

METROPOLITAN ASYLUMS BOARD.—A letter has been received from the Electrical Trades Union, asking that a clause may be inserted in contracts for electrical work given out by the Board insisting upon what is termed "trades union working regulations" being complied with. The matter was referred to the Committee on Contracts.

OLDHAM.—At the meeting of the Town Council, on Wednesday, the Electric Lighting Committee reported that Prof. Kennedy had estimated the cost of the electric lighting extensions at £10,000. The original estimate was £27,000, and of this sum £25,550 had already been expended. The applications for current had been so numerous that the Corporation's plant was not sufficient to meet the increased demand, and they were obliged to extend the cables to Werneth Park and along Huddersfield-road.

PERTH.—The Waterworks Committee have recommended the Commissioners to sanction the lighting of the works by electricity, and the suggestion has been adopted. It is estimated that, with an initial outlay of less than £100, a saving of about £30 per annum will be effected over the gas-lighting cost. When repairs have to be effected in the wells under the engines, it has been found necessary in the past to provide movable lights, and it is considered that the adoption of the electric light will obviate the use of movable lights, and enable the work to be carried out in a much more satisfactory and efficient manner.

PLYMOUTH.—This otherwise go-ahead town, which is not inaptly termed the metropolis of the West, appears singularly backward with regard to electric lighting. At a meeting of the Western District Ratepayers' Association last week, one of the members pointed out that wherever electric lighting had been introduced by the Local Authority it had proved financially satisfactory to the ratepayers, and as a result of the persuasive eloquence of this gentleman a committee was appointed to consider the subject with the object of waking up the Local Authorities to a sense of their remissness in this important matter.

PRESTON.—A suggestion made at the last meeting of the Town Council that advertisements should be issued for tenders for lighting the Town Hall and Public Hall by electricity was discussed, but no action was taken in the matter. It is probable that the Town Hall Committee will consider the subject at its next meeting.

ROTHESAY.—With regard to the lighting of the harbour at Rothesay by electricity, the Harbour Committee, at a special meeting of the Harbour Trust and Town Council, recommended that the scheme proposed by Mr. Mavor, of Glasgow, should be proceeded with. Although the feeling of the meeting was generally favourable, the gas interest was fully represented, and was ultimately successful in postponing the further consideration of the matter for the present.

SHIPBUILDING AND THE ELECTRIC LIGHT.—About 18 months ago the officials at Devonport received instructions to utilise the spare electric light plant in the Dockyard for lighting ships in course of construction on the building slips. This was done, and the experiment has been so satisfactory that the Admiralty have now decided to spend a large sum of money in perfecting the arrangement, and when completed none but the electric light will be used on a ship from the time she is laid down until she is passed into the Fleet Reserve. During the present year it is intended to spend at Devonport £2,650 on additional plant, one half of which will be for perfecting the electric lighting arrangements of ships in course of building, and the other half for additional lighting plant to be used after the vessels leave the building slips.

SHIP LIGHTING.—Very few of the vessels of the principal steamship lines now leave our shores without an electric lighting outfit. Messrs. J. H. Holmes and Co., of Newcastle-on-Tyne, have recently secured orders for electric lighting plants for a number of the vessels belonging to the Russian Steam Navigation Company, and for steamers now building for the Russian Volunteer Fleet. The firm are very busy with ship-lighting plants.

ST. HELENS (LANCS.).—The Gas and Lighting Committee, after considering the report of Mr. R. Hammond on the proposed electric lighting scheme, have decided to put in plant at the gas works in Warrington-road. It is intended to first supply current for lighting the Town Hall and the Gamble Institute, and to arrange the plant so that, should the demand warrant it, extensions may be made at any time. Mr. Hammond has been instructed to submit plans and specifications for the necessary site and plant.

A SHAM ELECTRICIAN.—Wolverhampton has recently been troubled with a young man named Waterhouse, who rented a shop in Birch-street at 2s. 6d. per week, where he represented himself to be carrying on the trade of an electrician, and claimed to have in stock dynamos and other electrical machinery and apparatus. The accused started business with a capital of £1. 13s. 7d., and succeeded in obtaining various sums of money from tradesmen in the district.

SHOREDITCH (LONDON, E C.).—At a meeting of the Vestry last week the Electric Lighting Committee recommended issuing an advertisement for a clerk of works at a salary of £3. 3s. per week, to superintend the erection of the buildings in connection with the Vestry's electric lighting scheme, and the recommendation was approved.

STORES LIGHTING.—The Ryhope (near Newcastle) Co-operative Stores were lighted electrically for the first time on the 20th ult. The installation has been carried out by Messrs. Barnett and Co., of Newcastle-on-Tyne, at a cost of £1,000; six arcs and 200 incandescents are used.

SYDNEY (N.S.W.).—In an exhaustive report presented by the City Surveyor (Mr. Richards), dealing with the treatment of the city refuse, he recommends the application of a purifying liquid, "electrozone," prepared from electrically-treated sea water, which he considers secures perfect decomposition and disinfection.

TUNBRIDGE WELLS.—Petitions are being received from various suburban and other centres, asking that the area of the original electric lighting scheme may be extended. Contracts having been entered into absorbing the whole of the money for which the Electric Lighting Committee have obtained borrowing powers, it has been found impossible to grant the request of the petitioners. Owing to the very large number of applications for electric current, the Committee are of opinion that the time has arrived when considerable extensions should be considered, and recommend the Town Council to apply to the Local Government Board for powers to borrow a further £12,000 for this purpose.

WORCESTER.—At a meeting last week of the City Council, Mr. Millington, the chairman of the Finance Committee, made an unofficial statement as to the probable receipts and expenditure of the first year's working of the Council's electric lighting scheme. For the previous six months to March 25th, he estimated a debit balance of £17, in addition to the sum required for interest and repayment of capital. For the whole twelve months they would have to provide £5,096, and their probable receipts would be about £5,250. The actual amount of capital expended up to April was £57,083. 6s. 1d., which left an unexpended balance of nearly £3,000 out of the £60,000 voted by the Council for electric lighting purposes. Against this balance there was a claim by the contractor for rather more than £1,000, regarding which the Council disputes its liability.

YORK.—A special meeting of the City Council on Monday discussed the report of the Streets and Building Committee, which recommended the adoption of the scheme of the Electric Construction Company for the electric lighting of the city, and further recommended the acceptance of the Company's tender to supply the necessary plant and fittings for the sum of £10,865, and to work the plant for a term of three years in consideration of the payment by the Corporation of the following charges per unit for electricity supplied:—3¾d. per unit on a minimum of 75,000 units per annum, and on quantities up to 150,000; 3½d. per unit on 150,000 to 300,000 units per annum; 2¾d. on over 300,000 units. A lengthy discussion ensued, and several amendments were proposed and argued, but in the end the following amendment was carried:—"That the report be referred back to the Committee, with an instruction to report further on the electric lighting question, and particularly as to (1), the entire cost of plant, buildings, and land in each case; (2), the various works visited by them; and (3), whether Prof. Kennedy agrees with the advice given to them by the City Engineer." Mr. Ald. Wragge said that it seemed to be the intention of certain members of the Council to defeat, if possible, the installation of the electric light in the city. This opposition was contrary to the wishes of the ratepayers, who were anxious that the electric light should be established. The large towns of Yorkshire were pushing ahead with their electric light installations, and they would soon find the ancient city of York alone without the modern illuminant, although there was no city where the electric light would be of more service than in their own.

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LEGAL INTELLIGENCE.

Slade v. Hooper's Telegraph and India Rubber Works (Limited).

This was an action heard in the City of London Court, before Sir Forrest Fulton, Q.C., and a common jury, and brought by Messrs. Slade, Templeton and Co., engineers, of New Broad-street, E.C., to recover £114 for telegraph buoys and other goods supplied to the defendant Company. The defendants paid £47. 13s. 1d. into Court, and raised a set-off and counter-claim for the balance of £66. 6s. 11d. The defendants, it was stated, were the contractors for laying a telegraph cable in Cuba. and had ordered 12 buoys, which were needed for the purposes of that work, from the plaintiffs. The plaintiffs say that after the order was given, Mr. Gee, the Managing Director of the defendant Company, requested certain alterations to be made in the original specification, This caused delay in the manufacture of the buoys, but ultimately the work was completed, and the buoys shipped to Cuba. The defendants declined payment on the grounds that there had been undue delay, that they had been put to expense in consequence, and that the buoys were not made in accordance with the order. Their counter-claim of £55. 16s. 11d. was made up of expenses to which the defendants alleged they had been put in consequence of the defects and delay in delivery. The principal question at issue was whether there had been unreasonable delay in delivery. The plaintiffs admitted that time was to have been of the essence of the contract, but said that in consequence of the alterations made at the defendants' request there was delay, and that they were only bound to deliver within a reasonable time, which they had done. After the case had proceeded for some time, the learned Judge said it was not one which could be conveniently tried by a jury. He should, therefore, refer it to an arbitrator. A formal verdict was returned for the plaintiffs for £98, and for the defendant on the counter-claim, subject to a reference to Mr. F. S. Jackson, the Registrar.

Whiffen and Others v. the Crompton Electric Supply Company of Australia (Limited).

In an action in the High Court, it was asked that the secretary of the Company (Mr. F. R. Reeves) should be appointed as receiver and manager. There were three series of debentures issued, and plaintiffs were holders in all of them. The interest was in arrear, and this action was taken in order to protect the property and assets of the Company, the whole of which were in Australia. The secretary was resident in England, but plaintiffs were ready to undertake for his receipts.

The application was granted, but power was reserved on the question of appointing a deputy-receiver resident in Australia, and giving him power to make any necessary advances for carrying on the undertaking.

Wallace v. the Planet Electrical Engineering Company (Limited).

Judgment was given in this action on Saturday last by Mr. Justice Stirling. Plaintiffs held all the debentures to the amount of £2,500, which were issued in December, 1893. On February 26th an extraordinary resolution was passed for winding up the Company, and Counsel now asked for judgment.

His Lordship granted judgment in the terms asked, and gave plaintiffs liberty to apply in Chambers for any further consideration of the matter

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

April 16, 1895.

7,649. E. H. Crosay and O. M. Shaw. London. Improvements in and relating to electric arc lamps.*

7,657. W. M. McDougall, H. B. Adams and G. P. Smith. London. Improvements in secondary or storage batteries.*

7,668. J. Devonshire. London. Improvements in systems of electric distribution. (E. W. Rice, United States.)*

April 17, 1895.

7,703. G. F. L. Alexander. London. An improved electric bell switch and burglar alarm.

7,705. W. McKenzie and J. A. Fleming. London. Improvements in the construction of holders for electric glow lamps.

7,711. G. D. Burton. London. Improved method and means of heating metals and ores for forging, melting, smelting, welding, and other purposes, by means of a voltaic arc sprung between the metals or ores and an electrolytic solution.

7,712. G. D. Buxton. London. Electric bath metal-heating apparatus for metals and ores.*

7,713. G. D. Burton. London. Electric bath metal-heating apparatus.*

7,735. H. H. Lake. London. An improved electromotor. (A. D. Casa. Italy).

April 18, 1895.

7,773. H. Tee. Liverpool. Improvements in or connected with the production of electricity.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

5,863. Reason. Electric fuse-boxes.
6,315. Shepard. Electric controlling device.
7,050. Fricker. Electrically illuminated signs.
9,534. Kolbe. Electric accumulators.
9,565. Gray. Fixing electric insulators.
9,647. Nicolson. Telephones.
14,492. Adamson. Electric light photography.
15,129. Malignani. Evacuating incandescent lamp bulbs.
17,498. Benest. Electric alarm clocks.
19,934. Hübner. Galvanic batteries.
22,637. Hebard. Electric uterine battery.
8,224. Aldridge. Electric lighting.
10,172. Hopkinson. Electric rail or tram vehicles.
10,332. Suter. Arc lamps.
10,426. Kingdon. Dynamo-electric machines.
25,289. Ludvigsen. Primary battery.

1895.

1,949. Pye. Mat and electric alarm contact.
2,333. Adamson. Using electric light for photography.
3,062. Boynton. Electric locomotives.
3,086. Lake (World Flash Company). Telegraphic apparatus.
3,358. Wheless. Electric railway systems.
2,918. Devonshire (Steinmetz). Dynamo electric machines.
4,106. Lones. Dynamo electric generators and motors.
4,153. Johnson (Downes). Insulating electric conductors.

COMPANIES' MEETINGS AND REPORTS.

Eastern Extension, Australasia, and China Telegraph Company (Limited).

The forty-third ordinary general meeting of this Company was held on Wednesday, at Winchester House, under the presidency of Sir John Pender, G.C.M.G., M.P.

The SECRETARY (Mr. F. E. Hesse) having read the notice convening the meeting and the minutes of the last meeting, which were confirmed by the present meeting and signed by the Chairman as correct, the report of the Directors was taken as read.

The CHAIRMAN: Before asking you to approve the report I will, as usual, go over the accounts and show you the result of the working of the business during the last six months. The gross receipts for the half-year under review have amounted to £261,322, against £251,689 for the corresponding period of 1893 showing an increase of £9,633, which is entirely due to the large Government and Press traffic carried on with China and Japan since the commencement of hostilities between those countries. The working expenses have amounted to £89,740, against £76,574 for the corresponding period of 1893, showing an increase of £13,166. Of this nearly £9,000 is due to increased cost of repairs and maintenance of cables, which is always an uncertain factor, and the balance to the opening of new stations at Labuan and Sourabaya, the establishment of electric lighting at various stations, and other exceptional items. Comparing the figures for the whole year, the results are as follows:—The gross receipts for 1894 were £509,003, against £509,684, or practically the same as in 1893. The working expenses for 1894 were £170,035, against £154 803 in 1893, or an increase of £15,232, as already explained. The usual interim dividends have been distributed during the past year, making, with the dividend proposed to be paid to-morrow, a total payment of 5 per cent. for 1894. It is also proposed to pay a bonus of 4s. per share or 2 per cent., making a total distribution of 7 per cent. for the past year (applause). The balance of £89,686 has been carried to the general reserve fund, which now stands at £641,598 after charging during the past year £100,000, in part payment of the new Singapore-Hongkong cable. Altogether over a million and a quarter has been spent out of revenue since the formation of the Company on cable renewals, duplications and triplications, during that time we have not increased our capital, excepting to a very small amount (cheers). In terms of the trust deed, a further drawing by lot of 389 of the Company's Five per Cent. Australian Subsidy Debentures took place on the 1st ultimo for payment at par on July 1st next, when the debenture debt, which originally amounted to £640,000, will have been reduced to £209,500 (applause). The maintenance ships have as usual been

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kept busy during the past half-year in efficiently maintaining our extensive system, but as most of the cables are duplicated, the revenue has in no instance been materially affected. Neither has the war in the Far East interfered with our cables, the service having been conducted as regularly as in time of peace. But for this we are doubtless indebted to the friendly but strict neutrality which the Company has maintained towards the two belligerents throughout the hostilities (hear, hear). As announced in the printed report, your Directors have lost in the decease of the Right Hon. Viscount Monck an esteemed colleague, who had been connected with the Company from its formation. For some time previously Lord Monck had been in a bad state of health, preventing him from actively participating in the duties of the Board, as I explained to the shareholders at a former meeting. Since I last had the pleasure of meeting you, another Inter-Colonial Postal and Telegraph Conference has been held in Australia, at which our guarantee arrangements with the Colonies were fully discussed. As you are aware, the Colonies have been passing though a severe financial crisis, and with a view to retrenching as much as possible, the Government of Victoria had given notice to the other guaranteeing Governments that she would probably withdraw from the guarantees at the end of the year. After full consideration, however, it was decided that the arrangements should be continued, with certain slight modifications, for a fixed period of at least five years, instead of being subject to cancellation at the end of any year, as was previously the case. Consequently, the cheap tariffs now in force between this country and Australia will remain unchanged during the next five years (applause). I think that that is a very pleasant announcement (hear, hear). It was hoped from certain remarks made to the Conference by the Queensland delegate that that Colony would join in the modified arrangement, and thus enable us to charge the same reduced rates to Queensland as the other Colonies enjoy; but up to the present time we have not received any definite announcement on the subject. The amount of guarantee Queensland would have to make up would be quite trifling compared with the advantages she would derive from the reduction of tariffs, and I still hope she will see the advisability of coming into the arrangement (hear, hear). With regard to the Pacific cable, I daresay you have heard a great deal about it, as we all have, and were I to give you my opinion upon it I should be virtually repeating what I told you at the last two half-yearly meetings. I do not think it has advanced one step further than it was when I last addressed you. This project was also fully discussed at the Hobart Conference; but the resolution submitted by the Queensland delegate for *practically* dealing with it was unsupported and withdrawn, and an amendment was subsequently passed simply reaffirming the desirability of cable communication across the Pacific, and urging the various Governments to take steps to further the project at the earliest opportunity. Judging from the telegrams appearing from time to time in the newspapers, Canada is losing no opportunity of keeping the project before the public; but until the Colonies, including Canada herself, are in a better financial position, and are agreed amongst themselves as to the details of the scheme, which is very far from being the case at present, I do not believe that any real progress will be made in the matter (Hear, hear). I have received a letter—and only one—from a shareholder, expressing disappointment at not having been invited to take part in the celebration of our twenty-fifth anniversary, but when I mention that there are nearly 16,000 shareholders in the Eastern and Extension Companies, it will be seen that it would have been physically impossible to ask them all, in addition to the many customers, Government officials, and other representatives who it was desirable to invite (hear, hear). The principle we adopted with regard to the shareholders was to invite only those whose names were on the share register at the formation of the companies, and of these, holders of 100 shares and upwards were asked to the banquet, and the remainder to the reception. By this means we were enabled to keep the number within reasonable limits, and as the principle was a perfectly fair one, it should be satisfactory to all concerned (hear, hear). I feel quite sure that the shareholder will be satisfied with this explanation. and I only regret that he was not present, owing to the circumstances of the case. I think I have laid before you to-day a most satisfactory account of the past six months' working (applause). We occupy a position which is very unique. We have done our work remarkably well, and have thus secured during these years the full confidence of the telegraphing public (Cheers). We have paid you a fair dividend, but not an exorbitant one, although one which is much larger than is generally paid by many of the companies which have been floated during the last 25 years (hear, hear). I believe that we have established for you a thoroughly sound system—a system which the world could not now do without (hear, hear). The work we do is extremely popular, and we have done very much to extend not only trade throughout the world, but political influences also, and we have also brought nearer to the mother country all those countries which have sprung from her. I think it is a very fine position for the shareholders, and the Companyas (applause) to occupy. During all these years we have never had one fault found with us for doing anything that was not perfectly straightforward in the conduct of our business. I therefore speak with some pride, and I say that the accounts submitted to you to-day are accounts on which I congratulate you, while I think we are also to be congratulated by the shareholders for being able to present them with such a gratifying statement (cheers). With reference to my remarks about the Pacific cable, I may say that it is not our business to oppose cables, but to carry cables to every point where trade is established, and our flag flies (hear, hear). That is a leading part of our policy, and we shall continue it. Confidence generally is reposed in us, and great sympathy is shown towards us. As I have just told you, the Australian Colonies have extended their guarantee with us for a period of five years, but I do not believe, after all, it will cost them much, if anything.

A SHAREHOLDER: Will you tell us how much the guarantee has cost the Colonies already?

The CHAIRMAN: It has cost them up to the present time between £50,000 and £60,000, but I do not think it will cost them much in future, if anything. The Colonies, as you know, do not always agree with one another. Our business is to get them to agree with us, and I think we have had singularly good fortune in having the hearty co-operation not only of the Colonies at headquarters, but of their representatives—the Agents-General—in England. I hope my reply to you is satisfactory.

The SHAREHOLDER: I only wanted to know, because the prospect of their continuing the guarantee will depend a good deal upon the weight which it throws on them.

The CHAIRMAN: I give them the credit for continuing the arrangement. I think I have now said everything that I had intended to say, but if any gentleman has any question to put to me regarding any point upon which I have not touched, I shall be glad to answer him.

The SHAREHOLDER: Would you have patience with me if I ask you if you ever take into consideration whether you will give us more than 7 per cent. dividend?

The CHAIRMAN: I do not think it would be good for you if we did (laughter). I think I could satisfy you on that point in a private conversation. The 7 per cent. which you are getting to-day is a handsome dividend, and compared with what it would have been a few years ago it is now very much higher. What I want to do is to secure to you this good and satisfactory dividend, and the more that we can build up the reserve fund and strengthen our system without increasing our capital, the more beneficial it will certainly be to the shareholders (hear, hear). That is our policy, and we are following it with a great deal of care and caution. I now move—

"*That the report and accounts of the Directors n w submitted be received and adopted, and that a dividend be now declared of 2s. 6d. per share, together with a bonus of 4s. per share, both free of income tax, payable on the 2nd inst., making, with the previous distributions, a total payment of 7 per cent for the year 1894.*"

The Marquis of TWEEDDALE: I beg to second the resolution.

Mr. W. GRIFFITH: I am sure we are all indebted to you for the very clear and lucid statement you have made to us, and I think that the policy which you have enunciated must commend itself to the shareholders at large. It is better to keep a good reserve fund, so that you may be able to develop our system without increasing our capital. It is evident that that will increase the value of our shares, and while you continue the payment of this dividend of 7 per cent., I certainly think there is no cause for complaint. With respect to the twenty-fifth celebration, I think it might have been recorded in a more permanent way, and in a way which would have been more beneficial to the Company, if a medal had been struck commemorating the great development of submarine telegraphy, or if a small book had been published containing views of the different places at which we stop, with a short historical account of our different stations. I think that we might have improved the position of our Company by circulating these medals and books among the public at large, as well as among the shareholders. But, of course, this is a question of detail. It seems to me that it would have been of more permanent benefit to us had such a course as this been followed, instead of giving a dinner and a reception, which gratify a few for one particular night.

The CHAIRMAN: There are two ways of advertising—the sensational and the sober (hear, hear). As a rule I like something that is permanent, but we cannot always be dealing with hard and dry facts. We must have a day of joy in our lives occasionally, and after 25 years' dry work, I think it was not a wrong thing for us to have a little jollification over it (hear, hear. and laughter). My impression is that it has done more for our Company and its work throughout the world than anything else we could have thought of. If we had struck a medal and given one to each of our shareholders, it might have cost 5s. or 20s. each, and thus represented a much larger expenditure than was incurred, and we should never have heard anything more about it. The money would have been spent, and the medals would have been practically useless, but this dinner will live in the memory of the present century (cheers). It was very highly appreciated (hear, hear). I have done a great deal of good work myself at a dinner, and I know what can be done on such an occasion where half-a-dozen thoughtful men meet. It is marvellous how things progress at a dinner (laughter).

Mr. JOHN NEWTON: I should just like to say a word or two on this subject, for I think that you acted quite rightly in connection with this banquet. In my early experience of submarine telegraph enterprise, I happened to know a certain gentleman who asked Mr. Cyrus Field this question: "How did you come to accomplish the carrying out of a cable from England to America?" He replied, "I sold my horses and carriages, and I gave a lot of banquets in New York." That statement was given to me soon after it was made by Mr. Field. Everyone knows what immense advantages arise from a banquet—of course, judicially given; and this banquet in celebration of our 25th anniversary was one of the most successful that has ever been held (hear, hear). I am perfectly satisfied with the position of the Company, and it has shown an example of strengthening its position and making itself secure, and you actually now say that you do not think it wise to increase the dividend. I think, however, that there is a way by which that object might be accomplished. Your reserve fund is one of the most splendid of any joint-stock company in the kingdom. No railway company makes its new lines and does its repairs to the extent we do out of reserve fund. A railway company, if it makes a new line, charges its cost to capital. Could you not see your way to giving us a bonus by issuing shares at par when you lay a new line, as you sometimes do, thus creating important feeders for the main system. You recently opened a cable at Borneo, which I am sure will be of immense advantage later on. You might possibly see some way of acting upon this suggestion. The Directors have done so well that to that fact we may attribute the circumstance that so little is said on this side of the table when we meet (hear, hear).

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The CHAIRMAN: Do you not think it very good policy, Mr. Newton, to leave well alone? We are doing uncommonly well. If we were going back in any way, and we required the spur, I should be very glad to entertain any proposition; but a very great statesman, when he was asked to go on, said, "Do you not think it better to leave well alone?" I think that the bulk of the ladies and gentlemen I am addressing now are satisfied with their 7 per cent. dividend, and will let well alone (cheers). I like a good dividend; but I do not care about having a good dividend to-day and no dividend next year. I want you to have confidence in this concern, that you may know that the dividend you receive to-day you will receive in years to come (hear, hear). That is our policy, and in these days of competition we have to keep our eyes open to see that things are not done which will lessen instead of increase our dividend. The policy we are pursuing of increasing our power without increasing our capital is one which I think no shareholder should object to; and I believe that the bulk of the shareholders of this Company will agree with me when I say, Let well alone (hear, hear). He then put the resolution, which was carried unanimously. Continuing, he said, I now propose "That Charles William Earle, Esq., who now retires by rotation, be and is hereby re-elected a Director of this Company."

Mr. F. A. BEVAN seconded the motion, which was unanimously carried.

The CHAIRMAN: I now propose "That George Garden Nicol, Esq., who now retires by rotation, be, and is hereby re-elected a Director of this Company."

The Marquis of TWEEDDALE seconded the motion, which was carried unanimously.

The CHAIRMAN: It was not necessary for me to say a word in regard to these two gentlemen, who have been connected with the Company from its inception. They have taken part in the good management of the Company, and I think you must feel that in re-electing them to-day you are paying them the compliment of exhibiting your confidence in them both as regards the past and the future. The next resolution, which relates to the appointment of auditors, will come from the shareholders' side of the table.

Mr. JOHN NEWTON: I propose "That Messrs. Deloitte, Dever, Griffiths and Co., and Messrs. Welton, Jones and Co., be and they are hereby elected auditors for the ensuing year at a remuneration of £100 each." I think that our auditors' certificate in this case is a very gratifying one, for they simply say, "Audited and found correct."

Mr. G. HEWAT seconded the motion, which was carried unanimously.

The CHAIRMAN having intimated that that concluded the business,

Mr. GIBB said: I move that a cordial vote of thanks be given to the Chairman and Directors for their able conduct of our affairs. I propose this resolution formally now, but really all the remarks that have come from this side of the table have substantially meant a vote of thanks. We all recognise that the work of the Company has been admirably done, both in large matters of policy, as in the Hobart Conference, and in small matters, comparatively, such as our 25th anniversary celebration. I propose this vote of thanks with great cordiality.

A SHAREHOLDER seconded the motion, which was carried by acclamation.

The CHAIRMAN: You have always been very kind to my colleagues and myself, and I can assure you that we have always appreciated your good-will and confidence. I am quite satisfied that no company can be prosperous if the shareholders are pulling one way and the Directors another (hear, hear). It has been our desire from the beginning to put you in possession of all the information that we considered it desirable you should have, and there is really very little that we know with which you are unacquainted. Moreover, if there is anything that you do not know at the moment you will hear of it very soon afterwards, because we carry on our diplomatic relations in such a spirit that they show themselves. At this very meeting we have been able to tell you with pleasure and pride that we have accomplished certain things since I last had the gratification of addressing you (hear, hear). I think we have made such arrangements with the Australian Governments as to show that they have thorough confidence in us, while we have every desire to benefit them. I thank you again for the confidence you repose in us.

The proceedings then terminated.

Submarine Cables Trust.

The thirty-fourth ordinary annual meeting of the certificate holders in the Submarine Cables Trust was held at the offices, Winchester House, Old Broad-street, yesterday (Thursday), Sir John Pender, G.C.M.G., M.P., presiding.

The SECRETARY (Mr. A. Brodrick) having read the notice calling the meeting and the minutes of the last meeting,

The CHAIRMAN said: You have had the report in your hands for some days, so I suppose you will take it as read, but before you do so I wish to make one amendment in it. It says, "The meeting will have to elect two auditors for the current year. Mr. John G. Griffiths and Mr. John Gane offer themselves for re-election." I wish it to be understood that it is the firms of these two gentlemen who are to be elected. The reason why I want this alteration made is that it might happen that Mr. Griffiths was away and that Mr. Gane was away, in which case any partner in their firms could do the audit. As it stands it binds us now to these two gentlemen to do the audit, and this might inconvenience us. It did inconvenience us on one occasion, and having experienced that inconvenience, the other companies in which these gentlemen act as auditors have made the alteration which I propose now to introduce in this Company. That is the only amendment which I have to ask you to approve being made in the report; but before I ask you to accept the resolution which I shall propose, I will give you, as has always been done on these occasions, a few figures showing you the position we are in to-day. The revenue for the past year amounted to £21,464, as against £22,592, or a decrease of £1,128. This is owing to our having received a smaller dividend for the current year on our investment in the Anglo-American Company. The expenses for the year amounted to £1,194, as against £1,301, or a decrease of £107. As will be seen from the report, the trustees regret to record the death of their colleague, Lord Monck, who was one of the original founders of the Trust. This in the principal cause of the reduction in the expenses. I may, however, mention that the total expenses are £805 less than the amount provided by the trust deed. Our revenue for the past year, including £240 brought forward from the previous year, has enabled us to meet two coupons of £3 each, but we have not been able during the year to pay anything additional off the remaining portion of the overdue coupon. There is therefore still a balance of £1. 5s. in arrear, but this, we anticipate, will be paid about the middle of July next. The present market value of the investments held by the trust, as compared with the cost price, shows an increase of over 52 per cent. The 3,381 certificates remaining uncancelled are therefore worth on this basis £150 each. This I think you will consider a very satisfactory condition for the Trust to be in, notwithstanding the regrettable decrease in the income divisible from our investment in the Anglo-American Company. There is very little more for me, gentlemen, to state further. As you know, the constitution of this Company is rather a peculiar one. If it went on long enough the oldest holder would be the possessor of the whole concern. However, that is a long way off. I shall not be present, and I doubt if any one here will be, but it is a very good legacy to leave behind us. I now beg to move—

"That the report and accounts of the trustees to April 15, 1895, submitted to this meeting be, and they are hereby received and adopted."

Mr. KENNETH L. M. ANDERSON seconded the motion, and it was carried unanimously.

The CHAIRMAN: This is a very quiet concern. When you see that the telegraphs are prospering you may be quite sure that this Company follows in the same direction. Our shares have advanced very considerably of late, and we have been purchasing them for some of our other Companies. I think that, on the whole, it is a good investment, and one so closely associated with the prosperity of the telegraphs that I can only say when they flourish we shall flourish with them. The next business is the election of auditors.

On the motion of Mr. LUCAS, seconded by Mr. E. CUNLIFFE OWEN, Messrs. Deloitte, Dever, Griffiths and Co., and Messrs. Gane and Jackson, were appointed auditors of the Trust for the current year.

Mr. LUCAS then proposed a vote of thanks to the Chairman for the very clear statement which he had made to the meeting, showing the very satisfactory condition of the Trust.

Mr. CUNLIFFE OWEN seconded the motion, and it was carried unanimously.

The CHAIRMAN: On behalf of my colleagues and myself I beg to return you thanks. I have had to do with the Company from its inception. It has gone on, I think, very steadily and quietly, and I believe it has a very good future before it. So far as we Directors are concerned we shall keep it out of trouble, if possible, and do everything we can to make it prosperous.

The proceedings then terminated.

Indo-European Telegraph Company (Limited).

The twenty-eighth ordinary general meeting of the members of this Company was held at Winchester House, Old Broad-street, on Monday under the presidency of Mr. J. Herbert Tritton.

The CHAIRMAN having declared the meeting duly constituted, called upon the Managing Director to read the notice convening it.

The MANAGING DIRECTOR (Mr. W. Andrews) having read the notice, the seal was affixed by the Chairman to the register of shareholders, and the report of the Directors was taken as read.

The CHAIRMAN: I have now to move—

"That the report and accounts now submitted be received and adopted, and that a dividend be and is hereby declared for the half-year ended December 31, 1894, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both free of income tax, making in all 10 per cent. for the year."

It is once more my pleasing duty to congratulate you upon the outcome of the working of the Company. The past year shows, it is true, a slight falling off in the business as compared with the year 1893, the total decrease in the traffic receipts from all sources amounting to some £3,750. The expenses are on all accounts £64,838, and compare with £64,959, so that practically they are the same. Following the prudent course which the shareholders have repeatedly approved, we have, however, written down certain items, and the actual expenses of working the system and maintaining the lines are somewhat lower. The falling off—or, as I should perhaps say, the fluctuation—of the message business has occurred mainly in the trade with India, and the loss would have been greater but that it has been partially compensated for by increases in other sources of revenue. You will no doubt remember that on a previous occasion I drew your attention to the fact that with Indian business there cannot be the same continuous and always increasing traffic which is expected, and which, indeed, almost invariably makes itself manifest with differently constituted communities, such as Australasia. I am pleased to tell you that the agreement with Australasia, under which the Governments guaranteed a proportion of the loss arising from the introduction of the low tariffs—without which guarantee these tariffs could not have been introduced—has been extended, and will now run for another five years. Certain modifications of the arrangement

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have been effected, but these are not likely to act prejudicially on our receipts, and I think I may congratulate you upon the establishment for so considerable a period of these low rates. Our business continues to be performed by our own and the Government lines in connection with ours in a manner which appears to be quite satisfactory to the mercantile public. We have no complaints, but many expressions of satisfaction; and those who actually use the wires, and who may therefore be supposed to know their own business and their own needs the best, in all the large number of letters exchanged with our Company, seem to feel that the return given by the Governments and the Company in the costly and efficient working and maintenance of their lines under circumstances, you will remember, of great difficulty, through pretty nearly all the extremes of climate in the world, is completely satisfactory. In fact, no exertion is ever wanted on our part to run abreast or even ahead of the requirements of the mercantile world, and we therefore feel some confidence that we shall continue to maintain with our customers the relations which have proved so agreeable down to the present time. Our whole system continues in excellent working order throughout. Our reserve fund also continues to flourish, owing, I may honestly say, to the extreme care with which the investments on that account have been, and, I trust, will continue to be made. It may interest you to know that at the present moment the investments if sold would realise upwards of £20,000 more than their cost price. There is just one other point which I think I ought to touch upon, seeing the very high price that our shares have reached, and that is the terminability of our concessions, which, as most of you are doubtless aware, run out in the year 1905—perhaps I should say are liable to terminate in the year 1905. In the concession to which I am now more particularly referring the clause relative to this particular point says that the Company is bound to come to terms with the Government before the date at which the concession would otherwise expire, and the lines pass over to the Government. Consequently, though I feel bound, under the circumstances, publicly to call attention to this point, I must not be understood, if you please, to do so with any pessimistic views whatever. Anything of that sort, indeed, is far from my thoughts, but I mention it because I feel that there may be some among our shareholders who are unacquainted with the details of the concessions. We shall, of course, the moment the proper time is held to have arrived, enter upon the negotiations which are pointed out in the concession itself as the necessary and proper course for us to adopt, and you may depend upon it that we shall be mindful of the great interests we have to protect. I need not repeat how much the Company owes to the most efficient services of our Managing Director, Mr. Andrews—who has this year completed his twenty-fifth year of connection with us—and also to Mr. Moll, Mr. Pagenkopf, and in fact to the whole of our staff at home and abroad. You could not be better served, we are well assured. The two Directors who retire are Major-Gen. Tremenheere and myself; but both offer ourselves for re-election. I now beg to propose the resolution which I submitted at the opening of these remarks.

Major-Gen. G. B. TREMENHEERE, R.E., seconded the resolution.

Mr. MacANDREW observed that the Chairman had stated that in regard to the concessions the Company was bound to come to an understanding with the Government before 1905. He would like to know what Government was referred to.

The MANAGING DIRECTOR intimated that it would not be advisable to go into details with respect to the different Governments.

A SHAREHOLDER inquired whether all the concessions would expire at the same time.

The CHAIRMAN: No, they do not all expire at the same time.

The CHAIRMAN then put the resolution to the meeting in the usual way, and it was carried unanimously.

Mr. C. W. EARLE next proposed the re-election as Directors of Mr. J. Herbert Tritton and Major-Gen. Tremenheere. He did not think it necessary to say a word in praise of either of these gentlemen, who had for so many years been well known to the shareholders.

Mr. C. HOLLAND briefly expressed his pleasure at seconding the motion, which was carried unanimously.

The CHAIRMAN, on behalf of Major-Gen. Tremenheere and himself, said they would be glad to devote themselves to serving the Company for the future as they had done in the past, and he thanked the shareholders for their re-election.

On the motion of Mr. ST. LAWRENCE SMITH, seconded by Mr. MacANDREW, the retiring auditors, Messrs. C. F. Kemp, Ford and Co., were re-elected.

Mr. MacANDREW then proposed a vote of thanks to the Chairman for presiding and to the Directors and staff for their management of the Company's business.

Mr. HÖLTZER seconded the motion, which was carried unanimously.

The CHAIRMAN acknowledged the vote, and the proceedings then terminated.

Oriental Telephone and Electric Company (Limited).

The first annual general meeting of this Company was held on Monday, April 29, 1895, at Cannon-street Hotel, Mr. William Addison presiding.

The SECRETARY (Mr. Alexander B. Chalmers) read the notice convening the meeting.

The CHAIRMAN said: Gentlemen, before moving the adoption of the report and accounts, I am glad to tell you that the reconstruction of the Company has been accomplished satisfactorily, and with as little expense as could have been anticipated. We are now fairly launched on our new career, with all the shares of the Company of the same value, and without a fraction of liability on any of them. This result has not been attained, however, without considerable trouble and anxiety to your Board, but I feel sure its effects will be conducive in many ways to the welfare of the Company; there are now no conflicting interests. You will recollect that the liquidators of the old Company made a distribution last year to the shareholders equal to nearly 4½ per cent. per annum on the amount of the new capital, and for a period of 14¼ months, consequently the dividend now to be paid will only be for about 9¾ months, as explained in the report. I am glad to say that the business generally is progressing, and although the capital of the Company is more than that of the old Company, on which dividends were paid, the rate per cent. of the dividend is higher than in any former year. In dealing with the net amount available for distribution, I think you will all agree that the policy of the Board in writing off the whole of the preliminary expenses of the present Company is a sound one. The subsidiary companies in India call for little comment from me. Their revenues, I am glad to say, are improving, and should silver rise in value we may expect still better remittances on account of the shares which we hold in them. Athough exchange has told hardly against the business of the China and Japan Telephone Company, we hope now that the war has been concluded, the business of that Company may be extended. I do not think there is any other point in connection with the report to which it is necessary for me to refer. Turning to the balance sheet, you will notice on the credit side the item of goodwill and expenditure on exchanges is set down at £69,189. 0s. 6d., which your Directors think a moderate figure. You will see that the valuation of the shares, &c., held in subsidiary companies, is set down at £86,713. 2s. 6d., against £91,937. 14s. 10d. in the old Company's balance sheet, the difference being occasioned by the writing down of the value of the rupee securities from 1s. 5d. to 1s. 1d. exchange. The only other item to which I shall refer is that of £13,004 0s. 7d. in Two and Three-quarter Consols, which have been taken in at the value put upon them by the old Company, viz., cost price. In conclusion, I think under all the circumstances the shareholders of this Company may congratulate themselves upon owning a property which is thoroughly sound. If there is any point to which I have not referred, and on which anyone present is desirous of information, I shall be glad to give it.

Mr. BENNETT PELL asked for the total market value of the shares held by the Company in subsidiary companies. According to quotations in the newspapers he found that the shares in the Bengal Company were quoted at 100 rupees, and that, taken at 1s. per rupee, would work out at about £28,000 for these shares only. Then there were the Preferred shares in the Telephone Company in Egypt, the value of which worked out at about £60,000, so that they had in those two items alone more than the amount at which the whole of the shares in subsidiary companies stood at in the balance sheet.

The CHAIRMAN: I do not see how you can value the Egyptian shares as there is no market for them. The shares in the Bengal Company are taken at the valuation put upon them some years ago.

Mr. PELL remarked that he simply wanted to point out that their property was undervalued.

Commander HANNAY, R.N., said it appeared to him that the report was eminently satisfactory, considering that they had brought in the Vendors' shares, and were still able to pay a substantial dividend. One thing he could not make out was why there did not appear to be any improvement in the value of their shares on the Stock Exchange, although their Company had progressed.

The CHAIRMAN: I do not quite agree that no improvement has taken place in our shares, inasmuch as a few months ago they stood at 10s. per share, and I believe they are a little higher now. If there is no other question, I will move the following resolution:—

"That the Directors' report, together with the accounts and balance sheet to December 31, 1894, be approved and adopted, and that a dividend at the rate of 4½ per cent. per annum, free of income tax, be declared on the paid-up capital of the Company for the period from March 12th to December 31, 1894."

The resolution was agreed to *nem. con.*

Mr. B. ST. JOHN ACKERS moved the re-election of the Chairman as a Director, which was seconded by Commander HANNAY and agreed to.

The re-election of Mr. T. Lloyd, proposed by the CHAIRMAN, and seconded by Mr. HENRY GREWING, was also approved. The re-election of the auditors, Messrs. Deloitte, Dever, Griffiths and Co., at a fee of 50 guineas, having been carried,

Commander HANNAY proposed, and Mr. SEAMAN seconded, a vote of thanks to the Chairman and Directors, which was unanimously accorded, after which the proceedings terminated.

London Platino-Brazilian Telegraph Company (Limited).

The following report of the Directors of this Company to December 31st last will be presented to the seventeenth ordinary general meeting, to be held at the offices, Blomfield House, 85, London-wall, London, E.C., on Monday next, May 6th, at 12 o'clock:—

The total earnings for the period amount to £20,674. 6s. 8d., as against £24,585. 7s. 3d., a decrease of £3,911. 0s. 7d. compared with the previous year. The working expenses amount to £8,327. 8s. 3d., as against £8,606. 19s. 2d., a decrease of £279. 10s. 11d. Including the amount brought forward from 1893 (£179. 10s. 9d.), the balance to the credit of the revenue account is £12,526. 9s. 2d.; from this has been deducted £6,000 for debenture interest; this leaves, after placing £1,500 to reserve, £5,026. 9s. 2d. The Directors recommend that a dividend at the rate of £1. 5s. per cent. per annum (2s. 6d. per share) be paid for the year, carrying forward £332. 19s. 2d. The dividend will be paid on May 6th.

The lines of the Company are in good working order.

The retiring Directors are Mr. John Coppen and Mr. C. W. Earle, who offer themselves for re-election, as do the auditors, Messrs. Deloitte, Dever, Griffiths and Co.

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NEW COMPANIES, STATUTORY RETURNS, &c.

JANDUS ARC LAMP AND ELECTRIC COMPANY (LIMITED).—This Company was registered on April 24th, with a capital of £20,000, in £10 shares, to acquire from John B. Barton certain patents for "improvements or connected with electric arc lamps," and the benefit of all improvements in arc lamps already made or to be made by John B. Barton and William Jandus, and for that purpose to enter into an agreement made February 20, 1895, between J. B. Barton and A. A. Gillies (for the Company), to manufacture, sell and supply Jandus electric arc lamps, and other electric lamps and apparatus, cables, conductors, insulators, globes, carbons, plant, machinery, and to carry on the business of an electrical company. The subscribers, with one share each, are: Bernard M. Dfake, T. A. Earle, E. N. Galloway, S. Garnett, J. T. Petrocokino, F. Reddaway, and A. Gillies. The first Directors are Bernard Drake, T. A. Earle, E. N. Gallowry, J. M. Gorham, J. T. Petrocokino, F. Reddaway, and J. B. Barton.

LAMP MANUFACTURING COMPANY (LIMITED).—This Company was registered on April 26th, with a capital of £20,000, in 10,000 Preference and 10,000 Ordinary shares of £1 each, to enter into an agreement with the Lamp Manufacturing Company, and the liquidator thereof (Mr. Harvey E. Preen), for the acquisition of the old Company's business, and to carry on the business of manufacturers of and dealers in lamps of every description, mechanical and electrical engineers. &c.

R. NAPIER AND SONS (LIMITED).—This Company has been registered with a capital of £250,000, in shares of £10 each, to carry on the business of shipbuilding and engineering upon the Clyde or elsewhere, and to acquire the goodwill of the business of R. Napier and Sons, engineers and shipbuilders, at Glasgow and Govan. The old firm constructed the cable steamers "Electra," "Mirror," "Amber," and "Recorder."

HUBERT GRENFELL (LIMITED).—An agreement with Gilfrid G. B. Cresswell, Evan M. Protheroe, Hubert H. Grenfell, Robest H. Pringle and Peter Strickland, provides for the acquisition of the rights and interests of these gentlemen in connection with the manufacture and sale of electric night lights and improved curved bar sights for ordnence, as from January 1, 1895, in consideration for the allotment as fully paid of 3,250 Ordinary shares of £1 each. An agreement with Capt. H. H. Greenfell, R.N., provides for the sale to the Company of the vendor's interest in British patents No. 13,549 (1888) for "improvements in apparatus for aiming or directing ordnanee; No. 7,711 (1889) for "improvements in sights"; No. 9,423 (1891) for an improved holder of electric incandescent lamps"; No. 934 (1892) for "improvements relating to sighting and indicating apparatus for ordnance;" and No. 10,637 (1893) for "improvements in sighting apparatus for guns"; and the French, Belgian, German, Austrian, Italian, Swiss, and United States patents for the same, subject to agreements with the persons mentioned in the contract described above, with Sir W. G. Armstrong, Mitchell and Co. (Limited), with Fried Krupp, and with G. Canet, of Paris, and also the business carried on by the vendor in connection with the said patents, in consideration for the allotment as fully paid of 5,000 Ordinary shares of £1 each.

HOUSE-TO-HOUSE ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company to February 22nd has been filed. The nominal capital is £350,000, divided into 57,900 Ordinary, 100 Founders', and 12,000 Preference shares, all of £5; 8,322 Ordinary, all the Founders', and 5,000 Preference shares have been taken up, and 1,000 Ordinary and the Founders' shares have been issued as fully paid. The full amount has been called and paid on the remaining 7,322 Ordinary and 5,000 Preference shares.

KESWICK ELECTRIC LIGHT COMPANY (LIMITED).—The annual return of this Company to March 14th has been filed. Out of a nominal capital of £5,000, in £1 shares, 3,420 have been subscribed for and allotted, and upon each of these the full amount has been called and paid.

LANCASHIRE AND YORKSHIRE ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return of this Company, to July 12, 1894, was filed on April 2nd. Out of a nominal capital of £100,000, in £5 shares, 127 have been taken up, upon which a call of £2. 10s. per share has been made.

LIVERPOOL ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company, to February 22nd, has been filed. The nominal capital is £300,000, in £5 shares, and 50,000 of these shares have been subscribed for and allotted. The full amount per share has been called, resulting in the payment of £250,000.

LOWCOCK, HILL AND CO. (LIMITED).—The statutory return of this Company to April 19th has been filed. The nominal capital is £15,000, in £10 shares, and 407 have been taken up. Of these 400 have been issued as fully paid to G. W. Lowcock and G. Hill, electrical engineers, of Manchester. The full amount has been called on the seven signatories' shares, but nothing has been paid thereon.

MAZARRON ELECTRIC LIGHT COMPANY (LIMITED).—The annual return of this Company to March 14th has been filed. The nominal capital is £15,000, divided into 500 £800 per cent. £10 Preference shares and 10,000 £1 Ordinary shares, and of these 131 of the former and all of the latter have been taken up; 9,993 Ordinary shares have been issued as fully paid, and the full amount has been called and paid on the remainder.

MERVEILLEUSE ELECTRIC ARC LAMP SYNDICATE (LIMITED).—The annual return of this Company to April 8th has been filed. Out of a nominal capital of £15,000, in £1 shares, 10,107 shares have been taken up, and 9,000 of these have been issued as fully paid. The full amount has been called on the remaining 1,107 shares, resulting in the payment of £725, and leaving £382 as arrears.

NOTTING HILL ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return of this Company to March 12th has been filed. The nominal capital is £100,000, consisting of 6,452 Ordinary, 550 Founders', and 2,998 Ordinary Preference shares of £10 each. All the Ordinary and Founders' and 1,737 Ordinary Preference shares have been subscribed for and allotted. The full amount has been called on all the Ordinary and Founders' and 1,370 of the Ordinary Preference, and a call of 10s. per share has been made on the remaining 367 Ordinary Preference, resulting in a total payment of £83,903. 10s.

CITY NOTES.

ALUMINIUM.—The report of the Aluminium Industry Company, of Neuhausen, Switzerland, for last year shows a profit of £36,953, as against £31,500 in 1893, a dividend at the rate of 10 per cent. being declared.

BERLINER ELEKTRICITATSWERKE.—The capital of this Company has been increased by 3,600,000 marks (£180,000), so that the total capital is now 12,600,000 marks (£630,000).

BIRMINGHAM CENTRAL TRAMWAYS COMPANY (LIMITED).—Mr. J. Ebbsmith has retired from the Chairmanship of this Company, and Mr. Neale has been elected in his stead. It is stated that Mr. Ebbsmith will remain on the Board as an ordinary Director.

BULUWAYO (SOUTH AFRICA).—Amongst the objects of the Buluwayo Waterworks Company (Limited), prospectus of which is issued this week, and for which a capital of £200,000 is invited, are to supply to the town of Buluwayo and the suburbs thereof, electric current, and the erection of the necessary plant for the generation thereof, laying of mains, &c. Shade of Lobengula, what a change was there.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended April 28th were £900, as against £901 in the corresponding week of 1894, being a decrease of £1. The total receipts for the half-year amount to £16,119, against £15,514 for the corresponding period of 1894, an increase of £605.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of April, 1895, amounted to £67,046, against £56,751 in the corresponding period last year, an increase of £10,295.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of April, 1895, amounted to £38,080, and to £38,802 in the corresponding period of last year.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 28th ult. amounted to £1,121. The amount for the corresponding week last year was £667.

LUDWIG LOEWE AND CO. (LIMITED), BERLIN.—At a recent meeting of shareholders of this Company a dividend of 20 per cent. for 1894 was declared. It was also decided that the original capital should be raised by 2,250,000 marks (£112,500), for the purpose of building new works for the manufacture of electrical machinery, which has hitherto had to be bought from foreign makers. The issue of Four per Cent. Bonds of the amount of 10,000,000 marks (£500,000), to replace the existing Four and a-Half per Cent. Bonds of 6,500,000 marks (£325,000), and to increase the Company's working capital, was also agreed upon.

MIX AND GENEST (LIMITED), BERLIN.—At a meeting of the shareholders of this Company, held last week, a dividend of 11 per cent., payable forthwith, was declared for the year ended December 31st last. The gross profit amounted to 434,552 marks, which, after deducting expenses amounting to 152,391, leaves an available profit of 282,161. After writing 48,000 marks off plant and tools account, and 40,000 marks off patents (which latter stands now nominally at 1s. only), and after transferring 7,000 marks to workman's benevolent association, a balance of 690 marks was carried forward to next account. The Directors state that the works have been busy since the beginning of the present year, with large orders from various Governments, as well as from their regular trade customers, and the prospects are very promising, and the working staff, numbering nearly 1,000 hands, are fully employed. The Company have concentrated their various works since the beginning of January into their new factory, upon which, including outfit, 1,100,000 marks has been expended. The new building is fitted up with the most modern machinery and appliances, and sufficient adjoining land has been acquired for any ultimate extension that may be required.

UNION ELEKTRICITATS-GESELLSCHAFT OF BERLIN.—This Company considerably improved its financial position in 1894, and after writing off the deficit of 1893—£8,500—has now declared a dividend of 8 per cent. on its capital of £75,000.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—Yesterday (Thursday), the Directors of this Company, at their meeting, after placing £8,000 to reserve and £5,000 to the debenture redemption fund, and subject to audit, decided to recommend to the forthcoming meeting of shareholders a dividend of 6s. per share, free of income-tax. This will give 6s. to the Ordinary, 4s. 6d. to the Preferred Ordinary, and 1s. 6d. to the Deferred Ordinary shares, which, with the interim dividend paid in November last, makes a total distribution of £3 per share for the year ended December 31, 1894. The traffic receipts for the week ended April 26th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), amounted to £3,178, and to £2,871 in the corresponding period of last year, being an increase of £307.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Apr. 24.		Price Tuesday, Apr. 30.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Apr. 30. Highest	Lowest
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	10/0	Anglo-American	44	46	44	46	4 7 0	Jan., Apr., July, Oct.	45⅝	45
£2,993,560	Stock	20/0	Do. Preferred	82	83	81½	82½	4 17 0	,, ,,	82⅞	81¾
£2,993,560	Stock	5/0	Do. Deferred	8¼	8¾	7¾	8¼	..	,, ,,	8½	8
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	101	104	3 17 10	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	12¼	12¾	12½	13	5 0 0	Mar., June, Oct., Dec.	12⅞	12 5/16
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	110	114	110	114	4 9 1	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	148	152	148	152	4 12 1	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	13½	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	,, ,,	..	..
12,931	5	2/0	Direct Spanish (fully paid)	3½	4½	3½	4½	4 8 11	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10	9¾	10¼	4 7 7	,, ,,	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	9	9½	9	9½	4 4 3	Jan., Apr., July, Oct.	9½	..
400,000	10	2/6	Eastern	16¼	16¾	16¼	16¾	3 19 6	,, ,,	16 5/16	16½
70,000	10	6%	Do. 6 per Cent. Preference	17¼	17¾	17¼	17¾	3 7 7	,, ,,	17⅝	..
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	124	127	124	127	3 4 0	May and November	125½	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105	108	105	108	4 13 8	February & August	..	..
250,000	10	2/6	Eastern Extension	17½	17¾	17½	17⅞	4 0 8	Jan., Apr., July, Oct.	17⅞	17 5/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	123	126	123	126	3 3 6	February & August	125½	124
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	107	104	107	4 15 0	January and July	106	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	107	104	107	4 15 0	,, ,,	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106	109	106	109	3 14 0	February & August	..	—
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	112%	115%	3 10 10	May and November	..	—
180,227	10	2/3	Globe Telegraph and Trust	9¾	10¼	9¾	10¼	4 8 11	Jan., Apr., July, Oct.	10 3/16	9 15/16
180,042	10	6%	Do. 6 per Cent. Preference	16⅝	16⅞	16⅝	16⅞	3 11 3	,, ,,	16⅞	16⅝
150,000	10	7/2	Great Northern	22	22½	21¾	22¼	3 15 7	Jan., April, and July	22⅜	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	..	..
17,000	25	12/6	Indo-European	51	53	51	53	4 14 4	May and November	..	..
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	105	109	105	109	5 11 1	March & September	..	—
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	108	105	108	3 14 11	..	..	—
11,839	8	4/0	Reuter's	4	5	4	5	..	April and October	..	—
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	122	127	122	127	4 14 6	,, ,,	..	—
15,609	10	5/0	West African Telegraph	4	6	4	5	..	January and July	..	—
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	101	104	102	105	4 15 11	March & September	103½	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	—
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	103	98	103	7 15 4	June and December	..	..
88,321	10	6d.	West India and Panama	1	1½	⅞	1⅜	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	11	11½	11	11½	5 4 4	May and November	11½	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	109	112	109	112	4 10 8	June and December	..	..
64,242	15	3/0	Western and Brazilian	9¾	10¼	9¾	10¼	4 9 5	May and November	10 1/16	..
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	—	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	3¾	4¼	3¾	4¼	..	..	3 13/16	..
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5 15 11	February & August	..	—
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5 15 11	,, ,,	..	—
$1,211,000	$1,000	7%	‡Western Union 7% 1st Mort. (Building) Bonds	115	120	115	120	6 0 2	May and November	..	—
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	101	103	101	103	5 17 8	March & September	..	—
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	—	..	..	..
224,850	10/0	2⅔d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	—	May and November	..	—
171,504	£1	..	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	9/16	..
484,597	5	2/6	National	5¼	5¾	5¼	5¾	4 13 0	June and December	5 5/16	5 5/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15½	16½	15½	16½	3 12 9	,, ,,	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	,, ,,	..	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¾	6	5¾	6	4 3 4	—	6	..
1,000,000	Stock	3⅔%	* Do. Debenture Stock, 4½% (red.)	104	106	104	106	3 6 0	January and July	105½	..
58,000	5	1/0	United River Plate	1	2	1	2	..	,, ,,	..	—
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	85	90	85	90	5 9 11	,, ,,	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	13	14	13	14	1 15 8	—	13¾	13½
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15	15½	15	15½	3 17 5	..	15⅝	15
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	135	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	..	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5	5½	5¼	5¾	..	—	5 9/16	5⅝
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900					..	—	..	—
8,322	£5	..	House-to-House Electric	..		..		..	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		..	—	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	..	—
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7½	7¾	7⅝	7⅞	..	—	—	—
111,000	5	..	London Electric Supply	..		..		..	—	..	—
49,900	£10	6/0	Metropolitan Electric Supply (fully paid) xd	10	10½	10	10½	2 17 2	..	10⅜	10 1/16
£150,000	Stock	4½%	* Do. 4½% Debs.	118	120	118	120	3 15 11	June and December	..	—
6,452	£10	2 0	Notting Hill Electric	7¼	7¾	7¼	7¾	..	..	..	..
19,980	£5	4/6	St. James and Pall Mall	7½	8	7½	8	..	—	8	7 15/16
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8½	9	3 17 9	—	9	..
59,900	5	5%	Westminster Electric Supply (fully paid)	7⅝	7⅞	7¾	8	3 2 6	—	..	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅜	2⅝	2⅜	2⅝	5 14 3	—	2 9/16	2½
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2¼	2½	4 16 0		2½	2⅜
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	113	116	113	116	3 18 1	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref	2½	3	2½	3	—	January and July	2⅝	..
12,139	5	—	Edison and Swan United	1⅝	1⅞	1⅝	1⅞	—		—	—
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		—		—	..	—	..
120,000	2	..	Electric Construction	¼	½	¼	½	..	..	⅜	..
12,845	2	2/9⅔	Do. 7 per Cent. Cumulative Pref.	1¼	1¾	1¼	1¾	—	..		[illegible]
91,195	2	10/0	Elmore's Patent Copper Depositing	1¼	1⅜	1	1¼	—	..	..	—
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	—	..	1	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	February & August	22 1/16	21¾
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	101	103	101	103	4 7 7	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..	..	..	..
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	⅛	—	⅛	..	..	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	39	41	39	41	8 15 7	March and July	39⅝	—
£150,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4 11 9	January and July	..	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,870	10	12/0	W. T. Henley's Telegraph Works Ordinary	9½	10½	9½	10½	5 14 3	..	..	..
£30,000	10	..	Do. Preference	..		..		..	..	..	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1¼%	City and South London Railway	45	47	45	47	2 13 2	May and November	46	..
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	..	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture xd	130	133	128	131	3 1 1	May and November	..	..
37,500	£10	2%	Liverpool Overhead Railway	8¾	8⅞	8½	8⅝	2 6 4	..	..	..
6,295	10	5%	Do. 5% Preference	14	14½	14	14½	3 11 5	..	..	..
125,000	Stock	4%	Do. 4% Debenture	112	114	110	112	3 10 2	January and July	..	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 886. [No. 2: Vol. XXXV.] FRIDAY, MAY 10, 1895. PRICE SIXPENCE.

NOTES.

It would appear as if the question of the duration of municipal electric lighting loans were at last settled. The periods agreed upon by the Treasury and the London County Council, viz., 50 years for land, buildings, culverts, and bare copper mains, and 20 years for all other items, were not to the liking of the London Vestries; and pertinacity has once more won the day. The Lords of the Treasury have compromised the matter. In future municipal electric lighting loans may be granted for 42 years, provided that the cost of all renewals of plant, &c., bought with money raised for this term, be defrayed out of revenue or from a renewal sinking fund. If it prove practicable to keep local authorities to the conditions of the bond, the requirements of sound finance would seem as likely to be complied with by this arrangement as by the one originally promulgated.

There is no work which deserves better of the electrical industry than that of bringing to the notice of municipal engineers, and their employers, the manifold advantages of electricity as a lighting and power agent. The main fact to drive home on such occasions is that the business, if properly managed, can be made an assured financial success. The unvarnished, but thoroughly convincing tale, which Mr. Wright had to tell the Incorporated Association of Municipal and County Engineers at their recent meeting at Brighton should, therefore, have considerable influence, since his discourse on the points of interest in the development of electric supply at Brighton bristled with figures, but not with technicalities. Brighton, Mr. Wright took no little pride in pointing out, is a town of considerable electro-historic interest. It was the first town in England to possess a central station erected for the express purpose of affording an electric supply, and it also led the way in the use of meters. It has, moreover, seen the rise—and fall—of many different systems of distribution. First came series arc lighting, then the multiple-series system, the house-transformer system, the two-wire system, the three-wire continuous system; and, lastly, a happy combination of an alternating with a continuous supply. Last, but not least, Brighton has given its name to the well-known differential method of charging which is destined to do much towards lightening the load on the central station manager's mind.

Dr. Fleming makes some useful suggestions in our present issue with regard to the representation of periodic currents by polar diagrams. The chief objection to the use of polar curves is that they are not so well understood as the more ordinary ones in which rectangular co-ordinates are used, and, moreover, as squared paper is no longer of service in plotting them, they are not so readily drawn. On the other hand, they possess some undoubted advantages, and polar ruled paper, with a pole in the middle and radial lines from the pole and a succession of thick and thin concentric circles, could very well be manufactured; and though this style of paper would be limited in its use to the delineation of periodic functions, it would probably find a considerable number of grateful patrons. The area of these curves has a simple meaning, the importance of which Dr. Fleming points out in his present article. Moreover, the ordinary sine curve used to represent alternate currents is replaced by a circle in the polar method; that is to say, by a curve whose properties everyone is familiar with. Two sine curves separated by a difference of phase become, on the new system, two circles intersecting at the phase angle. It becomes interesting to consider whether some of the properties of alternate currents, usually demonstrated by means of sine curves, could not be more easily be proved by means of circles. The polar method will probably be even more useful when the currents do not obey a pure sine law, for in such cases averages of squares are dealt with, and, as Dr. Fleming points out, these averages are most readily obtained by inspection of the polar curve.

At the conclusion of his series of lectures on "Alternating and Interrupted Electric Currents," at the Royal Institution, Prof. Forbes showed, in a very beautiful manner, an experiment which, though due to Lord Armstrong, and by no means recent, has been seen by few audiences, and is little known. We refer to the mechanical effect of very high pressure uni-directional currents on a piece of wetted thread or wick connecting two vessels of distilled water. The passage of the current causes the wick or thread to move bodily in the reverse direction to the current, while the water creeps along in the same direction as the current. We have already referred to the original form of this experiment in connection with the changes in the insulation resistance of bare copper conductors, when they are switched into circuit. The form of experiment exhibited by Prof. Forbes is a modification of the original one due, we believe, to Mr. Campbell Swinton. An inner and an outer glass vessel were filled with distilled water, the vessels communicating with one another by a small orifice in

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the conical bottom of the inner vessel. Some thread was placed in this vessel, and the end of the thread inserted in the orifice. The whole arrangement was projected on a screen. On starting the current from the outer to the inner vessel, the thread was seen to glide at a uniform rate from the orifice, while the convection currents of the inflowing water could clearly be seen in the inner mass of water. When the current was reversed the thread receded into the orifice, and streams of water poured from the orifice into the outer vessel. Perhaps, as Prof. FORBES hinted, there may be the germ of a useful electrical measuring instrument in this very interesting phenomenon. At any rate, some quantitative investigations of it might be made with advantage to pure, if not to applied, science.

AN interesting relation between the currents at various loads, in a synchronous motor, was pointed out by Prof. SILVANUS THOMPSON in the discussion on Mr. W. G. RHODES's Paper at the Physical Society last Friday week. The chief interest lies in a certain resemblance between this relation and the well-known JACOBI's "law" of maximum output of continuous-current motors. JACOBI showed that such a motor is at its maximum rate of working when the back electromotive force cuts the current down to one-half of that which passes when the motor is at rest. Mr. RHODES's development of the fundamental equation for synchronous motors showed, as Prof. THOMPSON observed, that a motor of this type will be generating its maximum power when the current in it is cut down to one-half of that which passes, not when the motor is at rest, but when it is running round idle on frictionless bearings.

THE curious phenomena which a correspondent describes this week, in connection with the glowing of vacuum tubes, has been observed frequently by other experimenters, but we do not remember to have met with an adequate explanation. It is probable, if not almost certain, that the effects are due to the tube acting in some way as a condenser; but it is difficult to see how such small tubes as those in which the effects may readily be produced can have electrostatic capacity enough to give such sharp shocks, or to develop so brilliant an after-glow. The effects are quite distinct from those which are associated with the name of TESLA, and which occur when the tube is placed on a potential gradient in an externally excited field. It is easy to see how the phenomena would be induced under those conditions. But in the instance cited by Mr. W. LOMAS, this week, the tube is assumed to have been removed from the external field, and, though it is evident that the tube acts as a condenser, itself giving rise to the glow which occurs, it is not so easy to understand how apparently so minute a capacity can develop such marked effects. We hope that some of our readers will be able to throw light on what must be regarded as a set of obscure phenomena.

IN commenting on Mr. CROMPTON's recent Paper, on "The Use of Electricity for Cooking and Heating," the *Journal of Gas Lighting* confesses that the heating of water for household purposes, which has proved a rock of offence to electrical heating, "is still the gravest problem to be solved by those who would popularise gas fuel." It is not at first easy to see why the ordinary coal fire gains such an advantage over gas and electric heating in this matter of kitchen boilers, while it is completely beaten by them in all other thermo-domestic work. The fact is simply that the kitchen boiler is a somewhat scientific and efficient affair. This arises from the brick setting in which the boiler is placed, and in a properly arranged kitchen apparatus a very high percentage of the heat of the gases may be made to pass into the water, and the moment anything like a reasonable number of heat units are utilised, electric heating, which has only some 6 per cent. of the total given to it to do the best it can with, becomes, commercially speaking, out of the running.

Light Railways Bill.—This Bill was again down for Second Reading in the House of Commons yesterday.

Personal.—Mr. C. Faraday Proctor has been elected a Member of the Institution of Mechanical Engineers.

Trunk Telephonic Communication in Spain.—The telephone trunk line between Madrid, Saragossa and Barcelona was put in operation on the 26th ult.

Helmholtz Monument.—Committees have been formed in Berlin and Frankfort for the purpose of collecting money for a Helmholtz monument, to be erected at Berlin.

Cable Interruptions:	Date of Interruption.
Latakia—Cyprus	Nov. 27, 1894.
Gibraltar—Tangier	April 24, 1895.

The Researches of M. Melsens.—The students of the late M. Melsens, so well known for his work in connection with lightning conductors, have undertaken the publication of his scientific memoirs.

Electric Traction Bills.—The Earl of Morley's Committee on unopposed Bills has passed the Bill giving an extension of time for the construction of the City and South London Railway from Stockwell to Clapham Common. On Monday last the Dublin United Tramways Bill was read a second time.

Low Temperature Research.—At the General Monthly Meeting of the members of the Royal Institution on Monday afternoon, the special thanks of the members were returned to Mr. George Matthey for his donation of £50 to the fund for the promotion of experimental research at low temperatures.

A Pyrometer Competition.—One of the gold medals being offered this year for competition by the Société Industrielle de Rouen is for an improved pyrometer. The apparatus is to be portable and capable of indicating temperatures of over 300°C. All drawings, designs, &c., are to be sent to the President of the Society before September 2nd next.

Light Railways in Ireland.—In the House of Commons, on Tuesday last, in answer to Mr. Strachey, Sir J. Hibbert said the Acts of 1883, 1889, and 1893 authorised the Treasury to give assistance to light railways and tramways not exceeding a total sum of £65,000 per annum. Of this sum £30,722 was hypothecated to payments for which the Treasury had made itself liable in aid of guaranteed dividends.

Electrically-Propelled Vehicles.—Mr. Naoroji, in the House of Commons, has asked whether the President of the Board of Trade proposed to take steps for allowing vehicles propelled by stored electricity or petroleum, if unobjectionable to the public, to be freely used in this country.—Mr. Shaw-Lefevre, in reply, said he was about to introduce a Bill upon this subject, which he hoped would meet the views of the hon. member.

Obituary.—We regret to announce the death of Mr. Thomas Fuller, who expired at Brighton last Friday, aged 63. Mr. Fuller was Managing Director of the Brazilian Submarine and African Direct Telegraph Companies, and a Director of the West African, the Pacific and European, and the Europe and Azores Telegraph Companies, His loss will be greatly regretted

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by all who came in contact with him during his long connection with submarine telegraphy.

Société Internationale des Electriciens.—The Council of this Society for the year 1896-97 will be composed as follows:—President: M. Gaston Sciama. Vice-Presidents: M. Léon Violet, M. G. Violle. General Secretary: M. A. Hillairet. Secretaries: M. P. Boucherot, M. Paul Janet. Members: MM. J. Aylmer, Victor Bélugou, Ernest Boistel, Ch. E. Chaperon, Ed. Clémancon, E. Ducrétet, E. Harlé, Ed. Labour, G. Lippmann, E. Marey, H. Ménier, F. Meyer, H. Pellat, Poincaré, J. Sarcia, de la Touanne, Eugène Sartiaux. Finance Committee: MM. Armengaud, jun., A. Berthon, G. Masson.

The Gülcher Arc Lamp.—This day legally expires patent No. 2,038, dated May 10, 1881, which was granted to R. L. Gülcher for "Improvements in Electric Lighting Apparatus." The patent originally embodied two important items; firstly, the well-known Gülcher lamp with its electro-magnet turning on a pivot and attracted by a fixed iron bar; and secondly, a claim for the system of running the lamp in parallel with others. But the invention of the parallel system was disclaimed by the patentee in a formal disclaimer dated October 18, 1882, and an amended specification was published on that date.

American Motormen.—According to the *Electrical Engineer* of New York, a Bill has been introduced in the New Jersey Legislature providing that none but an American citizen over the age of 21 years shall be employed as a motorman in New Jersey. He must undergo an examination as to his fitness before a Board of three motormen selected from among the employés by the superintendent of a road. In order to avoid difficulty in time of strikes, through the refusal of the Board to act, the Bill provides that in such case the Directors of the Company may choose three electricians to examine and license motormen. The Bill also fixes 11 hours, with 45min. for meals, as a day's work for a motorman.

Death from Electric Shock.—A recent accident in the mines of the Leavenworth Coal Company, reported by the *Electrical Engineer* of New York, opens the question as to the possibility of death from a 280-volt shock. One of the labourers was killed, apparently by an electric shock received while handling the machine, notwithstanding the fact that the pressure on the circuit did not exceed this amount. Continued efforts failed to restore animation, although the current was shut off immediately. A post-mortem examination by physicians showed that the heart and brain, and indeed the entire body, was sound, and no marks were present to show the cause of death. The deceased was a strong, well-built man.

Track Bonding.—In a commmunication to the American Institute of Electrical Engineers, Mr. George P. Low, of San Francisco, describes a bonding system devised by F. T. Newberry, a civil engineer of the Pacific coast. It is termed "direct bonding," and the bond consists simply of a copper dowel pin that is shrunken fit into holes drilled into the abutting rail ends. Two or more are used at a joint. The holes are bored just before placing the rails. The ends are heated with a gasoline torch. The dowel pins are driven in the end of one rail, and the abutting rail is forced over the other end of the dowel. With $\frac{5}{16}$in. pins in 70lb. rails, the carrying capacity of two pins would be one-half that of the rail. The bond is protected thoroughly, and its connecting surface is seven times its cross-section. The shrunken fit secured is said to be very tight, and if the bond is not injured by slight lateral movements of the rail ends, it ought to have some advantages.

Electricity in Mills.—At Blies-Schweyen, near Saargemünd, a water-power generating station has been erected for the purpose of supplying current to adjacent works. The plant has a head-water canal of about one mile in length, which supplies about 500 cubic feet per second. The total fall is 13·1ft. There are three turbines of 200 H.P. each, which drive on to a main shaft. From this latter at present two 135-kilowatt "drehstrom" generators of the Oerlikon type are driven by belt, which at 375 revolutions give a potential of 2,900 volts. The exciters are coupled direct to each machine. The first consumer is a paper mill at Ensheim, a distance of about four miles from the power house. Here three 30-kilowatt transformers are employed to transform the current down to 120 volts, driving four motors and lighting the mill.

Brewery Worked by Electricity.—The *Zeitschrift für Elektrotechnik* gives, in its last number, a description of an interesting electrical plant at the Zipfin Brewery, Austria. In the generating station there are four dynamos, two of a total output of 30 kilowatts at 115 volts for lighting, and two of 40 kilowatts at 500 volts for motor driving and the working of an electric railway about one mile in length. This latter connects the brewery with the railway station, and is used for passenger and goods traffic. The average gradient is about 1 in 84. The locomotive, which is fitted with a 15-H.P. motor, draws a train of trucks at a speed of about six miles per hour. Overhead conductors of copper-bronze 8mm. thick are used. The trolley arm had to be placed on a bracket by the side of the locomotive, as doors only 12ft. high have to be passed through.

Mersey Railway Company.—An application was made in the High Court of Justice by the receivers and managers for leave to spend a sum of about £800 in promoting a Bill in Parliament with the object of conferring upon the Company power to work their railway by electricity in lieu of steam. The summons was heard in Chambers, but his Lordship gave judgment on Saturday morning in Court. Mr. Justice Stirling said that the question was whether the money in the hands of the receivers could be thus applied under Section 4 of the Railway Companies Act, 1867. It did not appear to come within "working expenses" of the railway or other proper outgoings in respect of the undertaking. It was an application to Parliament to vary the mode of carrying on the business of the Company. Neither was it in the nature of salvage. If all the parties had been agreed his Lordship might have been inclined to accede to the application. It seemed probable that it might help the business of the Company, but it was a speculation, and his Lordship could not allow any part of the fund in Court to be applied for that purpose.

City and Guilds of London Institute.—The income of this Institute for 1894, not including £275, the amount specially allocated to scholarships by the Clothworkers' and Saddlers' Companies out of their subscriptions, amounted to £33,974, made up as follows:—Subscriptions and donations, £23,767; school fees, &c., 10,207. The total expenditure of the Institute in all its departments has amounted to £30,430. The net amount receivable as fees from students at the Central Technical College was £4,670, the net expenditure on the College being £11,380. The net cost of the College, after deducting students, fees, &c., was £6,709. The net amount receivable as fees from students at the Finsbury Technical College was £3,304, the net expenditure being £9,347, so the net cost of the College was £6,042. The expected income available for general purposes for the year 1895 from contributions amounts to £23,567, from fees, &c., to £9,310, together £32,877; and the Council, on the recommendation of the Executive Committee, have accordingly allotted £32,300 as the provision for the present year. The total amount of the donations and subscriptions to the Institute since its foundation 15 years ago aggregates in round figures to £453,000.

Strassenbahnwagenuntergestelle.—"If," says the *Electrical World* of New York, "any of our readers, in looking over articles on electric railways in the German language, should come across the word *Strassenbahnwagenuntergestelle*, they need not be alarmed or discouraged, nor be afraid to use it in good society. Instead of getting at the subject directly, as is done in English, this single word relates quite a little story—a sort of riddle of which you are expected to guess the answer. The story is, briefly, as follows:—In about the middle of the word we find that the object referred to has some connection with a car, and, returning to the beginning, it appears that this car is intended to run on rails (as cars usually do, by the way), that these rails are in the streets of a city, and that the car is supported on some structure; near the end it is explained that this supporting structure is below, and not above, the car, and, finally, it is added that it refers to the apparatus in general, and not to any one form in particular. With the aid of this description it will not be difficult to guess correctly

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that the German writer would have said *trucks* instead, had he been privileged to use the English language." It seems to us that this verbal machine is somewhat over-compounded.

Street Subways for Large Towns.—At a meeting of the Society of Engineers, held at the Westminster Palace Hotel on Monday evening, May 6th, a Paper was read by Mr. Charles Mason on "Street Subways for Large Towns." The author, impressing the importance of an improved method of underground construction for the reception of the numerous mains laid beneath the streets, stated that the subject was one requiring the immediate and serious consideration of all engineers to public authorities, gas, water, electric light, and other companies. Further, the difficulties experienced in making periodical examinations of the mains as to leakages and repairs has imposed a duty upon those having the control of the streets to devise some better means whereby the safety of the public is absolutely secured, and the life and cleanliness of the pavements materially benefited. The present system of leaving disused pipes beneath the streets was strongly condemned. The author, in explaining the construction and uses of existing subways both in the provinces and the metropolis, pointed out the chief difficulties in the way of their general adoption as being the question of light and ventilation, and cost of construction; also in his opinion, the "single" system was open to objection, as the mains having to be placed on one side of the subway, compel the supply pipes to be taken across the same for supplying premises on the opposite side of the street, thus blocking the passage way and causing obstructions in the flow of the pipes themselves; the difficulties of sewer ventilation were also referred to. The author proposed "triple" subways having a central avenue for trunk mains, and side avenues for subsidiary or service pipes, vaults being provided beneath the footways remaining the property of the public authority and leased to the adjoining owner, thus providing some return for the outlay.

Research in Education.—In a recent number of *Nature*, Mr. D. S. T. Grant, of the Chemical Laboratory, Lahore, Punjab, delivers himself of the following interesting criticism:—

"Prof. Armstrong's trenchant indictment of the present methods of teaching science is a little too much akin to Carlyle's fulminations against things in general—destructive but not constructive. Probably all good teachers are agreed upon the pernicious futility of the text-book and lecture room cram system, and are in thorough accord as to the educational value of practical work; and are waiting only to learn or discover the best system of employing it. To this end destructive criticism helps but little. What is wanted is some definite scheme of work constructed by masters of practical instruction. Prof. Armstrong does certainly advocate what may be termed the 'research method'; but it does not elucidate the question much, for it is difficult to understand how far he would extend this method. Would he, for instance, never mention Dalton's laws to students until, by a series of analyses, they were in a position to discover them for themselves? Or in the case of specific heat, how much information should be given before the beginners are set to investigate the phenomena alone? There are two ways of learning practically physical and chemical truths, either by repeating methods which have been explained and demonstrated, and then verifying each step by actual contact with real objects, and so acquiring real knowledge of fact and the application of theory, or by struggling to the truth by a process of trial and error. That the latter process, when successful, is the more stimulating to the intellect may be admitted, but that it is practically possible must be doubted. In introducing any new subject to the mind, surely broad outlines should be given first, and details filled in afterwards; observation requires teaching as much as any other faculty. Tyndall tells this story of Faraday. As Tyndall was about to show the latter an experiment, Faraday laid his hand on his shoulder, and said, 'Wait a minute; what am I to look for?' The application is plain—even Faraday felt the advantage of having the observer fore-armed. Beginners know not what to observe, and cannot fashion experiments for themselves, and therefore it seems more rational that students should have the recognised methods of science explained and demonstrated to them, and then be caused to repeat the necessary operations practically, numerical details being varied as in mathematical exercises. When thus equipped with sound theoretical knowledge and fair manipulative dexterity, they will be in a position to embark upon 'research'; for they will then have acquired some power of observation, accuracy, and the faculty of making inferences. The 'research method' *ab initio* appears like an attempt to teach a child to read before he knows his letters. I am fully conscious of my audacity in venturing into the lists, and am not ignorant of the sort of folk who 'madly rush where angels fear to tread'; but if I can elicit some definite scheme from Prof. Armstrong, I shall regard my own dialectic annihilation as a small price to pay for the ultimate gain."

An American Two-Phase Station.—It is now about a year ago that the station of the Brush Electric Company, of Baltimore, was almost entirely destroyed by fire. The officers of the Company made temporary arrangements to supply their customers and the city lights with current, and at the same time set to work planning a new station. The new station consists of a one-storey building, with substantial brick walls. The roof is one span, without columns, 30ft. to the underside of truss, and 65ft. high at its peak. The roof is of iron, and lined with fireproof material. The floor is granolithic. The only woodwork about the building is to be found in the doors and window frames. Beneath the floor of the station there are a series of brick passages, two of which are arranged to carry the exhaust steam, water, and drain pipes, and two others to carry the large cables from the dynamos to the switchboards. The station is arranged for four two-phase Westinghouse alternating machines, each having a capacity of 15,000 16-candle lights. They are direct-coupled to vertical double-acting Westinghouse compound engines. Each engine and dynamo weighs 139 tons, the armatures alone weighing 20½ tons. The engines are placed on brick foundations. It is the intention of the Company to run eventually all the arc lights and motors on the two-phase circuits, using the Tesla two-phase motors. The present arc-light equipment of the station consists of 18 65-light machines of the Brush type, and five 80-light machines of the Westinghouse type. The machines are belted to vertical Westinghouse compound engines. The boiler house contains a large tank for the storage of coal, capable of holding 1,500 tons. There are five vertical Climax water-tube boilers of 500 nominal horse-power capacity each, with space for three more boilers of this type. In addition to this, there are two batteries of horizontal tubular boilers, four in each battery. These are not now in regular use, but are retained for occasions of emergency. The Company contemplates replacing them shortly with horizontal water-tube boilers. Arrangements are now being completed for the introduction of coal-handling apparatus and mechanical stokers. Soft coal mixed with anthracite screenings is used, and from 50 to 75 tons a day is consumed. The smoke from the boilers is carried off by two stacks, each 150ft. high.

Electric Traction Proposed for the Leeds Municipal Tramways.—The report of the Tramways Committee of the Leeds Corporation, setting forth their investigation into tramway traction and their recommendations in the matter, has now been prepared, and will shortly be presented to the Highways Committee for approval. The existing system aggregates 27 miles of track, and when the proposed extensions are carried out the total will be over 41 miles. The total capital expenditure on the lines already in existence is £143,617. The Committee have come to the conclusion that the present dual system of haulage, viz., by steam and horse-power, should be superseded; that oil, gas, and compressed air are at present impracticable; and that having regard to the many different routes in Leeds and the total length thereof, the varying requirements of each route as to frequency of service, and the fact that the steep gradients are here uncommon, they are unanimously of opinion and recommend to the Highways Committee that electric traction is the most suitable for the tramways of the city, and, on the whole, the Committee's preference is for electric traction with overhead wires, except in the centre of the city, where a conduit system should be adopted. The city accountant has submitted to the Highways Committee a balance sheet showing the result of the working of the tramways. The undertaking was handed over to the Corporation by the old Company on February 2, 1894. During the year ended March 25th last, the total income was £51,013. 10s. 7d., and the expenditure £44,123. 8s. 11d., leaving a gross profit of £6,890 1s. 8d. From that has to be deducted the interest and sinking fund charges, which amounted to £6,756. 14s. 3d., so that there is an actual surplus on the year's working of £133. 7s. 5d. Since the tramways came under the control of the city, the Committee have had to meet heavy exceptional expenditure out of revenue. Then, again, the Committee have reduced the number of hours worked by the employés, and have increased their wages. During the period covered by the accounts the Corporation have carried over 1¼ million more passengers than the late Company ever did in a similar time, while the mileage run has been increased by over 160,000.

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ELECTROMAGNETIC THEORY.—LXVIII.*

BY OLIVER HEAVISIDE.

(Continued from page 786, Vol. XXXIV.)

§ 264. Having accumulated a stock of formulæ in the last few sections, it becomes necessary to explain their connection with Fourier series. Given an electromagnetic operational equation, say $e = ZC$. Here C is some particular effect due to a cause e, as, for instance, the current in one part of an electrical system due to an impressed force in another part, though it is not necessary to restrict their meanings in this way. The operator Z is to be constructed in the way previously explained in § 244 (or in any equivalent way), that is, in the same way as if the elements of the combination were mere resistances subject to Ohm's law, to be generalised in the final result to the functions of p, the time differentiator, which are appropriate to the real nature of the elements.

Some ways of algebrising such operational equations have been already given, especially applicable to diffusion problems, though they have a wider application. One way in particular should be noted and remembered, namely, the resolution of the operator Z by algebraical division into wave operators. This is a very simple and powerful method, which applies very generally in physical problems concerning continuous media. The effect is to express the solution in the form of the sum of a series of waves. These may be either simultaneous or successive, according to circumstances. There may be but one wave, or two, or an infinite number. If the method had no other recommendation, it would have this important one—that in considering the effect due to a source it imitates nature by directly expressing the course of events in the way it happens in actual fact, whereas an alternative and equivalent formula might completely disguise it.

But there is another very different way of resolving an operator into other more elementary ones, which leads to a strikingly different functional expression of the developed solution. The results are so entirely unlike the wave results that their equivalence produces algebraical identities which are rather astonishing at first. Only by the familiarity with them, which their universal existence in physical problems involving propagation (subject to certain restrictions) makes possible, do they become commonplace. We may express our results either in terms of the waves or in terms of the vibrations of normal systems of disturbances. Or, in the latter case, if the vibrations be frictionally resisted, in terms of the subsidences or decadences of the normal systems. We may compare the two developments to the branches and the roots of a tree. They are widely separated, but have a common bond in the trunk which joins them. The trunk corresponds, of course, to the operational solution. No doubt the analogy will fail if pushed much further. A perfect analogy in every respect would require an identity, for nothing is wholly like anything but itself, and an identity would be useless for an analogy. The present one is good enough as far as it goes here.

It is not a matter of indifference which way of development is employed. It may be that in some particular problem one of the two is far more manageable than the other, or more amenable to numerical calculation. Apart from this, it depends upon circumstances which of the two ways is to be preferred by its natural recommendations. Take, for instance, the case of a long stretched cord, fixed at its ends. If we disturb it so as to make a hump or a number of humps run along the string, that is, if we produce evident and visible progressive waves, it is natural to express the mathematical results in the form of waves. Again, if we displace the whole cord to the form of a sine curve, and let it go, it will vibrate in the same form over and over again, whether the sine curve be only half a complete wave length, or have intermediate nodes. Here it is obviously natural to express mathematically the visibly evident simple vibrations as vibrations simply.

But in the former case the progressive wave may be expressed entirely in the form of normal vibrations, and in the latter the vibrations may be expressed entirely in the form of progressive waves. The methods are perfectly equivalent quantitatively. We see at once, however, that it is not natural to express the simple progressive wave in the form of normal vibrations, or the normal vibration in the form of progressive waves, because the results would disguise the reality. The examples used here are extreme. In intermediate cases it may be quite difficult to say which way is preferable, owing to both ways being complicated. There may, however, be numerical advantage in using one form; or, more likely, one form may be useful in one part of the history of events, and the other form later, of which there are many examples in diffusion problems. The normal vibrations may involve much labour in calculation for some particular value of the time, when, under the same circumstances, the waves are easily done; and conversely.

We should remark, however, that in pure diffusion problems we are not concerned with true vibrations, as of a string. The resistance stops the vibrations, so the disturbances simply subside or decay. Thus, if the potential in a submarine cable, imagined to be quite free from self-induction, be distributed according to a sine curve, say $V = V_0 \sin ax$, with nodes at beginning and end, if earthed terminally, and be left to itself, the curve of potential will preserve its sine form, though continuously falling to equilibrium. But self-induction will make it pass through the equilibrium position, and the potential will vibrate, though decaying at the same time. This is oscillatory subsidence. By reducing the resistance, or increasing the self-induction, or in both ways together, we make the vibrations last longer, and resemble those of a stretched cord. The limit would be reached if there were no resistance. The vibrations would continue for ever, without loss of intensity, like those of the string in acoustical theory, when friction is ignored. The stretched cord makes by far the best analogy for a telegraph circuit when it is desired to have a simple analogy, because every one knows something about how a cord vibrates, and how pulses are transmitted along it, and reflected, and so on until finally killed by friction. They are visibly evident. Now all these things have their close representatives in a telegraph circuit, which makes the simple analogy be very useful. Of course, it is an entirely different matter when the etherial theory is in question; then suitable analogies are of a different nature, which may, perhaps, be as difficult to follow as the electromagnetic theory itself, as, for instance, the continuous medium first imagined by MacCullagh, in which rotational elasticity is involved. In one respect, however, the stretched cord fails. It does not, at least in any simple manner, represent the effect of leakage on a telegraph circuit. Prof. Fitzgerald, however, by employing the vibrations of air in a pipe in the analogy, was able to include leakage. But the pipe analogy is not so easily followed in most respects as the stretched cord, since compressions and condensations of the air are less easily pictured than the motions of a cord.

In speaking of the diverse modes of representation as being in terms of waves and of vibrations, of course progressive waves are referred to, whether undistorted or distorted as they progress. Progression is the essence of a wave. "Standing" waves are somewhat deceptively so called, if simple normal vibrations be included therein. Now the reader must be cautioned against supposing that every operational equation is convertible, as described, into waves or normal vibrations. Some operational equations refuse to go more than one way, save perhaps by artificial expedients. They make waves only, or vibrations only, but not both. Why these failures occur is evident in practice by physical considerations. Mathematically, it is due to peculiarities in the form of the Z operator. As an example of waves only, there can be at most only two waves from one source situated in an infinitely long cable, as in § 255. Then we cannot have a vibrational form of solution (if we include subsiding normal systems under vibrations), except artificially. And, of course, when there is only a limited number of degrees of freedom in an electrical arrangement, as in the theory of condensers and coils, we have vibrations or vibrational subsidences or pure subsidences of normal systems in limited number which do not admit of

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expression in the form of continuous waves, except perhaps very artificially. Generally speaking we may have both, when there is a continuous medium for propagation in some part of the system. The distinction is usually connected with the presence or absence of boundaries. If we create a disturbance in an elastic medium which is quite homogeneous and is unbounded, the disturbance goes out to infinity in wave fashion, and no free vibrations in definite and separate modes are possible. But if the medium is bounded, the wave cannot dissipate itself freely, but is reflected and re-reflected any number of times. We can now express the disturbance in terms of the vibrations of definite normal systems of a complicated nature, depending upon the nature of the medium and on the form, &c., of the boundary. The possibility arises from the superposition of an infinite number of progressive waves, and we may express our results either in terms of waves or of vibrations.

This brings us to the reservation made about an artificial way of representing a progressive wave by vibrations. If in the last case we imagine the boundary shifted further and further away, however far we go the normal systems remain distinct and separate, and the two modes of representation are in force. Now, in the limit, when the boundary is removed to an infinite distance, the expression for the sum of the normal systems becomes a definite integral. Thus a single progressive wave may be expressed by a definite integral as the sum of vibrations of infinitely numerous normal systems differing infinitely little from one to the next. Instead of a definite sequence of separated periods, the periods run into one another. Of course it is simpler to think of the progressive wave than of the definite integral which equivalently expresses it, though not in a desirable manner, and to derive it directly from the operational solution when possible, instead of through the integral.

After these general remarks about the chief peculiarities, we must proceed to show practical methods of manipulating the Z operator so as to convert operational solutions to vibrating or subsiding normal systems. It is not difficult by the general method to be explained. Perhaps it is too easy. That is, too easy in execution, for the theory thereof is more difficult. As, however, it applies to all sorts of normal systems besides those concerned in Fourier series, it will perhaps be best to show the connection of Fourier series with the operational forms in more special ways, which, though longer, may be more immediately intelligible to the unpractised in operational methods.

§ 265. Take, to begin with, an interesting special case, namely, the effect due to steady impressed force e at A, where $x=0$, when earth is on at both A and B, where $x=l$. As before shown, the operational solution is

$$V=\frac{\text{shin}\, q(l-x)}{\text{shin}\, ql}e. \tag{1}$$

The conversion to a Fourier series in this and many other simple cases can be done by using well-known trigonometrical identities, assisted by an elementary operational result. Thus, we have

$$\frac{ql}{\text{shin}\, ql}=1-\frac{2}{1+\left(\frac{\pi}{ql}\right)^2}+\frac{2}{1+\left(\frac{2\pi}{ql}\right)^2}-\frac{2}{1+\left(\frac{3\pi}{ql}\right)^2}+\dots, \tag{2}$$

by trigonometry. Here noting that q^2 means RSp, we see that we have merely to algebrize $(1+P/p)^{-1}1$, where P is a constant. Thus, in full,

$$\frac{1}{1+\frac{P}{p}}=1-\frac{P}{p}+\left(\frac{P}{p}\right)^2-\left(\frac{P}{p}\right)^3+\dots=1-Pt+\frac{(Pt)^2}{\lfloor 2}-\frac{(Pt)^3}{\lfloor 3}+\dots;$$

or, in the usual brief expression of the exponential function,

$$\frac{1}{1+\frac{P}{p}}=\epsilon^{-Pt}. \tag{3}$$

This result should be noted, as it often turns up. Applying it to (2), we obtain

$$\frac{ql}{\text{shin}\, ql}e=e\{1-2\epsilon^{p_1t}+2\epsilon^{p_2t}-2\epsilon^{p_3t}+\dots\}, \tag{4}$$

where the constants p_1, p_2, &c., are given by

$$p_n=-n^2\pi^2/RSl^2. \tag{5}$$

Comparing (1) with (4), we see that V will be found by operating on (4) by

$$\frac{\text{shin}\, q(l-x)}{ql}. \tag{6}$$

This is a function of q^2 also, so involves only complete differentiations. They may be carried out at length if desired, but that is unnecessary. For the power of p in the operator (6) on ϵ^{Pt} is simply P. It is therefore zero on the first constant term on the right of (4), then p_1 on the second term, and so on. That is, these values are to be put in (6) for p to express its effect. So (1) is converted to

$$V=e\left(1-\frac{x}{l}\right)-2\frac{\text{shin}\, q_1(l-x)}{q_1l}\epsilon^{p_1t}+2\frac{\text{shin}\, q_2(l-x)}{q_2l}\epsilon^{p_2t}-\dots, \tag{7}$$

where the q's are the constant values corresponding to the p's, through $q^2=RSp$. Equation (7) is the full solution, but for trigonometrical convenience, since the values of q^2 are negative, it is best to put $q^2=-s^2$. This makes

$$V=e\left(1-\frac{x}{l}\right)-2\frac{\sin s_1(l-x)}{s_1l}\epsilon^{p_1t}+2\frac{\sin s_2(l-x)}{s_2l}\epsilon^{p_2t}-\dots; \tag{8}$$

or, since $\sin sl=0$ for every s,

$$V=e\left(1-\frac{x}{l}\right)-\left(2\frac{\sin s_1x}{s_1l}\epsilon^{p_1t}+2\frac{\sin s_2x}{s_2l}\epsilon^{p_2t}+\dots\right), \tag{9}$$

where the s's are the roots of $\sin sl=0$, which is the same as saying that the p's are the roots of $\text{shin}\, ql=0$. In the customary form (9) is the same as

$$V=e\left(1-\frac{x}{l}\right)-\frac{2e}{\pi}\Sigma_1^\infty\frac{1}{n}\sin\frac{n\pi x}{l}\epsilon^{-n^2\pi^2t/RSl^2}. \tag{10}$$

This is the equivalent of the wave solution before got.

When $t=\infty$, the time factors vanish, and there is left the final state expressed by the outside term. On the other hand, when $t=0$, the time factors are unity, and

$$V=e\left(1-\frac{x}{l}\right)-\frac{2e}{\pi}\Sigma_1^\infty\frac{1}{n}\sin\frac{n\pi x}{l}. \tag{11}$$

We know that V is initially zero everywhere except at A, where it is e. Therefore

$$1-\frac{x}{l}=\frac{2}{\pi}\Sigma_1^\infty\frac{1}{n}\sin\frac{n\pi x}{l}, \tag{12}$$

except at $x=0$, where the right member gives zero. That is, the steady state, which is $e(1-x/l)$, has become expanded in a series of sines. But we have got more than we wanted. For the Fourier series is periodic, with period $2l$. So the right member represents $1-x/l$ between 0 and $2l$; then the same values are repeated from $2l$ to $4l$; and so on. Similarly on the left side of the origin. Equation (11) is, in fact, the solution of the problem of finding V due to an infinite number of equal impressed forces of strength $2e$ acting all the same way at the points 0, $2l$, $4l$, &c., $-2l$, $-4l$, &c., in an infinitely long cable. This was shown before as regards the operational and wave solutions.

§ 266. There is another similar way of getting (9) which is worth noticing. Use the trigonometrical identity

$$ql\coth ql=1+\frac{2}{1+\left(\frac{\pi}{ql}\right)^2}+\frac{2}{1+\left(\frac{2\pi}{ql}\right)^2}+\frac{2}{1+\left(\frac{3\pi}{ql}\right)^2}+\dots, \tag{13}$$

differing from (2) on the right side only in the signs of the terms. Let the operand, as before, be 1 in the usual manner, and we obtain

$$ql\coth ql\,.\,e=e(1+2\epsilon^{p_1t}+2\epsilon^{p_2t}+2\epsilon^{p_3t}+\dots), \tag{14}$$

instead of (4) above, with the same values of the p's.

Now (1) is the same as

$$V=(\cosh qx-\cosh ql\,\text{shin}\, qx)e$$

$$=\cosh qx\,.\,e-\frac{\text{shin}\, qx}{ql}e(1+2\epsilon^{p_1t}+2\epsilon^{p_2t}+\dots), \tag{15}$$

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by (14). Here the power of p is zero in the cosh function, and also in the other so far as the constant term goes, and p_1 on ϵ^{pt}, &c. So, putting $q^2 = -s^2$, we get

$$V = e\left(1 - \frac{x}{l}\right) - 2e\Sigma\frac{\sin sx}{sl}\epsilon^{pt}, \qquad (16)$$

which is the same as (9).

Since circular functions are finally to be employed, we may put $q^2 = -s^2$ at the beginning if we like, and write

$$V = \frac{\sin s(l-x)}{\sin sl}e, \qquad (17)$$

instead of (1). Here of course s^2 is a differentiator, namely, $-RSp$. It finally takes the meaning of a constant, or rather of an infinite series of constants, merely because p has the power of a constant on the exponential function.

The determinantal equation shin $ql = 0$, or, more strictly, (shin $ql)/ql = 0$, is really the equation finding the admissible values of p in the normal systems. To every p belongs an s^2, so if we choose to consider the determinantal equation in the form (sin $sl)/sl = 0$ as finding the values of s, we need only attend to the positive values.

Notice also that the operator in (1) does not contain $p^{\frac{1}{2}}$, but only the complete p. The elementary waves which make up the solution (1) do depend on $p^{\frac{1}{2}}l$, but the union of all the wave operators to make the solution (1) causes $p^{\frac{1}{2}}$ to be eliminated. The determinantal equation for a cable of finite length—that is, bounded both ways by some restraint, is always a rational equation in p, provided the terminal arrangements themselves are finite combinations whose resistance operators are themselves rational functions of p.

(To be continued.)

REPRESENTATION OF PERIODIC CURRENTS BY POLAR DIAGRAMS.

BY DR. J. A. FLEMING, F.R.S.

Two methods of graphically representing simple periodic currents or electromotive forces, viz., clock diagrams and wave diagrams, are in constant use. Each of these methods has some peculiar advantages of its own. There is, however, a third method which has sometimes especial utility, and this is by a polar diagram.

Let a straight line O P (Fig. 1) revolve round one of its extremities O, and let the angle of inclination θ which the revolving line makes with another fixed straight line O A, passing through this centre of revolution be called the angle of displacement of the revolving line. Let any point P be taken on the revolving line, and let the distance of this point from the centre be denoted by r. The length r is called the radius vector. Let r increase or diminish as O P revolves, but so that the length $OP = r$ varies according to any law connecting it with the angle of displacement A O P. The extremity P of the line O P will then trace out a curve called a polar diagram.

Suppose that O P runs through a cycle of values beginning with a zero value when $\theta = 0$, and after reaching a maximum value becoming zero again after the line O P has completed one half revolution, or when $\theta = \pi$, the polar diagram will be a closed curve passing through the origin. Since the radius O P runs through a cycle of values from zero to a maximum, and returns to zero again during a revolution of the radius through two right angles, or an angle π, the radius r may suitably represent the value of any periodic quantity which completes a cycle of values in the time represented by one complete half revolution of the radius vector. Suppose, then, that O P varies as sin θ where θ is the displacement phase angle—that is, let

$$r = R \sin \theta,$$

it is then clear that in this case the polar curve is a circle. For if we draw the line O B through O perpendicular to O A, and draw P B at right angles to O P, since $AOP = \theta$ and $OP = r$, and since by supposition $r = R \sin \theta$, it follows that the angle P B O is always equal to θ, and then, therefore, the length O B is a constant length equal to R. In other words, the *locus* of the point P is a circle passing through O, P, and B. Hence the circle is the curve which represents in a polar diagram a simple periodic quantity, and if the length O P is taken to represent the magnitude of a simple periodic current or electromotive force at any instant corresponding to a phase angle A O P, the circle passing through O will be the polar curve representing this simple periodic current or electromotive force.

If the current or electromotive force is periodic, but not simply periodic, then the polar curve representing it will be a unicursal curve passing through the origin O, but will not be a circle. The polar diagram of an alternating current or electromotive force enables us very easily to determine the

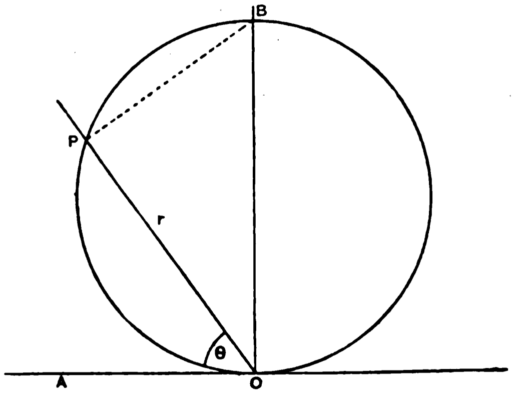

FIG. 1.

square root of the mean-square value of the periodic quantity represented by it. It is more difficult to do this with the ordinary wave-curve diagram.

Suppose, for example, that in Fig. 2 we have a wave diagram drawn representing a half wave of an alternating electromotive force which is not a simple sine curve. The ordinates represented by the dotted lines are proportional to the instantaneous values of the periodic quantity taken every 20deg. If we wish to find the $\sqrt{\text{mean}^2}$ value of the ordinates of this curve there is no other way of doing this than by drawing a number of numerous equidistant vertical ordinates, measuring their lengths, squaring these magnitudes,

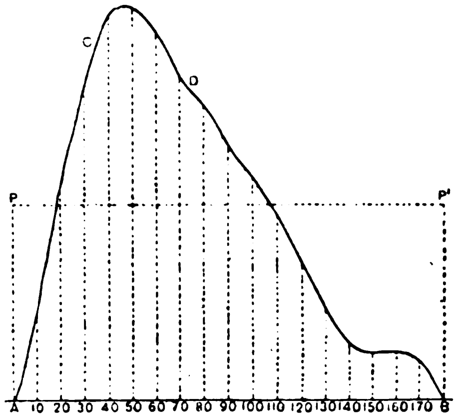

FIG. 2.

and taking the square root of the mean of these squares. This is a troublesome arithmetic process, and in proportion as the wave curve is more irregular or complex, so much the more numerous must be the ordinates to obtain a correct result for the mean-square value. It is, however, a much easier process if the periodic quantity is represented by a polar curve. Let Fig. 3 represent the same periodic function as in Fig. 2 drawn in a polar form. The dotted radii are proportional to the instantaneous values of the periodic quantity, and are placed at angular intervals of 20deg. Let any radius O P (*see* Figs. 3 and 4) be denoted by r, and let the corresponding phase angle P O A be denoted by the letter θ. If we consider the radius to move forward by a small angle $d\theta$ and to increase

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in length by a small amount dr, then it is obvious that the small increment of area dA swept out by the radius r is equal to $\frac{1}{2} r^2 d\theta$. To obtain the whole area, and included by the polar curve O P Q R, we have to integrate this quantity $\frac{1}{2} r^2 d\theta$ from 0 to π, or to obtain the integral

$$A = \frac{1}{2}\int_0^\pi r^2\, d\theta.$$

On the base line drawn through the polar centre O let a semicircle A C B (*see* Fig. 3) be described equal in area to the area included by the polar curve O P Q. Let O A = R be the radius of this semicircle. Then

$$\frac{\pi R^2}{2} = A = \frac{1}{2}\int_0^\pi r^2\, d\theta,$$

or

$$R = \sqrt{\frac{1}{\pi}\int_0^\pi r^2\, d\theta}.$$

The expression on the right hand side of this last equation is obviously the square root of the mean of the squares of the

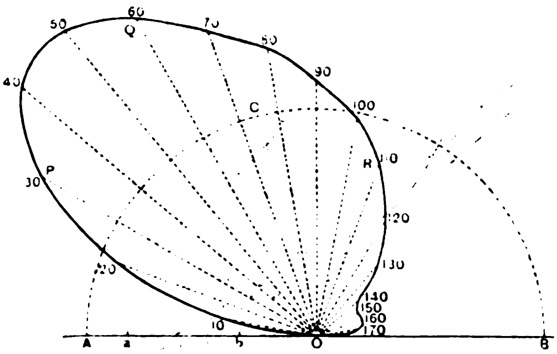

Fig. 3.

instantaneous values of the periodic quantity r. Hence, we can obtain at once the $\sqrt{\text{mean}^2}$ value of a periodic quantity current or electromotive force as follows. On any straight line describe a semicircle and draw radii of this semicircle at angular intervals equal to those phase intervals for which the instantaneous values of the current or electromotive force are observed. Set off on these radii lengths equal to the respective values of these instantaneous quantities and join the extremities of all these lines so set off by a curve. This curve

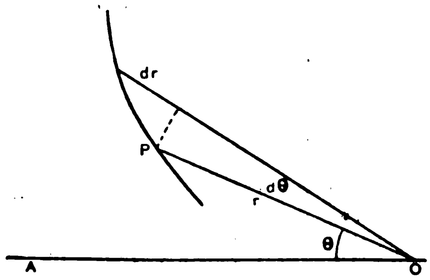

Fig. 4.

is the polar diagram, and it is a closed curve. Take the area included by the polar diagram with an Amsler's or other planimeter, and from a table of areas of circles find the circle whose area is double that of the polar curve. Then the radius of this circle is the square root of the mean of the squares of the periodic quantity. If, for instance, we have a periodic current curve plotted down in polar form this operation will give us the dynamometer value of the current, or the value which would be read on a dynamometer.

The polar curve, therefore, lends itself very easily to the determination of the mean-square value of a periodic current or electromotive force, of which the instantaneous values are known throughout a semi-period, whether those values are taken at equidistant intervals of time or not. The reader will, therefore, note that if we plot down a periodic quantity in rectangular co-ordinates (Fig. 2) or *wave form*, and find the rectangle A P P′ B of equivalent area to the half wave, the altitude A P of this rectangle gives us the *true mean ordinate* of the periodic curve; but if we plot down the periodic quantity to a *polar diagram* (Fig. 3) and find the semicircle A C B of equivalent area, the radius O A of this semicircle gives us the *square root of the mean-square value* of the periodic quantity represented by the radii of the polar curve.

SHEFFIELD ELECTRIC SUPPLY STATION.

Until the commencement of the present year, when the new extension plant was put in operation, the generating station of the Sheffield Electric Light and Power Company suffered from a condition—highly desirable in moderation—of having abundance of work to do. It was smitten with that disease for which the mathematical diagnosis is, that the rate of increase in the demand for light was far in excess of the utmost possible increase in the rate of meeting that demand. Consequently, at times of highest load, there was not only no reserve plant, but the working plant was taxed to its utmost limits. That anxious moments and bad quarters-of-an-hour should result was only to be expected. We are sure that there are many stations in this country where the managers would wish to see their surplus

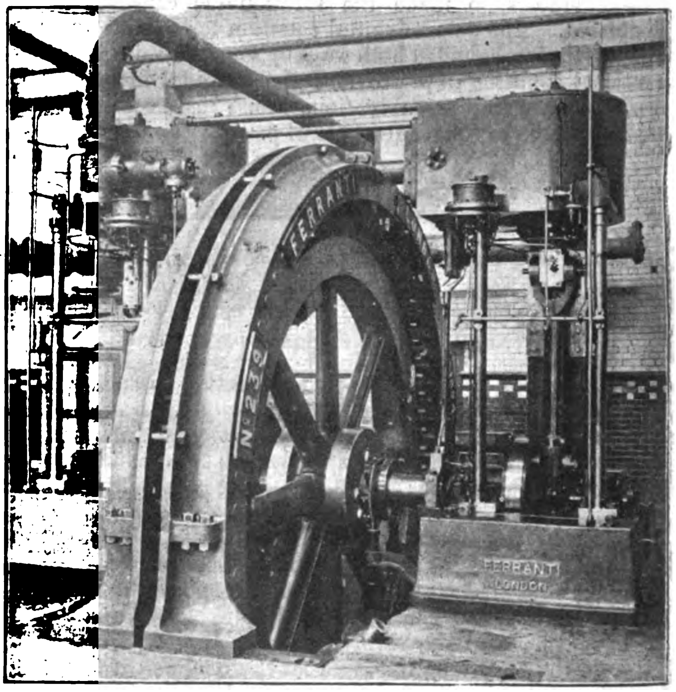

Fig. 3.—Sheffield Electric Supply Station. Extension Plant.

plant less persistently idle than is actually the case; but there are few, if any, who would care to run such a close shave as there was at Sheffield before the extension took place. Differences of opinion, as well as differences of fact, exist in regard to surplus plant. Some of the Sheffield customers thought there ought to be 100 per cent. of reserve; on the banking principle, we suppose, of holding cash reserve equivalent to circulated paper! But the directors of the Sheffield Electric Light Company do not see their way to such a luxury, though they do expect in future to keep a reserve of not less than 20 per cent. At present the extension plant is capable of taking over the entire normal load of the original plant; that is to say, while the total capacity of the four older machines is only 285 kilowatts, the single new machine has a capacity of 300 kilowatts.

The lighting at Sheffield is arranged on the high-pressure alternating-current transformer system, the original contract for the electrical plant being carried out by the Brush Company. Figs. 1 and 2 show this plant from opposite ends of the spacious bay which forms one-half of the large and well-constructed machinery hall. There are two bays, but one of these is at present entirely unoccupied by machinery. The plant shown in these illustrations comprises two 100-kilowatt, one 50-kilo-

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watt, and one 35-kilowatt Brush alternators and steam engine. These were at first rope-geared on the usual Brush plan, using only one rope for each machine. But the failure of a set through the parting of the rope one busy Saturday night, led the engineer to abandon this arrangement in favour of the safer practice of driving with several independent ropes.

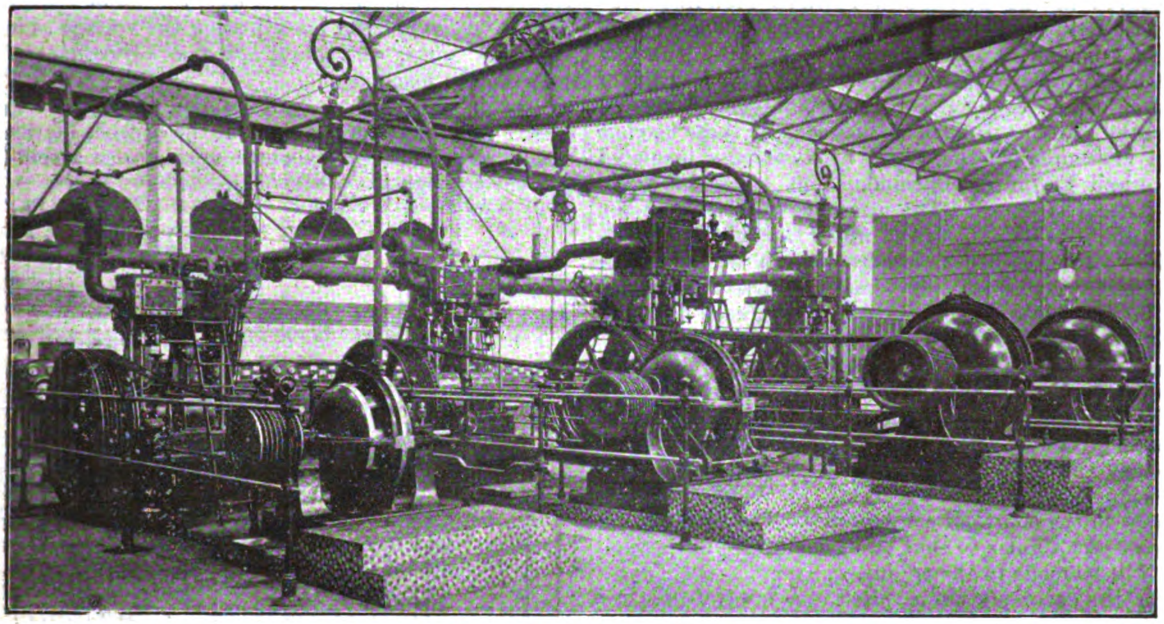

Fig. 1.—Sheffield Electric Supply Station, showing original Generating Plant. Space for extension in far corner.

The extension plant has been built by Messrs. S. Z. de Ferranti and Co.; the steam engine, which is coupled direct to the flywheel alternator, having been sub-contracted for by Messrs. Browett, Lindley and Co. A view of this plant is given in Fig. 3, the splash-guards having been removed to show the working parts.

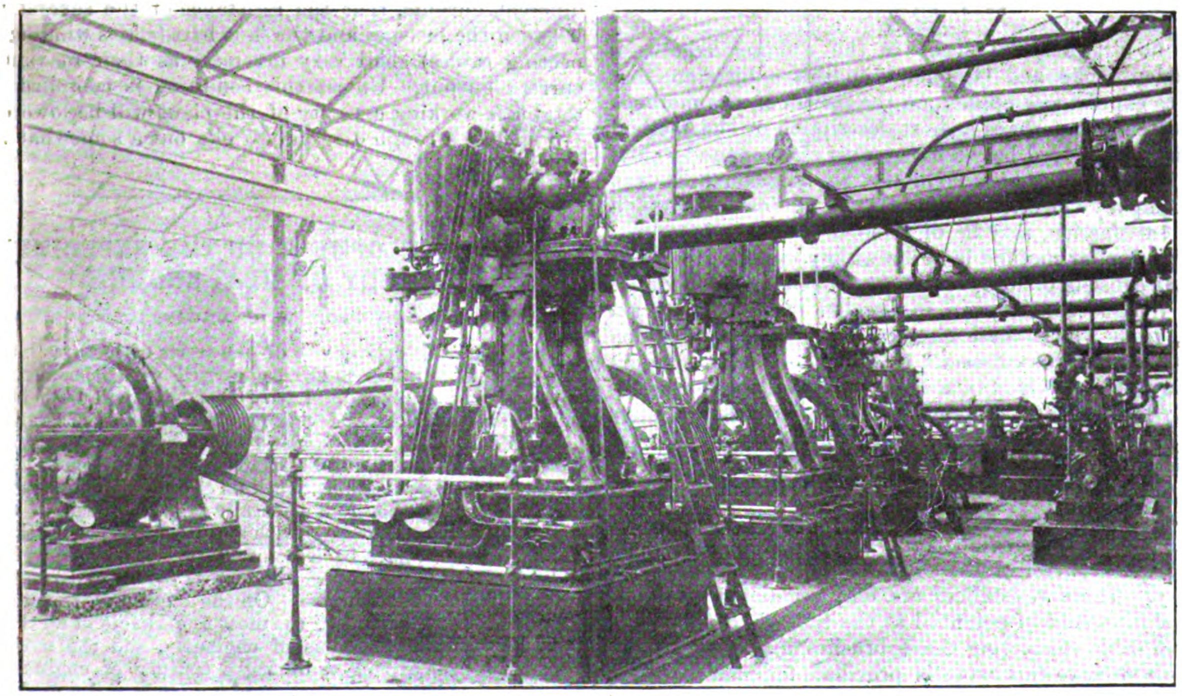

Fig. 2.—Sheffield Electric Supply Station. View from site of Extension Plant.

This steam plant consists of a high and low-pressure engine placed one at each end of the alternator shaft, the main bearings of the engine also serving as the alternator bearings. There are thus only two main bearings in the whole machine, and, as these are constructed on Mr. Ferranti's spherical system, no trouble can occur from their being out of line. The high-pressure engine has a cylinder 19½in. in diameter and a stroke of 20in., the cylinder being supported on a massive cast-iron standard at back, and on two stiff turned steel stays in front. A piston valve is used, actuated by an eccentric on the shaft, a shaft governor being used to control the speed by varying the cut-off. The low-pressure engine has a cylinder 32½in. in diameter by 20in. stroke, and is fitted with a double-ported Trick slide valve, also driven by means of an eccentric on the engine shaft. Very liberal strengths are allowed all through, and complete provision for copious oiling and prevention of oil splash or waste has been made. The crank pins are fitted with spherically-seated brasses, and are oiled on Lindley's patent system. The crank discs are of cast steel. Oil is supplied under pressure to the main bearings, and other bearings are fed from a large oil box in front of the engine with an adjustable oil supply to each. The engine is fitted with sight-

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feed lubricator relief valves, and everything requisite to ensure satisfactory and efficient running. The alternator is designed to run in parallel with the original plant, at a frequency of 100 ∿.

On the rim of the flywheel is mounted the armature of the Ferranti alternator, which consists of 40 pairs of bobbins of an improved construction, but similar in principle to that always employed in the well-known Ferranti high-frequency dynamo. The design allows very great rigidity. The bobbins are wound on a laminated brass core, with alternate layers of corrugated copper ribbon and white fibre. Each pair of bobbins, after being connected together, is solidly riveted into two heavy gun-metal carriers, and each of these carriers or brackets is secured to the wheel by two bolts, insulated with ebonite and Ferranti compound. This gives the armature great lateral strength. The armature revolves between two massive cast-iron frames, each of which supports 80 electro-magnets, the weight of each complete frame being 5½ tons. The frames themselves consist of heavy castings, in each of which are placed 80 wrought-iron cores, or pole pieces, each fitting in an accurately-machined 3½in. hole. On each of these cores is placed a field magnet coil, consisting of copper tape wound on edge, according to Messrs. Ferranti's latest design, which, while allowing the greatest amount of copper to be placed in the smallest space, gives very efficient insulation and large radiating surface, and at the same time gives a handsome appearance to the machine. A new 300-kilowatt plant by the same makers is now in the course of construction. The dynamo will be in every respect similar to that lately installed; but several alterations will be made in the engine.

Steam for the entire station is raised in five water-tube and two Lancashire boilers, of an aggregate capacity of 2,000 H.P.

Our thanks are due to Mr. W. Johnson, the manager and secretary of the Sheffield Electric Light and Power Company, and to Messrs. S. Z. de Ferranti and Co., for their kindness in supplying us with the information and illustrations for this article.

PARALLEL RUNNING OF COMPOUND-WOUND MACHINES.

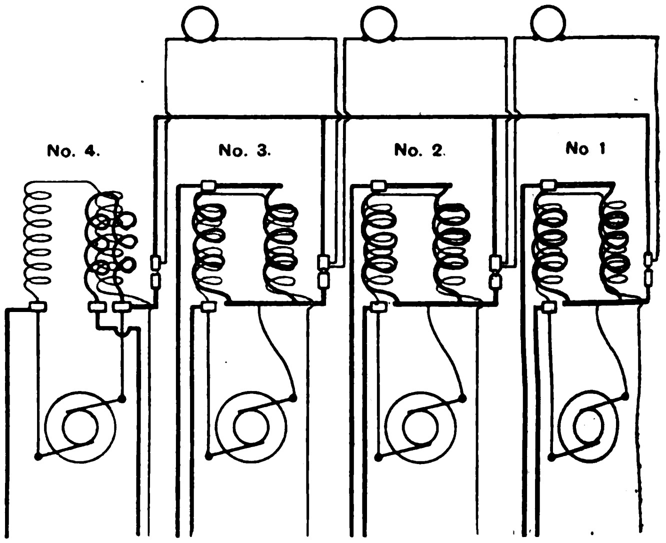
BY J. PIGG.

I have no desire to intervene in the discussion between Messrs. Addenbrooke and Goodchild on this subject, neither do I wish to express any opinion on the merits of the methods they advocate; but perhaps a short description of the method for apportioning the load between a number of compound-wound machines in parallel, which is in use at the North-Eastern Railway Company's electric lighting station at York, and which has given satisfaction, may be of some interest, as I am not aware that a similar method is in use at any other station.

The plant consists of four over-compounded dynamos direct driven by Willans engines, run in parallel on to the station 'bus bars, from which three circuits are fed, one of which carries both arc and incandescent lamps. The only ammeters used are in the lamp circuits, and are not available for ascertaining the loads of the different machines. The voltmeters are usually kept on the pilot wires to indicate the difference of potential at the ends of the mains, but they are, of course, available for adjusting the difference of potential of any incoming machine to that of the 'bus bars. Shunt regulating resistances are provided, but they all work together, and independent control of the shunt excitation is not possible or necessary. These resistances are only occasionally used to regulate the difference of potential at the ends of the mains.

The usual cable connecting the + brushes of the machines is used, and a switch to this cable is provided for each machine, so that they may be dropped in or out, as the requirements of the load necessitate. Three small ungraduated indicators, consisting of a *polarised* needle with a few turns of wire round it, are also provided, and one of these is connected between the + brushes of each *pair* of machines. If at any time current passes between two machines when running in parallel, part of it passes through the indicator branch, and deflects the needle, and the winding of the coils of the indicators is such that the pointer is deflected towards the number of the machine which is giving current to the other. The switchboard attendant, who is also the engineer, simply lowers the speed of one engine, or increases the speed of the other, as may be necessary, until the pointer becomes vertical. The indicators, of course, are so placed on the switchboard that they can be seen when adjusting the speed regulator of any engine. Nearly the whole of the regulation is effected in this way, the shunt resistances being only occasionally used for adjusting the voltage as indicated on the pilot wires, and never for the adjustment of the load between the machines.

The arrangement, as will be readily seen, is intended to ensure an equality of potential at the brushes of the machines, which, when obtained, ensures against one machine sending current through the other.



Main Cables and Shunt Wires to Switchboard.

Since the fall of potential between the brushes of each machine and the 'bus bars is the same, it is necessary with this arrangement, whether the machines have the same or different outputs, that the resistance of the several machines between the brushes and the 'bus bars (series winding and connecting cables) shall vary inversely as their maximum rated current output. Unless this condition is complied with, the total safe-working capacity of the plant will be lowered.

I enclose a rough diagram to eke out a somewhat imperfect description.

THE DEVELOPMENT OF THE EXPERIMENTAL STUDY OF HEAT-ENGINES.*

BY PROF. W. C. UNWIN, F.R.S.

The request to deliver one of the series of lectures instituted at the desire of Mr. James Forrest carried with it something of the authority of a command. I trust that that will be held to excuse in some measure the undertaking of what I feel is a rather serious and difficult duty. I understand that it was Mr. Forrest's intention that these lectures should illustrate the dependence of the engineer in his practical professional work on the mathematical and physical sciences. They therefore naturally take the form of a review of some branch of engineering with special reference to the scientific principles which have been factors in its advancement.

I selected for this lecture the history of the experimental investigation of the steam engine. On the one hand, the steam engine in its many forms has been the most remarkable of all the machines which are due to the genius of engineers, and the most powerful auxiliary in the expansion during a century of engineering work. On the other hand, the creation of a science of thermodynamics on the basis of the principle of the conservation of energy during the years 1845-1855 is one of the most important advances ever made in scientific knowledge. Between 1855 and 1875 scientific men of very great intellectual eminence prosecuted researches on the action of heat motors as illustrations of thermodynamic principles, and engineers simultaneously invented many improvements and enor-

* The "James Forrest" Lecture, delivered before the Institution of Civil Engineers, May 2nd.

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mously extended the use of steam power. I shall endeavour to show that the scientific advance and practical improvement of the steam engine were not unconnected.

In a Paper recently read in this Society, an engineer, for whose practical ability and remarkable mechanical ingenuity I have the greatest respect, made the following statement: "A period of 67 years has been required for the development of the principles enumerated by Watt, Trevithick and Grose, and upwards of 40 years have been required for the reduction of the consumption of steam from 19lb. to 13lb. per indicated horse-power hour. . . . In these advances no new principles have been applied and no higher efficiency has been obtained. The progress has resulted from the labours of makers and designers of steam engines, purely scientific investigation having only explained what the steam-engine should do if worked in a manner wholly imaginary." That represents, I believe, a not uncommon opinion, perhaps also a not uncommon jealousy of the intrusion of science in the field of practical engineering. It is curious that the Paper in which this occurs is not a practical Paper at all but a theoretical Paper, in which the author uses the data of Regnault and not altogether correctly applies the methods of Rankine. It may be noted that out of thirty-six engine tests on which the author bases his conclusions, half are engine tests made by professors. It is something that the improvement of the steam engine is attributed to the development of principles laid down by Watt. But when Watt invented the steam engine he was not an engineer; he was a philosophical instrument maker, and he found his principles in the laboratories of Glasgow University. Black's discovery of latent heat gave him the key to the apparently extravagant expenditure of injection water in the model Newcomen engine, and Dr. Cullen's discovery of the low temperature at which water boils in vacuo—he himself states this—led him to perceive that steam would condense in a separate vessel, and to formulate the principle that steam will take the pressure corresponding to the lowest temperature of any part of the space in which it is confined. The writer I have quoted says that "the proposal of Watt to use steam expansively was not the result of abstruse investigations, but was due to the exercise of Watt's common sense." But when Watt patented expansive working in 1782 he had been experimenting incessantly for 15 years on the properties of steam. "If," says this writer, "we confine our attention to the actual steam-engine cycle, it is seen that in reality a properly-constructed steam engine is a very efficient prime mover." But surely some explanation is wanted why we must confine our attention to a cycle which involves the rejection of nine-tenths of the heat supplied into the condenser.

It will be the object of this lecture to show that other scientific ideas of a later date than those of Watt have been operative in promoting the improvement of the steam engine. It is impossible to go back to the mental attitude of 40 years ago, and those who assert that nothing new has been learned in that time forget that in the interval scientific discoveries have become commonplaces, and that they themselves reason and act on them, as M. Jourdain talked prose, without knowing it.

Twenty years ago Lord Armstrong stated that of all the coal raised in this country about one-third was used for household purposes, one-third for generating steam, and one-third for iron-making and manufacturing processes. He remarked that in the first two divisions the waste of fuel was shameful, and that, without carrying economy to extreme limits, all the effects now realised from the use of coal could be obtained by an expenditure of half the quantity. The improvement of the steam engine is mainly due to an incessant attempt to diminish the waste of fuel.

Tests of Steam Engines in Cornwall.

Steam engineers have been face to face with the problem of economy for more than a century. Coal was excessively dear in Cornwall, and as the mines were deepened and more power was required, the cost of working increased ruinously. By reducing fuel-cost Watt saved the mining industry from extinction, and he adopted the plan of taking in payment for his engines a sum reckoned equivalent to one-third of the fuel saved. By agreement with the miners, tests were made and the standard duty of a Newcomen engine was fixed at 7,037,000 foot-pounds per bushel. Regular duty determinations were made for all Watt's engines. Generally they gave a duty of 20,000,000. It is curious that though Watt had patented expansive working, his trials of it were not encouraging, and he did not use expansive working in his Cornish engines. Watt's connection with Cornwall ceased in 1800, the duty determinations were neglected, and the engines deteriorated. Then Capt. Joel Lean, who had reorganised the machinery at one of the mines and effected great economies, started again the system of duty trials. He and his sons carried on the work for many years and published reports of the results of the trials. Of these reports Dr. Pole says, "the publication produced an extraordinary effect in improving the duty of the engines. Engineers were stimulated to emulation amongst themselves. The practice of reporting is thought to have been attended with more benefit to the country than any other single event excepting only the invention of the steam engine itself." I have placed on the wall a short table giving the improvement of duty of the Cornish engines during the period covered by Lean's reports.

Duty of Cornish Engines.

——	Duty in foot-lbs. per bushel (94lbs.) of coal.	Lbs. of coal per I.H.P.-hour (estimated).
Newcomen	7,000,000	26·6
Smeaton	10,000,000	18·6
Watt, 1800	20,000,000	9·3
Lean's Report, 1815	52,300,000	3·6
" " 1827	67,000,000	2·8
" " 1834	98,000,000	1·9
" " 1840	107,000,000	1·7

Highest duty of Mr. Leavitt's pumping engine at Louisville 140,000,000 per 100lb. of Pocahontas coal. Lbs. of coal per I.H.P.-hour, 1·33.

I shall show later that the creation of a new and more scientific system of testing by Hirn and his colleagues in Alsace in 1855 was the starting point of a similar process of improvement. Quite lately there has been a revival of careful and independent engine testing, and of the publication of the results, and records have been established which would have been thought impossible ten years ago.

The history of expansive working in Cornwall is curious. Watt completely understood the principle and patented it. But he failed to make use of it. Woolf and Trevithick reintroduced expansive working, and Woolf tried compound engines in 1812. But the compound engines were not more economical than simple engines. It is clear that the scientific conviction that expansion must be economical held its ground in spite of practical failures, and this led to repeated attempts, till at last an extraordinary amount of success was achieved.

The peculiar character of the load against which the engine worked, the lifting of a heavy mass of pump rods, contributed to force the use of expansive working. To work without shock, a large initial and gradually diminishing effort was necessary. The extraordinary economy obtained was due probably in part to the special action of the steam, the Cornish engine being virtually a compound engine, and the admission surface being protected from cooling to the condenser; partly to the great effectiveness of a steam-jacket in an engine which worked slowly and with pauses at the end of the stroke, partly to the small clearance and separate admission and exhaust valves. The lesson engineers should have learned from Cornish experience was, that in restricted conditions high ratios of expansion were economical. In this case, as in others, later engineers generalised too crudely, and concluded that expansive working was always economical. A new scientific investigation was required to correct the error.

Experiments on Boilers.

To generate steam-power economically the boiler must be efficient and the engine must be efficient, and the conditions of efficiency of engine and boiler are completely independent. Hence the early method of Watt, in which attention was paid only to fuel used and water pumped, has been replaced by a method of independent boiler and engine testing. The boiler uses coal and generates steam; the engine uses steam and generates power. The economy of the boiler is reckoned on the fuel; that of the engine on the steam.

The earliest systematic trials of boilers are recorded in a Paper by Mr. Josiah Parkes in the second quarto volume of the *Transactions* of this Institution. They are interesting as showing how early engineers realised the necessity of studying experimentally the conditions of generating steam economically. Parkes obtained information about the calorific value of different coals; measured the feed and fuel, reduced his results to a rational common standard and recognised the importance of regulating properly the air supply. If his results can be trusted, the general average evaporation in boilers at that time was 7½lb. from and at 212deg. per lb. of coal. With improved firing, and especially with improved arrangements for air supply, the average evaporation was 8¾lb. and the best 10¾lb. A trial in Cornwall is given in which the evaporation was 15½lb. per lb. of coal, but in that case I suppose the measurements or the reduction of the results must have been defective.

As to the calorific value of coal, there has been for a long time no uncertainty of practical importance. The researches of Dulong showed that the calorific value could be ascertained from the chemical analyses very approximately. No doubt there has been a want of a convenient calorimeter for determining directly the calorific value. This want has now been supplied by the invention of the bomb calorimeter, which appears to give very trustworthy results without excessive trouble. Mr. Donkin has made it possible to get a bomb calorimeter in a less expensive form than that first used.

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Different coals, at any rate the better kinds of coal, do not differ much in absolute calorific value. Used in boiler furnaces they differ more partly from differences of mechanical aggregation, but chiefly because the more bituminous coals require a larger air-supply for tolerably smokeless combustion than those which consist chiefly of fixed carbon. The greater excess of air involves greater chimney waste. It is to test the commercial calorific value that Prof. Schröter has established in Munich a heat laboratory where fuels can be tested on a large scale and under ordinary practical conditions of combustion. The arrangements permit the determination of the exact conditions most suitable for each fuel.

An enormous number of boiler trials have been carried out, but most of them are mere individual tests of very little scientific value. Engineers have been too much under the impression that the evaporation depended chiefly on the type or proportions of the boiler, or the arrangement of the heating surface. But there are no obscure or complicated actions concerned in generating steam. Boilers of all types give nearly the same results provided only proper conditions of combustion are secured. They may differ in cost, in durability, in convenience, but in efficiency they differ less than, I think, is commonly assumed. The following Table shows that boilers of extremely different types, with very different proportions of heating surface and very different rates of combustion, and even with different coals, have all reached evaporations of from 11lb. to 13lb. of water from and at 212deg. per lb. of coal :—

Boiler Trials.

Type.	Ratio of grate to heating surface.	Coal pr. sq. ft. of grate per hour.	Evaporation from and at 212° per lb. of coal.	Coal.
Cornish	—	7·2	11·9	Welsh.
Lancashire	1 : 36	22·9	11·2	Lancashire.
Galloway	1 : 24	8·5	11·6	Anthracite.
Portable	1 : 69	12·8	11·8	Welsh.
Tubular	1 : 46	10·8	11·9	Anthracite.
Babcock	1 : 38	8·9	11·8	„
Marine	1 : 34	22·4	12·9	Welsh.
„	1 : 50	25·5	12·5	Lancashire.
Thornycroft	1 : 70	7·7	13·4	Welsh.
„	1 : 61	18·6	12·5	„

Trials of Welsh and North Country Coal.

Between 1857 and 1870 several series of trials were made, partly at the instance of colliery owners, partly under the direction of the Admiralty, to determine the relative value of Welsh and north country coal for generating steam. These trials extended over months and were laborious and costly, and they seem to me to have failed altogether to yield any useful result. In 1857, in trials carried on for many months, the result was obtained that Newcastle coal would evaporate 12·91lb. and Welsh coal 12·35lb. from and at 212deg. per pound of coal. Trials with the same boiler were then carried out under Admiralty direction by Messrs. Miller and Taplin. Their conclusion was that the Welsh coal evaporated rather more than the north country coal. A third series of trials were carried out at Cardiff, and in these the Welsh coal was found to be greatly superior to the north country coal. Finally, in 1881 to 1882, Mr. D. K. Clarke carried out extensive tests, obtaining from both coals evaporation of 12½lb. to 13¼lb. per pound of fuel. Mr. Clarke concludes that when both coals are treated properly they are equal in evaporative power and equally smokeless. How came it about that these long and costly trials gave such uncertain and discrepant results ? Quite similarly discrepant results, I believe, may be found in trials intended to determine the relative efficiency of different types of boilers.

In all these cases the failure to obtain definite and concordant results was due to overlooking the fact that the chief waste, the chief cause of loss of efficiency in the action of a boiler, is the heat carried into the chimney, and that this depends on simple conditions of air supply. In none of these trials was the chimney waste measured, and hence the observers had no key to understanding the discrepant results they obtained. Variations of chimney waste are large enough to swamp all differences due to type of boiler or quality of fuel. The experiments failed to be conclusive from the want of a scientific perception of the importance of determining accurately for each fuel the minimum necessary air supply, and for each trial the proportion of heat lost in the chimney.

Mulhouse Trials of 1859.

The earliest boiler trials carried out in a completely satisfactory way were those made by the Société Industrielle, of Mulhouse, in 1859. The Society offered a prize to the maker of any boiler which would evaporate 1,800lb. per hour at 75lb. per square inch pressure, and which would evaporate 9·1lb. of water from and at 212deg. per pound of Alsatian coal of not very good quality. In those trials the calorific value of the coal was determined, the ashes were weighed and analysed, the amount of air passing through the furnace was determined, the heat loss in the chimney measured, and a fairly satisfactory attempt was made to ascertain the dryness of the steam. With these data a proper balance-sheet of the expenditure of heat could be drawn up. The efficiency of the three competitive boilers, when worked in the way shown to be best for each in preliminary tests, was practically identical and equal to about 70 per cent. With the coal used in these trials 130 cubic ft. of air per pound of coal are chemically necessary for complete combustion. It was found that the reduction of the air supply almost to this limit, and to a point at which there was definitely incomplete combustion, reduced the chimney waste and increased the efficiency of the boiler. In two special trials, each of a week's duration, the evaporation was 9lb., with 331 cubic ft. of air per pound, and 9·53 or 6 per cent. more with 247 cubic ft.

Some striking results, showing the dependence of boiler efficiency on air supply, were obtained by members of the same Alsatian Society, at the works of Dollfus, Mieg et Cie. From several series of trials the following is selected :—

Date.	Coal burned per hour. Lbs.	Cubic feet of air at 0deg. and 0·76m. per lb. of coal.	Lbs. of water evaporated per lb. of coal.
February to March, 1859.	330	206	5·86
	330	204	5·85
	330	165	6·30
	330	139	6·60
	330	120	6·66

Here the efficiency increases as the air supply is diminished, even when it approaches the minimum chemically necessary. There are two ways in which decrease of air supply tends to increase efficiency. The quantity of heated air reaching the chimney is less, and the velocity of the heated gases in the boiler flues is less, so that there is more time for heat absorption.

The determination of the air supply to a boiler is not altogether an easy operation. An anemometer was used in Alsace, and in suitable conditions it will give approximately accurate results. In recent trials chemical analyses of samples of the furnace gases have been made, and the amount of air supplied calculated from the percentage of CO_2. This method is accurate in principle, but the samples analysed are a very minute fraction of the total chimney discharge, and the samples may not be average samples. In some trials in which this method has been used, there are discrepancies in the ratio of the chimney loss and the undetermined loss, chiefly due to radiation, difficult to understand. Neither anemometer nor chemical analyses is suited to serve as a means of regulating the air supply in the ordinary working of a boiler. What is wanted is an instrument as easily read as a pressure gauge and giving continuous indications.

The Dasymeter.

The dasymeter, invented by Messrs. Siegert and Durr, of Munich, is a fine balance in an enclosed case, through which a current of the furnace gases is drawn. At one end of the balance is a glass globe of large displacement, at the other a brass weight. Any change of density of the medium in the chamber disturbs the balance. A finger on the balance moving over a graduated scale gives the amount of the alteration of density. An air injector draws the furnace gas from the flues, and it is filtered before entering the balance case. An ingenious mercurial compensator counterbalances any effect due to change of temperature or barometric pressure.

The dasymeter is usually combined with a draught gauge, and an air thermometer, or pyrometer, in the flue is required if the amount of waste heat is to be calculated. The dasymeter requires initially exceedingly delicate adjustment, and its indications must be checked from time to time by a Bunte's burette. It is set to read zero with pure air, and then any increase of density due to CO_2 is read as a percentage on the scale. When in adjustment it is as easy to read the percentage of CO_2 in the furnace gases as to read the pressure on a pressure gauge. When the dasymeter is fitted to a boiler the stoker has directions to adjust the supply of air so that the furnace gases have about 12 per cent. of CO_2. With practice he learns what alterations of the damper, or fire door, or thickness of fuel on the grate are necessary, or whether an alteration of grate area is desirable. After a little time the percentage of CO_2 can be kept very constant.

The dasymeter is now largely used for boiler furnaces in Germany, and I am assured that in many cases a saving of 20 per cent. of the fuel has been secured. A similar instrument of somewhat different construction, invented by Mr. Arndt, is in use in France and Belgium. The air supply is the one controllable factor in the working of a boiler furnace, and we have trusted far too long to the practical experience of boiler-makers and the common sense of stokers to regulate this important factor in boiler management. We do not trust the common sense of the stoker to regulate the

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boiler pressure or the water-level, and it is equally necessary, if economy is to be obtained, that he should be supplied with some means of ascertaining definitely whether his management of the fire is good or bad. I believe in good and large installations, at least, it will come to be considered as necessary to have an instrument of the dasymeter type as to have a pressure gauge, and this, I think, may be regarded as a gift of science to the practical engineer.

Experiments on Steam Engines.

It has been seen that Cornish experience pointed to the rule that very large ratios of expansion could be adopted with economy, provided the conditions were those of Cornish engines. Expansion was generally used, but for a time with unfavourable results. Watt's rotative engines gave less than half the duty of Cornish engines.

If anyone would like to see what a curious state of mind engineers were reduced to by the success of expansive working in Cornwall, and its comparative failure elsewhere, I can refer them to a Paper by Mr. Palmer (1838) in the *Transactions* of this Institution. Mr. Palmer found that, while Cornish engineers claimed to have obtained a duty of 70,000,000, or even 100,000,000, per bushel of coal, no Boulton and Watt engine in other parts of the country was doing more than 28,000,000. He proceeds to a mathematical demonstration that, with steam of atmospheric pressure, it is impossible to obtain a duty, with no friction and no loss of any kind, exceeding 44,000,000, and that, with steam of higher pressure used expansively, the duty must necessarily be less. He concludes that the Cornish results are altogether incredible. "Strong indeed," he says, "must be the evidence that ought to induce this Institution to sanction statements of duty more than double that of the best Watt engine, and still more surpassing the limits Nature has assigned to steam to perform." With the help of more accurate science, we have been able to actually obtain a duty about five times as great as that supposed to be the limit of possibility by Mr. Palmer.

Isherwood's Experiments on Marine Engines.

About the year 1860, Mr. Isherwood, chief engineer of the United States Navy, began a series of systematic tests of engines and boilers on a very large scale, and with resources only available in a Government establishment. The trials were made with skill and determination; and the substantial accuracy of the results, startling as they were, has never been questioned. The service Mr. Isherwood rendered to steam engineering deserves the fullest recognition; and if some of his opinions from his earlier Papers are quoted which he would not now defend, it is only to show what was the condition of opinion in the mind of a very advanced engineer 30 years ago.

Mr. Isherwood seems early to have doubted the economy of expansive working, which, he says, had long been an undisputed article in the creed of the engineer. By what he terms "a simple arithmetical calculation suited to the meanest capacity," he endeavours to show that the advantage of expansive working has been over-rated. In this calculation he makes a blunder, often reproduced since, in assuming that the whole work done in the cylinder, during admission as well as expansion, is due to heat obtained by condensation of steam. The error was unfortunate, because then and since it has diverted attention from the true cause of waste in the action of steam. Isherwood did find by his experiments a large cylinder condensation, but he was too acute to attribute the whole of it to work done. He pointed out clearly the action of water on the cylinder wall in abstracting heat during exhaust, which would have to be supplied by condensation during admission. Further, he pointed out that priming water in the steam produces a loss greater than could be accounted for by mere abstraction of the heat in the priming water from the boiler. In his earliest Paper he argues against the utility of jackets and against superheated steam, but experiment soon after led him to modify his conclusions on both these points.

All Isherwood's trials of large marine engines showed that when expansion was extended beyond exceedingly small limits it caused not an economy but a waste. In his second volume he sums up his results as proving that when cut-off is earlier than 0·6 or perhaps even 0·7 of the stroke, the consumption of steam reckoned on the work is increased. Curiously enough, this led him to attack the compound engine. From the quantities in the Table of Experiments, he says: "It will be seen how useless in point of economic gain is the preposterous arrangement of steam engine known as the double cylinder, Woolf, or Hornblower engine. . . . Opposed to these facts, the declarations of interested patentees and engine builders must be classed in value with those set forth by quacks in advertisements of their nostrums." This is from a Paper dated 1865, and it is curious because Isherwood generally saw clearly enough the danger of drawing sweeping conclusions from narrow experimental premises.

Isherwood's experiments were made on large, low-pressure, slow engines, with large clearances, without jackets, and very great cylinder condensation. In these conditions, widely different from those of Cornish engines, any expansion, except to a very small extent, is uneconomical if regard is paid to indicated power, and still more, as Isherwood showed, if regard is paid to effective power.

Trials of Michigan. Isherwood, Michigan, 1861.

Cut-off.	I.H.P.	Steam per I.H.P.-hour.	Steam per effective H.P.-hour.
		Lbs.	Lbs.
0·92	301	40	43
0·70	211	35	38
0·44	204	33	36
0·30	134	35	39
0·25	118	34	39
0·17	74	37	44
0·09	61	46	61

The proper lesson from Isherwood's results was merely that certain conditions must be observed to secure economy in expansive working. Unfortunately, more generally the conclusion was drawn that the Cornish results were not to be trusted, and that expansion was not economical, and Isherwood's own language lent authority to the least accurate view of his results. To obtain greater insight into the true action in the cylinder, and to find a reconciliation of the Cornish and American tests, experiments of a much more refined character were wanted and insight due to wider scientific knowledge.

The Physical Properties of Steam (Regnault).

No useful progress could be made with a theory of the steam engine, no accurate reduction even could be made of the results of engine tests, without exact determinations of the relations of pressure, temperature, volume, latent heat, and liquid heat of steam. It was fortunate, therefore, that about 1840, M. Regnault obtained the means from the French Government to make a series of researches on the physical properties of steam with splendid instrumental appliances. He wisely carried out his determinations over a very wide range of conditions, and spared no labour or trouble in attaining accuracy. Regnault's results were of the greatest importance as a foundation for accurate study of the steam engine.

The Foundation of Thermodynamics (Carnot and Joule).

The next important step was the discovery of the equivalence of heat and work. Joule's investigations began with an attempt to improve Sturgeon's magnetic engine. He was so led to consider motive-power problems from the engineer's standpoint, as a question of duty, or of something obtained for something expended. He ascertained the amount of electric current produced by the chemical combustion of a given amount of zinc, and comparing his results with those obtained in good steam engines, he concluded that, making the largest allowance for possible imperfections of his magnetic engine, it was never likely to be a rival in economy to the steam engine. That was a negative but a useful result. It closed one direction of useless endeavour only too likely to attract the inventor.

One of the effects of electric action which Joule noticed, was the heating of his conductors, and it was to the measurement of this heating effect he next addressed himself. The heat developed in the conductor by the electric action due to elements combining in the galvanic cell, was found to be identical with that which would be generated by the direct combustion of the same elements. Finally he came to consider the relation between the mechanical work expended in driving a magneto-electric machine and the heat developed in the external circuit of the machine. He concluded that for 838 foot-lb. expended, a pound-degree of heat was generated. Later experiments corrected this value, but the discovery of the equivalence of heat and work was made.

Here, for a short time, Joule was misled by his own discovery. Examining the case of the steam engine, he found that of the heat generated in the boiler furnace less than one-tenth was actually converted into work. On that he too hastily assumed that this was a measure of the remediable imperfection of the steam-engine. It was not till six years after that he understood the physical limitations to the conversion of heat into work. The motivity of heat, or its capability of conversion into work, depends on local conditions. To increase the proportion converted in the steam engine, except so far as decreasing subordinate losses is concerned, it would be necessary to remove it to another planet where more favourable conditions for heat-conversion exist.

As early as 1824, 20 years before Joule's discovery, Sadi Carnot, in a remarkable pamphlet on the Motive Power of Heat, demonstrated the fundamental principle that the amount of work obtainable from any given quantity of heat cannot exceed a quantity, proportional to the fall of temperature. Unfortunately, adopting, though with hesitation, the view held in his time that heat is material and indestructible as heat, he coupled with his

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true principle the false corollary that all the heat entering an engine is discharged in the condenser. Joule in 1845 found this principle of Carnot, and looking to the corollary as essential, supposed the principle itself to be false. He failed to perceive that Carnot's principle was the essential supplement to his own discovery, and that it showed why the apparent efficiency of the steam engine is so low. It took six years before Joule's and Carnot's principles were reconciled, and for three of them even Lord Kelvin refused to accept Joule's discovery because it apparently conflicted with the principle of Carnot.

Permit me a very short digression. In popular writings nothing is commoner than to find the efficiency of electric machinery and of steam machinery contrasted to the great discredit of the latter. The dynamo, it is said, has an efficiency of 90 per cent. to 95 per cent., the steam engine an efficiency of only 10 per cent. What a barbarous machine, after all the labour of a century, the steam engine must be! The comparison is generally made by an electrical engineer, and the first reflection which occurs to one is that of all people the electrical engineer should be the last to abuse the steam engine; for, whatever may be the case in some future century, at present the dynamo is absolutely dependent on the steam engine. Without the steam engine the dynamo would be a useless mass of metal and wire. But passing over the moral aspect of the question, the ingratitude of the electrical engineer, the comparison is an unfair one, and shows a want of apprehension of that important law of the motivity of heat which is one of the two fundamental laws of thermodynamics. Heat energy is undirected or mob-energy. It lies in the nature of the terrestrial conditions in which use has to be made of it, that only a fraction is convertible into directed or mechanical energy. The task of the steam engine is to do its best with the fraction which is convertible, and in that point of view it is not an inefficient machine. The dynamo has a much easier task. Energy is supplied to it in its directed or wholly convertible form, and naturally in transforming one kind of directed energy into another kind of directed energy only a small fraction need be wasted.

The Founders of the Rational Theory.—Rankine, Clausius, Zeuner.

The impetus given to the study of Thermodynamics by the discovery of Joule and the perception of the fundamental importance of Carnot's theorem was enormous. Heat problems could now be brought out of the region of mere empirical solutions, and treated from the rational standpoint of an exact science, and the steam engine as the most important example of heat transformation attracted at once the attention of scientific men of commanding intellectual ability. In a very few years Rankine and Clausius had built up a strictly rational mathematical theory of the steam engine, and a little later Zeuner carried further the analysis of some of the more subordinate details. The theory, with one exception, to be referred to presently, took account of all the actual conditions under which steam is used, and furnished exact rules for the relation of steam expended and work done for all arrangements of the actual steam engine practically adopted. Subject to only one restriction of importance, the rational theory would have given the means of determining by nearly exact calculation the relative economy of different types of engines, the precise advantage in any given case of any particular ratio of expansion, the loss due to clearance and other questions of that kind. No physical theory of any machine was ever constructed more complete or on less exceptional data.

It was just at this time that the experiments of Isherwood were published, and a comparison of experimental results and theoretical calculations showed directly a very large discrepancy. The steam consumption in some trials was 30 per cent., 40 per cent., or 50 per cent. more than it should have been in the assigned conditions of working according to the rational theory. Some action of quite governing importance had obviously been neglected in the theoretical analysis.

A rough illustration will perhaps make clear where the defect of the rational theory lay. Suppose a good water-wheel driven by a fall of water. The mechanical action of the water is of a simple kind, and a theory is easily constructed which would give the relation of the water expended and the useful work done. Now suppose that, unknown to the constructor of the theory, there existed a large leakage from the head race to a reservoir on the supporting walls. Obviously the water expended would be greater than the calculated expenditure. The error of the calculation would not be due to any defect of the theory of the water-wheel, but to an extraneous and additional action which had not been taken into account. There was a neglect of a very similar kind in the rational theory of the steam engine, a leakage of heat treated as negligible in the theory which is, in fact, far too large to be treated as negligible in the practical working of the engine. Rankine and Clausius and Zeuner were well aware that the operation of the steam in the engine has to be carried out in a metallic cylinder capable of absorbing and giving up heat. But the conditions in which this exchange of heat occurs are complicated and very difficult to include in a mathematical analysis. They left the heat exchange with the cylinder wall out of the analysis as a matter which could be allowed for by some empirical coefficient. No doubt they altogether under-rated the enormous facility of heat exchange which arises out of the contact between a conducting cylinder wall and a vapour in a condition of the greatest instability and liable to condense or evaporate on the slightest change of thermal condition.

(To be concluded.)

THE MADAGASCAR CABLE.*

The French Government received on April 1st telegraphic advice of the completion of the laying of the Majunga cable under the conditions and within the period stipulated. In a previous issue we published the terms of the contract, dated December 23rd last, for the establishment of this cable, the length of which is 405 nautical miles. We recall to the recollection of our readers that half the cable was to be constructed at the Calais works of the Société Industrielle des Téléphones, and half in those of M. Gramont, at St. Tropez; that the steamer "François Arago," belonging to the Société des Téléphones, having on board the 425 kilometres (228 knots) of cable manufactured by that Company, left Calais on February 8th for St. Tropez to embark the 330 kilometres (285 knots) manufactured by the firm of Gramont; that the ship sailed thence on February 27th; that immediately on its arrival at Mozambique on March 19th she commenced the laying, satisfactorily completed on April 1st; and that the cable was at once opened to official correspondence.

This is an undeniable success for the contractors, especially if account be taken of the restrictions imposed by the Government. We are happy to be able to congratulate them. But it is a far cry to magnify it into a *tour de force*, as it is termed in a stereotype article, which has been reproduced in numbers of journals, inspired by the contractors to glorify their feat. In fact, we are in a position to know that an English company had offered to make and lay a new cable within a maximum period of 65 days from date of contract in consideration of a sum of 1,350,000fr. (£54,000). For the same operation the contractors were allowed a period of 98 days and a sum of 2,100,000fr. (£84,000). Under such circumstances, is it reasonable to believe, without in any way depreciating the merit of the enterprise, that a *tour de force*, unprecedented in the annals of submarine telegraphy, has been achieved? In addition, we ask in what has this excess of price, amounting to 750,000fr. (£30,000), transferred under the pretext of patriotism from the pockets of the taxpayers to those of the contractors, benefited the general interest? And we can hardly comprehend why an industry which, by every means of publicity and otherwise, makes incessant appeals in order to obtain the financial assistance of the State, should profit by circumstances in which the Government has need of its services to form a coalition, and tie it down by a Draconian contract bearing a profit of cent. per cent. We doubt whether the most ardent Chauvinism and patriotism have reason to be satisfied with such a result, which, beyond all argument, makes it comprehensible why France has not a submarine system, and why she cannot have one while the same practices are followed—at least while the State continues to pay for cables at double their real value. It is very evident that it is not the public who, under similar conditions, will be tempted to place its capital in French submarine telegraph enterprises.

The above note was already in the press when our attention was called to an article in a morning paper which pretends to justify the difference between the price asked by the English and that granted to the French contractors by the following:—"Want of space prevented us yesterday citing in full the particulars furnished by one of our *confrères* concerning the conditions under which the English proposed to establish the Madagascar cable. In fact, our quotation stopped at the passage mentioning the price of 1,300,000fr. asked by the English against that of 2,100,000fr. granted to the French contractors. It is right to complete these particulars by the following, which amply explains this difference, which may have surprised our readers. The English propositions emanated from the group of companies by whose cables all the traffic from Madagascar passes, starting from Mozambique, where the messages enter the English lines, to Marseilles. The tariff on these messages is 10fr. per word, and the probable traffic for the first year is estimated, in consequence of the expedition, which will necessitate constant communication with the capital, at about 300,000 words, representing receipts of 3,000,000fr.—a considerable profit without expense to the recipients. This is the reason which permits the English contractors, assured in advance of so profitable a compensation, to lower at will their charge for establishing the cable in order to foil the efforts of our national industry. What they lose upon construction they will gain in the receipts which the establishment of the Majunga-Mozambique line will bring to their

* From *Bulletin de l'Électricité et de la Télégraphie* of April 7th.

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cables. One can comprehend, under these conditions, that competition was easy."

This explanation may be ingenious, but it is absolutely devoid of foundation. In the first place, the proposition for the establishment of the cable for the sum of 1,350,000fr. emanated from a construction company which has absolutely no interest in the cables by which the traffic from Madagascar, between Mozambique and Marseilles, will be carried. The proposal had only in view the profit upon the sufficiently remunerative price of 1,840fr. per kilometre (£136 per knot), which it is ridiculous to seek to qualify as manufacturing at a loss. In the second place, in the negotiations relative to the establishment of the Madagascar cable, which have in fact taken place with the group of companies who themselves work the telegraphic lines between Mozambique and Marseilles, it is well known that these companies offered the Government a reduction, on the tariff of 10fr., of half for official messages and of about 25 per cent. for private telegrams. Calculating, on the estimate of our contemporary, upon a traffic of 300,000 words, this arrangement would have effected an annual saving of more than 1,000,000fr. (£40,000) to France, apart from the difference in the price of the cable.

PHYSICAL SOCIETY.

At the Ordinary Meeting of this Society on April 26th, Mr. Walter Baily, Vice-President, in the chair.

Prof. S. P. Thompson read a Note on

"A Neglected Experiment of Ampere."

Ampère, in 1822, made an experiment which, if it had been properly followed up, must have led to the discovery of the induction of electric currents nearly ten years before the publication of Faraday's results. While attempting to discover the presence of an electric current in a conductor placed in the neighbourhood of another conductor in which an electric current was flowing, Ampère made the following experiment:— A coil of insulated copper strip was fixed with its plane vertical, and a copper ring was suspended by a fine metal wire so as to be concentric with the coil, and to lie in the same plane. A bar magnet was so placed that if an electric current was induced in the suspended ring a deflection would be produced. No such deflection, however, was observed.

In 1822, in conjunction with De la Rive, Ampère repeated this experiment, using in place of the bar magnet a powerful horse-shoe magnet. He describes the result in the following words:—"The closed circuit, under the influence of the current in the coil, but without any connection with this latter, was attracted and repelled alternately by the magnet, and this experiment would, consequently, leave no doubt as to the production of currents of electricity by induction if one had not suspected the presence of a small quantity of iron in the copper of which the ring was formed." This closing remark shows that they were looking for a permanent deflection. When, however, Faraday's results were published in 1831, Ampère, after again describing the experiment made in 1822 by himself and De la Rive, says: "As soon as we connected a battery to the terminals of the conductor the ring was attracted or repelled by the magnet according to the pole that was within the ring, which showed the existence of an electric current produced by the influence of the current in the conducting wire."

Verdet, when describing the above experiment, falls into a curious error. He says the apparatus consisted of a ring of fine copper wire, suspended by a silk thread in front of the pole of an electromagnet in such a way that the plane of the ring was parallel to the plane of the turns of wire on the electromagnet. On making the current the ring is said to have been repelled, but this deviation did not persist, and on "breaking" the current the ring was attracted, also only momentarily.

Mr. BLAKESLEY did not feel quite confident that in Verdet's form of the experiment there would ever be attraction. He also pointed out that with an alternating current the disc would tend to set itself parallel to the lines of force of the electro-magnet. With reference to repulsion by alternating currents in one of Elihu Thomson's experiments, where a sphere is supported over an alternating pole, a screen being placed so as to partly shield this sphere, there is generally a misstatement as to the direction in which the sphere rotates. It rotates in such a direction that the part of its surface next the magnet moves towards the edge of the screen.

Dr. BURTON said that from the fact that when the current on the electro-magnet in Verdet's experiment is broken, the induced current in the ring is in the same direction as the current in the magnet, and the ring will be attracted.

Mr. BOYS confirmed Dr. Burton's statement. He recommended setting the ring at an angle of 45deg to the lines of force, under which circumstances a rotation would be obtained. A distinction must, he pointed out, be drawn between such an experiment as that of Verdet and those of Elihu Thompson. The repulsions observed in these latter were only due to the "lag" in the induced currents caused by self-induction. The best materials to use for all such experiments were magnesium and aluminium, since for a given mass these had the highest conductivity.

Mr. W. G. Rhodes read a Paper entitled

"A Theory of the Synchronous Motor."

The object of this Paper is to give as simple a treatment as possible of the mathematical part of the subject, and to give theoretical proofs of some experimental facts. Starting from the energy equation

$$p + c^2 R = C E \cos \psi,$$

where p is the output of the motor, R the resistance of the armature, c the current through the armature, E the E.M.F. applied to the motor terminals, and ψ the phase difference between c and E, the cases of maximum output, zero output, minimum current at zero power, and maximum phase difference between c and E are considered. These results are, for the most part, obtained directly from the energy equation. The latter part of the Paper is devoted to a discussion of the phase relationships between the current and the E.M.F.'s in a plant consisting of a generator and motor, and to the variations in the armature reactions in both generator and motor. A theoretical proof is given of the fact, observed by Prof. Silvanus Thompson and others, that an over-excited synchronous motor acts as a condenser, and tends to make the current lead before the generator's E.M.F.

Prof. S. P. THOMPSON said that the mathematical part of the Paper was much simpler than that in previous investigations on this subject, and the method of arriving at the results by rejecting imaginary roots of the equations was particularly neat and instructive. The part of the Paper relating to armature reactions and phase relationships was quite new. Two results deserved special attention; first, that the maximum current at zero power was the same as if the circuit was non-inductive; second, that the maximum current at zero power was double the current corresponding to maximum output.

Mr. BLAKESLEY said that the Paper did not consider the stability of the system, and he thought some of the results corresponded to regions of instability.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, May 10th.

Iron and Steel Institute.

10:30 a.m. Annual Meeting at the Society of Arts, John-street, Adelphi.

Physical Society.

5 p.m. Meeting at Burlington House. The following Papers will be read: (1) "On the Iodine Voltameter," by E. F. Herroun; (2) "A New Method in Harmonic Analysis," by A. Sharp.

MONDAY, May 13th.

Society of Arts.

8 p.m. Cantor Lecture, "Recent American Methods and Appliances Employed in the Metallurgy of Copper, Lead, Gold and Silver," by James Douglas.

Northern Society of Electrical Engineers.

8:30 p.m. Ordinary General Meeting at the Palatine Hotel, Hunt's Bank, Manchester. The following Paper will be read: "The Uses of Accumulators," by J. C. Howel

TUESDAY, May 14th.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting in the temporary offices, 9, Great George-street.

WEDNESDAY, May 15th.

Royal Meteorological Society

7:30 p.m. Ordinary Meeting at the Surveyors' Institution, 12, Great George-street, S.W.

Society of Arts.

8 p.m. Ordinary Meeting. The following Paper will be read: "Means for Mitigating the Fading of Pigments," by Capt. W. de W. Abney, F.R.S.

Royal Microscopical Society.

8 p.m. Meeting at 20, Hanover-square, W.

THURSDAY, May 16th.

Royal Institution.

3 p.m. Afternoon Lecture. "The Liquefaction of Gases," by Prof. Dewar.

FRIDAY, May 17th.

Institution of Electrical Engineers.

8 p.m. Students' Meeting in the Library of the Institution, 28, Victoria-street, S.W. Paper to be read: "Aluminium," by Gerald C. Allingham.

The Bakerian Lecture.—This lecture was delivered before the Royal Society yesterday by Mr. A. Vernon Harcourt, F.R.S., and Mr. W. Esson, F.R.S., its title being "On the Laws of Connection between the Conditions of a Chemical Change and its Amount."

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The Electrician.

(The Oldest Electrical Journal, 1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "Coutts and Co."

All Editorial letters to be addressed to the Editor.

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as evidence of good faith. No notice whatever will be taken of anonymous communications.*

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SPECIAL NOTICE.

Last week's number of "THE ELECTRICIAN" commenced Vol. XXXV. and contained (Gratis) the Index to Vol. XXXIV. Complaints of non-receipt should be promptly made to the Publisher.

Owing to the growth of the electrical and allied industries the demands for space in "THE ELECTRICIAN" are, for the greater part of the year, so pressing that a permanent increase in the size of the journal has become necessary. To meet the increased cost involved by this step, and by other improvements, such as heavier paper and more numerous illustrations, the price of "THE ELECTRICIAN" has from May 3rd been advanced to 6d. Hitherto this sum has been charged when the number has contained a Supplement, and, as the industries grow, these may be more frequently necessary; but the practice of charging extra for Supplement numbers as issued will be discontinued.

The Subscription to "THE ELECTRICIAN," commencing with Vol. XXXV. (May 3, 1895), is as follows:—

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THE EXPERIMENTAL STUDY OF THE STEAM ENGINE.

Prof. UNWIN seems to have some hope of converting the rule-of-thumb engineer to a belief in scientific methods, and his lecture of last Thursday night was, to a large extent, devoted to this object. He pointed out that WATT experimented for fifteen years; HIRN tested JOULE's principle on an actual steam engine; and all engineers who improved the steam engine by more recent experiments, whether they were college professors or manufacturers, like the late Mr. WILLANS, have thought in the language of RANKINE. Even if the infidel were to be converted by this exhibition of historical fact, he would say that all Prof. UNWIN's objects would be satisfied by the existence of one or two scientific engineers in each generation; but, indeed, the conversion of the man who poses proudly as a non-scientific engineer is out of the question, for there can be no belief in scientific methods where there is no scientific knowledge. Happily, Time is quickly making all attempts at conversion unnecessary. Rule-of-Thumb is in the position of Private MULVANY—"I was a corp'ral wance, but now I am rejuced." Whether or not any of the older engineers read Prof. UNWIN's address, it will be eagerly welcomed by the

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younger generation, among whom the competition is strong enough to assure us that in the future there will be, with practical engineers, a happy and correct admixture of theory and rule-of-thumb.

The lecturer gave, very shortly, an account of the more important measurements made upon steam engines during the century. Engineers have discussed these measurements with such a mathematical and physical knowledge of the properties of water-stuff, with such knowledge of the principles of thermodynamics, and above all with so much of that kind of knowledge which we call common sense, that they have been able to develop the steam engine to its present satisfactory state. Undoubtedly the progress was very slow till about twenty-five years ago. Prof. Unwin is, we think, unnecessarily severe upon the electrical engineer. It is true that he has occasionally called attention to the fact that good steam plant, even under steady loads, gives out usefully only one-tenth of the energy of the coal. But there is no ingratitude in this; it is a fact that ought to be borne in mind continually, and when the electrical engineer goes on to point out that it is in the electrical direction that we must look for many times this efficiency in obtaining mechanical energy from coal, he does this modestly, for he knows well his dependence upon the steam engine at present. It is really not fair to charge us with either ingratitude or impertinence, and we might answer like the Indian chief, to whom the Nabob said, "Are you yet to learn who that Colonel Clive is, and in what station God has placed him?" "*I* affront the Colonel? I, who never get up in the morning without making three low bows to his jackass!" If there is any ingratitude, surely it is in the steam engine manufacturers, for the improvements in stationary engines made during the last 15 years have been very greatly due to the fact that electrical engineers can measure their energy and power with wonderful accuracy, and they demanded some approximation to accuracy in steam engine measurements; hence, instead of only one or two mechanical engineers being interested in accurate measurements of power and steam, almost every manufacturer is now so interested.

We question whether any middle-aged or young manager of works does not know now, exactly, what are the directions in which steam engine improvement is to be looked for. Watt was right; there must be great expansion; this leads to the use of high-speed and high initial pressure, and some plan to prevent cylinder condensation. Expansion in successive cylinders, steam jackets, the use of superheated steam—these are the plans recommended; the first two alone are in use to any great extent at present. It has been abundantly proved that jacketing leads to considerable economy if applied to a single-cylinder engine which previously gave bad results, but if applied to a three-cylinder engine in which there was previously not much cylinder condensation, although there is always an increased economy, it is now not very marked. The jacket steam must be very much warmer than the working steam if it is to prevent all condensation. When steam and water are alone present in the same vessel, and there is a difference of temperature between them, there is a condensation or vaporisation—what may be called an interchange of heat—which is exceedingly great compared with anything that ever occurs by radiation or conduction or convection between any body and a true gas, such as superheated steam. It is, then, to superheating that the modern engineer is now directing his best attention. It may be impertinent for the electrical engineers to venture a suggestion, but we should like to say that there is a method of preventing condensation when ordinary dry steam is used, which seems quite unknown to practical engineers, but which deserves experimental attention, namely, mixing with the steam either air or some other gas, or a vapour which has a lower boiling point than steam. Tests might easily be carried out with non-condensing engines at first. Prof. Osborne Reynolds showed, about twenty years ago, that the presence of a small quantity of a gas very greatly retards the condensation of steam when suddenly admitted to a cold vessel. At present we can only say that it is by superheating that the most economical steam engine result has yet been obtained for any engine of any type or size. Prof. Schröter, using superheated steam in a compound condensing engine of 60 I.H.P., with only the low-pressure cylinder jacketed, had a steam consumption of only 10·2lb., and a coal consumption of 1¼lb. per hour per indicated horse power.

We are glad to see that Prof. Unwin dwells upon the fact that the Willans rule—the total water per hour is, within reasonable limits, a linear function of the power, if speed and ratio of expansion are kept constant—is in agreement with Rankine's rules if we assume with Cotterill a constant fractional condensation. In some engineering classes known to us, the students have illustrated this by numerical examples, and also generally, ever since Mr. Willans published his results. The lecturer has not given us enough. He has condensed a great deal of information and suggestion into small compass, but it is quite evident that he himself regrets that so much condensation is necessary. In Prof. Cotterill's book we have a valuable treatise on this subject, but for the practical engineer, even if scientific, there is almost too much speculative mathematical detail. In Prof. Ewing's delightfully clear treatment we regret the absence of detail. Prof. Unwin has all the information of what has been done and is a-doing in the experimental study of the steam engine, and, in addition he combines scientific accuracy with a knowledge of the methods of the manufacturer and the user of engines, and whilst we are thankful to him for his occasional short contributions to discussions of Papers, and for this valuable lecture, we think that the engineering world would like to see him publish a much more extensive treatment of this subject, as he in a manner did in the case of his Howard lectures on "The Development and Transmission of Power from Central Stations." Steam plant economy under steady load is not so important for the central station engineer as its economy under loads which vary greatly during the 24 hours. But, as Mr. Kipling says, "That's another story." We can only say again that we are grateful to Prof. Unwin for what he has already given, and we ask for more.

NOTES ON SUBMARINE CABLE WORK.

BY H. D. WILKINSON.

(Continued from page 13.)

34. Cable Currents.—In a submarine cable there are various currents prevalent, arising from different causes, which interfere generally with testing. To eliminate their effect is the general aim in the best methods. It is a first essential to have the various currents clearly defined in the mind, and form a separate idea of the action of each, although they chiefly act together. These currents are considered separately as follows:—

(1.) *Earth Currents.*—These currents are due to natural causes, and arise chiefly from climatic conditions and magnetic disturbances. The varied rate of evaporation and condensation in different localities produces different states of atmospheric potential which act inductively on the earth. In two distant

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localities the earth may be at very different potentials, and a current then flows from the higher to the lower potential.

The direction of such currents may follow or cross the line of a cable, and if the conductor is in connection with earth at both ends, a part of the earth current will flow through it. Not only so, but, when the cable is insulated at both ends, induced currents will pass in the cable following every variation in strength or direction of the earth current.

Before condensers were used at the ends of a line, as they are now, the cable was in connection with earth through the signalling instruments, and earth currents flowed directly into it. The effect of this was that the zero on the mirror or recorder followed the waves of earth current. A long scale had to be provided to accommodate the mirror spot, which at times went off altogether and had to be brought back by the controlling magnet.

The direct flow of earth current is now prevented so far as signalling is concerned by condensers placed between the instruments and line; but in testing, of course, the line must come direct on to the bridge and galvanometer, which offers a path for earth currents by the galvanometer and bridge to earth. The extremes of these two natural causes—namely, lightning and magnetic storms (such as accompany the appearance or disappearance of sun spots)—are alike dangerous to the insulation of the cable and the signalling instruments, and, therefore, while a storm lasts the cable is put to earth for safety. Earth currents are quite independent of any testing current, and, as we have seen, flow in cables whether earthed or free, and whether perfect or faulty. They are sometimes so unsteady that it is impossible to make a test, but if fairly steady their

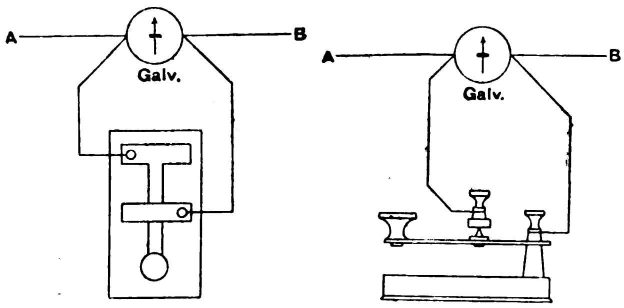

FIG. 105.

effect can be satisfactorily eliminated by (1) using reversals of current, (2) reading to "false zero," or (3) using two different strengths of current and reading to instrument zero, as in the Mance test.

(2) *Electrostatic Charge and Discharge Currents.*—These momentary and violent rushes of current take place on the application or disconnection of the testing battery. Immediately the battery contact is made, a strong, but momentary and gradually decreasing, current rushes into the cable. The greater the E.M.F. of the battery and capacity of cable the stronger will the charge be.

On releasing the contact key (so putting cable to earth) the accumulated charge is dissipated and produces a similar rush of current out of the cable, at first very strong and gradually dying away. These currents are not permitted to pass through the galvanometer, which is ordinarily short circuited by a small key (as in Fig. 105).

When the key is at rest, as shown, the galvanometer is protected, and currents passing between A and B are short-circuited through the key. After a few seconds, when the rush of charge or discharge has subsided, the key is opened (at first by tapping until the bridge is balanced) and then held down by a catch provided for the purpose in order to watch the behaviour of a fault by the spot of light.

(3.) *Natural Current from a Fault or Break.*—There is generally some current originating from the voltaic couple formed at the fault. Currents due to this cause are generally feeble, and may be treated as earth currents and eliminated with them by the above-mentioned methods.

(4.) *Polarisation Current from a Fault or Break.*—Under the action of current from a testing battery the fault or break becomes polarised or charged like a secondary cell, and an opposing E.M.F. is set up in it called the E.M.F. of polarisation. On releasing the battery key (which disconnects battery and puts cable to earth), the charge stored at the fault is discharged through the cable, producing what is known as the polarisation current. Its chief characteristic is that, from the moment it commences to flow, it falls quickly and steadily in strength, owing to the fall in the E.M.F. of polarisation. The potential active in charging the fault is not the full potential of the battery, but something less, depending on the distance of the fault.

The effect of the polarisation current can be eliminated by the same methods as for earth current. The two currents, in fact, combine and form one for the time. If reversals are used, the zinc current can generally be kept on; but the copper current can only be put on for a second or two, as it may run the resistance of the fault up to something very high. If the zinc current only is used, and the balance taken to false zero, the latter must be observed as soon as possible after the battery is disconnected, in order that it may represent the strength of polarisation current active during the test. The polarisation current may also be neutralised for a sufficient time to get a good test by putting a current on the cable for a few seconds in an opposite direction before balancing the bridge.

35. **Balancing to False Zero.**—As almost all fault testing is to false zero, it may be well to make this clear at the outset. What is termed "false zero" is the position of the spot of light when the testing battery is disconnected, and the galvanometer short-circuit key open. The deflection is due to any current or combined currents that may be passing in the cable. By balancing the bridge to this deflection as zero, the effect of the current or currents in the cable is eliminated. The results obtained are also true for either direction of testing current; and, therefore, the false zero is well suited for tests of faulty cables, as readings can be taken by the zinc current only, which opens and cleans the fault. In observing the false zero it should be borne in mind that the position of the spot should as nearly as possible represent the strength of cable current *at the time of the test.* The false zero deflection of course changes with each adjustment of the bridge, and therefore must be observed again after each alteration of resistance. The difference between the false zero deflection, and the position of the spot at balance gradually becomes less and less as the resistance is adjusted nearer, until finally they both coincide, at which point the bridge is balanced. When the cable current is simply an earth current (as in a good cable) it does not matter whether the false zero is observed before or after each fresh adjustment, because an earth current is not affected by testing current; but when one component of the cable current is due to polarisation of a fault the false zero should be observed as soon *after* each adjustment as possible, as the polarisation current rapidly falls after the battery is disconnected.

With the testing current on, and the resistance in the third arm of the bridge adjusted to bring the spot of light to the false zero mark, the bridge is balanced, and the resistance of the cable so determined is the correct resistance, the interference of polarisation or earth currents being eliminated. The discharge from a cable at the moment of breaking the circuit of the testing battery makes it extremely difficult to know when to read the false zero.

The deflection is a decreasing one, due to both discharge and polarisation; but the discharge at its commencement is at much higher potential than the polarisation current. On the other hand, it falls more rapidly, there being one instant of time when the potential of the discharge at the galvanometer terminal coincides with that of the polarisation. That point is reached in from one to three seconds, according to the length of the cable up to the fault, and it requires a great deal of practice and judgment to catch it at that point. False zero is also spoken of as "cable zero," or "natural zero," as distinguished from "instrument," "scale," or true zero.

In false zero testing a dead-beat galvanometer is the most convenient instrument to use. The movements of the mirror are damped by suspension in a closed tube containing water or air.

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In Lord Kelvin's dead-beat instrument the mirror is suspended in a tube closed with glass at front and back, in which the space is so confined that when the mirror is deflected it compresses the air within the tube, by which means its oscillations are checked. In the dead-beat instrument shown in Fig. 106 the mirror works in water, and is suspended as shown. The upper end of the silk is taken over a fixed disc D to the pin A, and the lower end to the spring S. (See Fig. 5 reproduced.)

After suspension the silk is drawn taut by shifting the bar P, and, when this is fixed in position by the screw, any further adjustment of the tension can be made by the pin A. This pin passes clear through the block, and its position is adjusted by the nut, so that the silk is not twisted. When adjusted, the whole is put into the tube B, which is filled with water and then closed at the end. This makes an excellent dead-beat suspension. The spot goes very slightly beyond its deflection, then comes back and settles down immediately.

It is very convenient and reliable to balance to false zero when taking an ordinary copper resistance test of a good cable

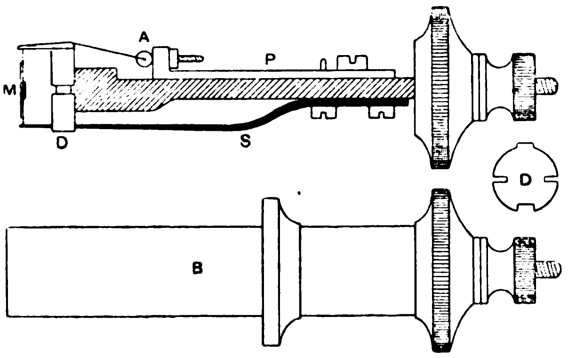

FIG. 5.—(*Reproduced.*)

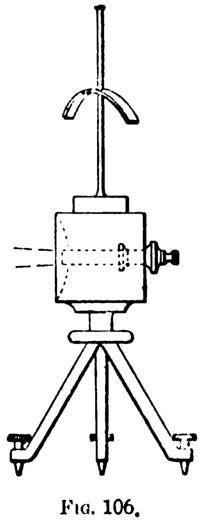

FIG. 106.

with an earth current present. A testing battery current acting in a given direction is either strengthened or opposed by an earth current, and if readings are taken to scale zero the apparent resistance with one direction of current to line is less than that of the other. The arithmetical mean of the two, viz., half their sum, generally gives the result with sufficient accuracy, but should the earth current be strong and the readings with zinc and copper widely differ, the geometrical mean of the two, viz., the square root of the product of the pair, gives a nearer approximation to the true resistance. The observations, however, with both currents are equalised, and a reliable result obtained directly by balancing to false zero.

When, however, (as in a good cable) there is no polarisation to vary the strength of the earth current one is apt at first to overlook the fact that this current (so far as it affects the galvanometer) depends on the resistance unplugged in the bridge. Mr. E. Raymond-Barker, in some communications to the *Electrical Review* of October 10 and 17, and December 12, 1885, has demonstrated by a geometrical treatment of potentials that the resistance in the third arm of the bridge should be as near an approximation as possible to that required to balance, in order to get the right false zero to work to. This is generally known sufficiently near on a good cable, but if not, a rough balance to scale zero should be taken. After that it is a step-by-step process, adjusting the bridge, and observing the false zero between each fresh adjustment, until the bridge is balanced with either direction of current to the same deflection as that observed on the galvanometer when bridge is to earth.

(*To be continued.*)

SERIES ELECTRIC LIGHTING.

The parishes of Kingswood and Keynsham, lying on the Great-Western main line between Bath and Bristol, are likely to attain to some celebrity as being among the first in Great Britain to use series incandescent electric lighting, and since the proprietors of the plant, the "Western Counties Electric Light and Power Syndicate" (Parfitt's Patents), are inviting public subscriptions to form a company on the strength of their experience at these two places, the good inhabitants of Kingswood and Keynsham may wake up one fine morning to find themselves famous.

On Monday last, by the invitation of the proprietors of the Parfitt Patents, a party of gentlemen representing the general, financial, and technical press, and other miscellaneous interests, made the round of the districts, and inspected the two station plants. After the inspection the visitors met in the Grand Hotel, Bristol, and an informal meeting was held under the presidency of Mr. Harry S. Foster, M.P., at which a discussion, also of an informal character, took place as to the advantages claimed for the system by the proprietors. After the introductory remarks of the Chairman, Prof. Silvanus P. Thompson, who, in the capacity of consulting engineer, reported upon the scheme some two years ago, gave a general idea of its chief features, and then various financial and technical questions were asked from the body of the meeting. A lively debate followed, in which the information elicited, although satisfactory to most of the laymen present, was not so convincing to the technical section. The fact is, the proprietors claim too much. Not content with the legitimate field which the system appears to possess, they wish to compete seriously with the usual well tried methods of distributing light and power from central stations.

It is well known that incandescent lighting by series lamps has not been successful, at any rate in any place in Great Britain, although we believe it has attained a certain degree of success at a few places on the Continent, and perhaps in some small installations in America. The difficulty has been two-fold; first, the candle-power provided has generally been too small, and secondly, the failure of a lamp filament has been apt to open the circuit, in spite of automatic devices, and to put out all the lamps on the series. In the experiment made at Barnet a few years ago both of these causes operated to condemn the series system. Mr. Parfitt has devised and patented a magnetic cut-out used in combination with a double system of positive mains and a common return; so that the failure of one lamp does not affect the lamps in series with it, but only that lamp, and that only temporarily, which is on the corresponding section. This will be clear from the diagram (Fig. 1), which shows the arrangement of lamps and magnetic cut-outs. It will be seen that the positive part of the circuit is divided into two branches, in each of which flows half the line current. Each lamp has in series with it the exciting coils of an electro-magnet, the resistance of which is equal to that of the lamp. Also a resistance is placed as a shunt to the lamp, one end of it being coupled to the line and the other disconnected from it, so long as the armature of the electro-magnet remains away from the magnet poles. The magnets are designed so that the normal lamp current will not lift their armature; but when a lamp breaks and the double current passes through the allied lamp, and consequently through the coils of its magnet, its armature is attracted, and closing the

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circuit through the shunt resistance provides a by-pass of the same resistance as that of the broken lamp. If the second lamp fails as well, then the whole of the current passes through the magnet coils and leaves things otherwise unaffected.

The automatic cut-out is shown in elevation in Fig. 2. This cut-out is the distinctive feature of the system, the commercial success of which depends on its mechanical and electrical efficacy, whilst on the validity of the patent as a necessary and *exclusive* device depends the financial value of the property of the syndicate now offered to the public. The current enters by the wire A, passes through the coils B of the electro-magnet, and leaves the instrument at C. An armature D pivoted at E is attracted when an excess of current passes through the magnet coils, so that its free end F enters between two surfaces placing the binding-post C in connection with the binding-post G, to which the wire leading to the resistance to be introduced is connected. It will be noticed that when the end F of the armature is between the surfaces the current is divided, part of it continuing to flow through the lamp as heretofore and part flowing through the plate, binding-post G to the shunt resistance.

Mr. Parfitt's patent is No. 17,324 of 1891 (October 12th). Its claims are two in number, as follows :—

(1.) In series electric lighting, sub-dividing the main line into several branches through which the current flows, and which branches have their lamps arranged in them in groups and in series, the said branches being metallically connected together in pairs in order that an excess of current passing through one part of the branch shall be again equally divided before passing to the next lamps, substantially as described.

(2.) The employment of an automatic switch adapted to be operated when an excess of current passes, in order to allow part of the current to flow to the lamps whilst the other part flows to a resistance, substantially as described.

It may be doubted whether the device is the only one capable of fulfilling the conditions necessary for a successful incandescent series system. But we think it to be a fact that as yet no other device has been used for this purpose with even a fair

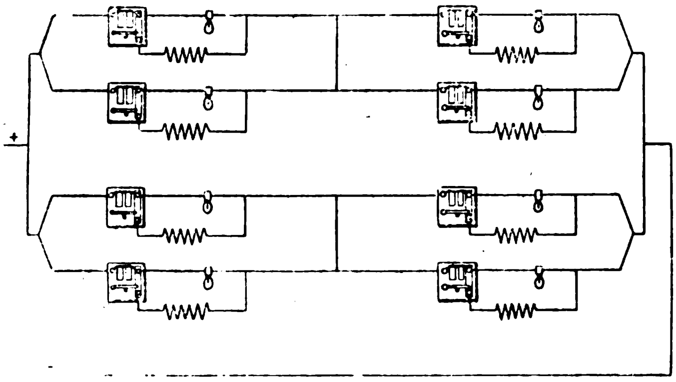

FIG 1.—Parfitt Series System of Lighting: Diagram of Circuit Arrangements.

degree of success, while the Parfitt system has been working without any failures from this cause for rather more than four years. If the Syndicate were content to rest their claims to public support upon this feature we think they would be wise. But, judging from a printed slip signed by Mr. E. Casper, one of the directors of the projected Company, copies of which were sent to the visitors, there is a tendency, perhaps unconscious, to go beyond this. There are in this document statements claiming that the Parfitt system of lighting is cheaper and superior to all others in respect to the cost of producing electricity, and especially in respect to fuel consumption. The following extract gives the gist of this circular :—"A salient proof of its practical importance is given by the fact that the public lighting of Keynsham and Kingswood (two suburbs of Bristol) *costs* [total] per unit less than 2¼d., whilst the average [total] of other towns is between 4d. and 5d. The cost of coal per unit at Bristol is 1·27d., against 0·325d. by Parfitt's system at Keynsham, *vide* the Board of Trade returns." The words "total," in brackets, are ours. We have inserted them because we were assured that the figure 2·25d. was the total cost of production, including depreciation.

The disingenuousness of this statement is apparent when we consider that the fuel consumption for Kingswood and Keynsham is based on the running of two compound engines worked at their most economic load practically throughout the time of supply, and that during the day the current is disconnected from the mains. In Bristol, as is well known, the capacity of the plant is far in excess of the present demand, and the average load factor is rendered still smaller by the compulsory continuous service. It should be noted also that no Board of Trade returns have been made by the syndicate. Mr. Parfitt told the visitors that the street lighting at Kingswood brought in a revenue of £650 per annum, while the *total* cost of production, including a sum equal to 7½ per cent. on the capital outlay for depreciation, was only £550, thus showing a clear profit of £100 per annum, whilst at Keynsham the public lighting realised £130 per annum, and the private lighting, at 6d. per unit by meter; or 17s. 6d. per 8-c.p. lamp by contract, brought in £195 for the same period. The working expenses for the latter station were not given, and, as the load factor is smaller than that at Kingswood, there is probably no profit at present; at least, we could not get information to that effect. In our judgment, and with all deference to Mr. Parfitt, it is courting financial disaster to supply local authorities at

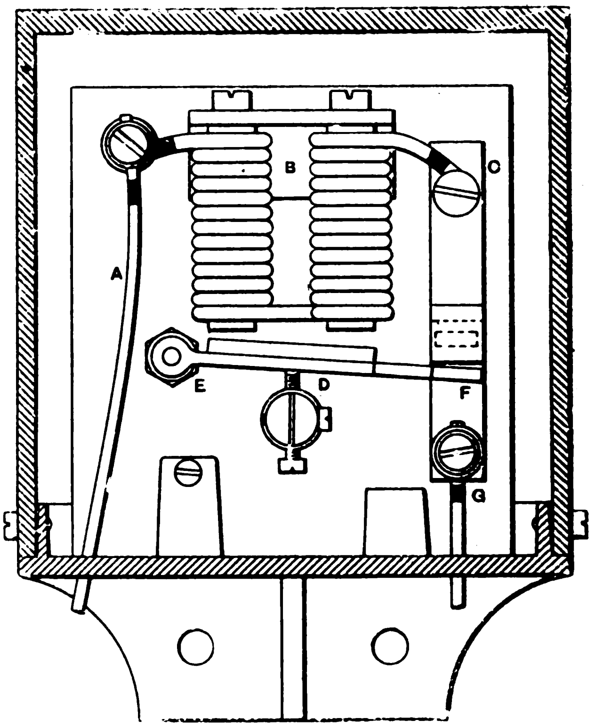

FIG. 2.—Parfitt Series System of Lighting: Elevation of Automatic Switch.

2·5d. per unit under the conditions obtaining at Kingswood and Keynsham. We appreciate the pluck of the originators of the lighting scheme, and we should be glad to see them face the inevitable, and charge a sum which will give them a fair chance of paying their way when the effects of depreciation make themselves fully felt.

Another point claimed by the promoters is the low cost of installation, and here we again join issue. It is, perhaps, true that the series system is the most economical as regards weight of copper for the given distribution of light, and as the mains are run on wooden posts, the outlay at the two places should not be large. We were informed that the total cost of the two installation, including freehold ground was just £10,000. But we are not sure that a high-pressure three-wire system, using 200-volt lamps, would be more costly. It would be certainly more convenient. We are also of opinion that the Board of Trade regulations will before long require *all* high-pressure electric light wires to be laid underground, in which case much of the advantage of a small cross-sectional area of copper would be lost; for it would be hardly worth while to go to the expense of laying underground such small wires as are used here, Nos. 12 and 14 S.W.G. In fact, series incandescent lighting appears to be suitable only for widely

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distributed districts, in which an overhead system of distribution is permissible.

To come to practical points. At Kingswood seven miles of streets are lighted by three circuits, respectively 2, 2½ and 3 miles in length. The lamps are spaced roughly at distances of 60 yards, and are elevated at from 14ft. to 20ft. from the level of the road, according to their candle-power. The lamps vary from 100 c.p. in the High-street to 35 c.p. and 25 c.p. in the side roads. The 100-c.p. lamps are switched out at 11:30 p.m., and others of 16 c.p. are put in circuit. The smaller lamps are switched in before the larger ones are cut out, and so the continuity of the light is maintained. There are 150 lamps, of which 16 are of 100 c.p., 52 of 35 c.p., 80 of 25 c.p., and a few of 16 c.p. The indicated horse-power at full load is about 32. There is a penalty clause in the agreement of 10s. per lamp per night for all defective lamps, and it says much for the regularity of the supply, and also for the good working of the magnetic cut-outs, that the fines for the past year do not amount to more than £7, and these were largely due to bad lamps. The station plant comprises a compound Davey-Paxman horizontal engine, which drives by belting three dynamos, a dynamo and its exciter, giving 800 volts and 12 amperes, divided into three circuits of 3 amperes each, and a shunt-wound dynamo, giving 130 volts and 60 amperes, which is used for running the private lighting. There is a battery of 384 T.K.7 type E.P.S. cells, which forms a reserve against breakdowns, and is useful for testing purposes. The boiler is a 16-N.H.P. Davey-Paxman Economic type, working at 140lb. pressure. The mains which supply the high-pressure circuits are No. 14 S.W.G., and are insulated. They are carried by slings from steel bearer wires strung from insulators in the usual way. The low-pressure circuits are of bare copper, No. 12 S.W.G.

An ingenious device in connection with the magnetic cut-outs has been contrived by which part of the main current is made to return to the station from any defective lamp through the steel bearer wire, and as this has a constant resistance per mile run, the current passing through a suitably calibrated ammeter is a rough indication of the position of the defective lamp. The current can also be made to ring a bell to call the attention of the attendant.

At Keynsham the engine and boiler are of the same type, and of about the same power. But since the area is more confined, and the lighting is largely private, two 65-volt shunt dynamos are coupled in series, one giving 200 amperes and the other 130. There are nine circuits, totalling four miles in length, run from the terminals, those for street lighting being at 130 volts, and those for private lighting at 65 volts. There is a battery of 35 Crompton-Howell L 23 cells and 66 E.P.S. K 23 cells. The street lamps are 69 in number, 14 of 100 c.p. and 55 of 25 and 30 c.p. The private lighting circuits have an equivalent of 550 lamps of 8 c.p. wired, the average load being equal to about 125 lamps. The circumstances here are thus not so well adapted for displaying the Parfitt system, and the lighting is chiefly operated as a parallel system.

To conclude. The Parfitt system, though it certainly will not revolutionise electric lighting, is not without interest, as being an ingenious attempt to tackle village lighting—a singularly barren field whether for oil, gas, or electricity. As a technical journal there is no need for us to follow the financial press in its diatribes against the promotion environment of the proposed company: it is passing strange that those who have in their day swallowed so many camels should suddenly strain at this very small gnat.

ON THE ELECTRIFICATION OF AIR.*

BY LORD KELVIN, P.R.S.

Continuous observation of natural atmospheric electricity has given ample proof that cloudless air at moderate heights above the earth's surface, in all weathers, is electrified with very far from homogeneous distribution of electric density. Observing, at many times from May till September, 1859, with my portable electrometer on a free and open beach on the island of Arran, in ordinary fair weather at all hours of the day, I found the difference of potential between the earth and an insulated burning match at a height of 9ft. to vary from 200 to 400 volts, and even during light breezes from the east and north-east it went up to 3,000 or 4,000 volts. I never found the potential other than positive, if for brevity we call the earth's potential at the place zero. In perfectly clear weather I even observed the potential at the 9ft. height to vary from about 300 volts gradually to three or four times that amount, and gradually back again to nearly the same lower value in the course of about 2min. I inferred that these gradual variations must have been produced by electrified masses of air moving past the place of observation. I did not remark then, but I now see that the electricity in these moving masses of air must in all probability have been chiefly positive. Thinking of the subject now, we see that the gradual variations minute after minute through so wide a range as three or four to one, and not infrequently rising to 20 times the ordinary minimum, must have been due to positively electrified masses of air, within a few hundred feet of the place of observation, wafted along with the gentle winds, of 5ft. or 10ft. or 15ft. per second, which were blowing at the time. The two fundamental questions in respect to the atmospheric electricity of fair weather force themselves on our attention; first, what is the cause of the prevalent positive potential in the air near the earth, the earth's potential being called zero? Second, how comes the lower air to be electrified to different electric densities, whether positive or indicative, in different parts? Observations and laboratory experiments made within the last six or eight years, and particularly two remarkable discoveries made by Lenard, have contributed largely to answering the second of these questions. In an article "On the Electrification of Air by a Water Jet," by Magnus Maclean and Makita Goto, experiments were described showing air to be inactively electrified by a jet of water shot vertically down through it from a fine nozzle into a basin of water 60cm. below it. Lenard conclusively proved that the electrification was due chiefly, if not wholly, to the violent commotions of the drops impinging on the water surface of the receiving basin, and he found that the negative electrification of the air was greater when they were allowed to fall on a hard slab of any material thoroughly wetted by water than when they fell on a yielding surface of water several centimetres deep. Lenard made an independent experimental investigation in the physical laboratories of Heidelberg and Bonn, by which he learned that the seat of the negative electrification of the air electrified is the lacerated water at the foot of the fall, or at any rocks against which the water impinges, and not the multitudinous interfaces between air and water falling in drops through it.

It still seems worthy of searching inquiry to find electrification of air by water falling in drops through it, even though we now know that if there is any such electrification it is not the main cause of the great negative electrification of air which has been found in the neighbourhood of waterfalls. For this purpose an experiment has been recently made by Mr. Maclean, Mr. Galt, and myself. The apparatus we used consists of an electrometer connected with an insulated electric filter applied to test the electrification of air drawn from different parts of a tinned iron funnel, 187cm. long and 15cm. diameter, fixed in a vertical position with its lower end opened and its upper end closed, except a glass nozzle of 1·6mm. aperture admitting a jet of Glasgow supply water shot vertically down its axis. The electrical filter R (see Fig.), a simplified and improved form of that described in the *Proceedings* of the Royal Society, March 21st, consists of 12 circles of fine-wire gauze, rammed as closely as possible together in the middle of a piece of block tin pipe of 1cm. bore and 2cm. length. One end of it is stuck into one end of a perforation through a block of paraffin K, which supports it. The other end, G, of this perforation is connected by block tin pipe and indiarubber tube through bellows to one or other of two short outlet pipes, M and P, projecting over the large funnel.

We first applied an indiarubber pipe to draw air from the funnel at the upper outlet P, and made many experiments to test the electricity given by it to the receiving filter R under various conditions as to the water jet, the bellows being worked as uniformly as the operator could. When the water fell fairly through the funnel, with no drops striking it, and through 90cm. of air below its mouth, a small negative electrification of R was in every case observed. But when the funnel was slanted so that the whole shower of drops from the jet, or even a small part of it, struck the inside of the funnel, the negative electrification of R was largely increased. In a series of experiments made on March 25 we found 0·28 of a volt in 15 minutes with no obstruction to the shower, and 4·18 of a volt in 5 minutes with a metal plate held 3cm. or 4cm. below the mouth of the funnel, the air being drawn from the upper outlet P. Immediately after, with P closed and air drawn from the lower outlet M, but all other circumstances the same, we found 0·20 of a volt in 5 minutes with no obstruction, and 6·78 volts in 5 minutes with the metal plate held below the mouth as before.

These results confirm Lenard's conclusion that preponderatingly strong electrification is given to the air at place of violent impact

* Abstract of a Paper read before the Philosophical Society of Glasgow.

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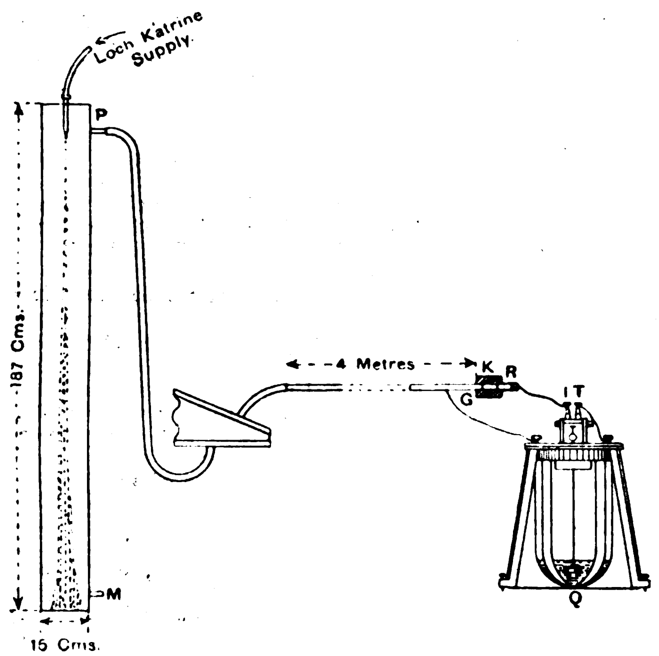
against a water surface or against a wet solid. But they do not prove that there is *no* electrification of air by drops of water falling through it. We always found in every trial decisive proof of negative electrification, though of comparatively small amount, when there was no obstruction to the shower. We intend to continue the investigation, with the shower falling freely down far enough from the mouth of the funnel to make quite sure that the air which we draw back from any part of the funnel is not sensibly affected by impact of the drops on anything below.

The other discovery of Lenard is that the negative electrification of air in his experiments with pure water is diminished greatly by very small quantities of common salt dissolved in it; that is, brought to nothing by 0·011 per cent.! That positive electrification is produced in the air when there is more than 0 011 per cent. of salt in the water, reaching a maximum with about 5 per cent. of salt, when the positive electrical effect is about equal to the negative effect observed with pure water, and falling to 14 per cent. of this amount when there is 25 per cent. of salt in the solution. Hence sea water, containing as it does about 3 per cent. of common salt, may be expected to give almost as strong a positive electrification to air as pure water would give of negative in similar circumstances as to commotion. Lenard infers that breaking waves of the sea must give negative electricity to the air over them; but finds a recorded observation of Exner, on the coast of Ceylon, showing the normal positive electric potential of the air to be notably increased by a storm at sea.

The strong positive electricity which I always found in Arran with an east wind, seemed at first to be an attribute of wind from



that quarter; but I soon found that in other localities east wind did not give any very notable augmentation, nor perhaps any augmentation at all, of the ordinary fair weather positive electric force; and for a long time I have had the impression that what I observed in this respect, on the sea beach at Brodrick Bay, in Arran, was really due to the 12 nautical miles of sea between it and the Ayrshire coast; and now it seems to me more probable than ever that this is the explanation, when we know from Lenard that the breaking waves must every one of them give some positive electricity to the air wherever a spherule of spray falls upon unbroken water.

From Lenard's investigation we now know that every drop of rain falling on the ground or on the sea, and every drop of fresh water spray of a breaking wave falling on a fresh water lake, sends negative electricity from the water surface to the air; and we know that every drop of salt water falling on the sea from breaking waves sends positive electricity into the air from the water surface. Lenard remarks that more than two-thirds of the earth's surface is sea, and suggests that breaking sea waves may give contributions of positive electricity to the air which may possibly preponderate over the negative electricity given to it from other sources, and may thus be the determining cause of the normal fair weather positive of natural atmospheric electricity. It has always seemed to me probable that the rain itself is the real restorer of the normal fair weather positive. Rain or snow, condensing out of the air high up in the clouds, must of itself, I believe, become positively electrified as it grows, and must leave positive electricity in the air from which it falls. Thus, rain falling from negatively electrified air would leave it less negatively electrified or non-electrified or positively electrified. Several times during the last 30 years I have made imperfect and unsuccessful attempts to verify this hypothesis by laboratory experiments; and it still remains unproved. But I found some degree of confirmation of it in Elster and Geitels' large and careful investigation of the electricity produced in an insulated basin by rain or snow falling into it.

Air blown from an uninsulated tube so as to rise in bubbles through pure water in an insulated vessel, and carried through an insulated pipe to the electric receiving filter, of which I have already told you, gives negative electricity to the filter; while with a small quantity of salt dissolved in the water it gives positive electricity. There can be no doubt that these results are due to the same physical cause as Lenard's negative and positive electrification of air by the impact of drops of fresh water or of salt water on a surface of water or wet solid.

MUNICIPAL ELECTRIC LIGHTING LOANS.

At the usual weekly meeting of the London County Council, held last Tuesday at the County Hall, Spring-gardens, the Finance Committee submitted an important report relative to the period for which loans for electric lighting purposes should be granted. The report was based on an application from the St. Pancras Vestry for a loan of £14,600, for the purposes of electric lighting. The Committee reported on the subject on July 17th last year, and recommended, consequent on the Council having granted 42 years to the Hampstead Vestry for the repayment of a similar loan, that sanction should be given the St. Pancras Vestry borrowing £14,300, and a similar term should be allowed for repayment. The Treasury, however, on being notified of the above terms, took exception to the period for repayment as being disproportionate to the life of the works. Communications there upon took place with the Treasury, and eventually an agreement was arrived at to the effect that the maximum periods for repayment of all loans for the initial cost of electric lighting undertakings should be as follows:—For land, building, culverts, bare copper mains, and royalty licences relating to such purposes 50 years, and for all other purposes 20 years. That agreement was fully set out to the Council on November 20th last, and the Council confirmed it, as applicable to all future loans for electric lighting. If, however, those terms were to be applied to the loans for electric lighting already made to the St. Pancras Vestry, it would be necessary to restrict the period for repayment of the loan now asked for to 20 years, as the previous loans had been for longer periods. The Vestry having been informed of that, asked the Council whether they would give them permission to borrow the money elsewhere. The Committee reported to the Council on that letter, to the effect that they must adhere to the principle embodied in the agreement with the Treasury. The Council, however, considered the matter on January 29th, and the recommendation was then withdrawn, on the implied understanding that a further representation should be made to the Treasury. The Committee had now to report that their lordships had approved of an alternative period of repayment, viz., 42 years, for the whole initial cost, provided that no further loan should be raised to defray the cost of renewing any works, plant, machinery or appliances which might require renewal during the currency of the original loan. That they considered to be a fair condition, and one which the Council should accept. The vestries would thus be able to borrow for 50 years for land, buildings, culverts and mains, and 20 years for other purposes as stated above, with right of borrowing for any necessary renewals of plant at the expiration of the 20 years, or of having an all round period of 42 years for the entire cost of installation, with a restriction as to further borrowing to supply any necessary replacement of plant and machinery until the amount raised has been paid off; any plant requiring to be renewed in the interim being defrayed out of a sinking fund for renewals or from maintenance account. The Vestry of St. Pancras, having been informed of the Treasury decision, had expressed their satisfaction therewith and willingness to accept the loan of £14,300, with repayment in 42 years on the condition mentioned. As the matter was of interest and importance to the Council and the Local Authorities generally, the Committee had directed the correspondence to be printed and attached to the report for future reference.

Mr. ROBERTS inquired whether the parish of Islington would be placed upon the same terms as St. Pancras in regard to the loan which they applied for at the same time as the St. Pancras Vestry.

Mr. A. HOARE, Chairman of the Committee, replied that St. Pancras had accepted the terms of the Committee without reservation; but the Islington Vestry had made certain reservations which made it necessary to enter into further correspondence with them. He had no doubt that it

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would be the pleasure of the Finance Committee to treat all vestries in the same manner.

Mr. BEACHCROFT said that as the recommendation involved such an important question of principle, he hoped the Chairman would postpone it for a week.

Mr. WESTACOTT, as representing St. Pancras, hoped that the Chairman would not consent to the postponement of the report, as it had been before the Council now for nearly 12 months.

Mr. CAMPBELL characterised the proposed period for repayment as partaking of the nature of dishonest finance, and he maintained that it was wrong to burden the future ratepayer for the benefit of the present generation. He proposed that the loan be granted for 20 years.—The amendment met with no seconder, and it was therefore negatived, and the recommendation of the Committee to grant the St. Pancras Loan was agreed to.

PARLIAMENTARY INTELLIGENCE.

SELECT COMMITTEE ON THE TELEPHONE SYSTEM.

The Select Committee sat again on Friday, the Postmaster-General presiding, when

Mr. A. D. PROVAND, M.P. for Glasgow, gave evidence as to the trunk-wire charges in Scotland. He said that the trunk-wire system had been more fully developed in Scotland than in England; but under the Agreement with the Post Office the rates (of which he handed in a table containing 2,330 inter-town rates) would be very much increased, because at present the mileage scales of the Company were less than those of the Post Office.

The CHAIRMAN pointed out that there was no reference to trunk wire charges in the Agreement.

The WITNESS said that it had been stated many a time that the Agreement was carrying out the Treasury Minute, and the rates which the Post Office intended to charge were contained in the Treasury Minute. If the Post Office did not intend to charge those rates, and the Postmaster-General would say so, that, of course, would make some difference; but the scope and effect of the Agreement would make the trunk-wire charges in Scotland enormously higher than they were at present.

The CHAIRMAN: Would you point out any clause in the Agreement that bears out that statement?

The WITNESS admitted that it was not to be found in the Agreement, but maintained that that would be its result.

The CHAIRMAN: I think you may take it from me that there is nothing in the Agreement which embodies these trunk-wire charges; the charges which are indicated in the Treasury Minute are subject to revision and Parliamentary control, and there is nothing in the Agreement embodying them, although they are charges which the Department at present proposes to make.

The WITNESS proceeded to compare the table of mileage charges of the Post Office with that of the National Telephone Company. Up to 20 miles the Company and the Postmaster charge the same; from 20 to 25 miles the Postmaster would charge twice as much as the Company; from 25 to 40 miles the charge would again be the same, but from 40 to 50 miles the Postmaster would charge twice as much as the Company; from 50 to 75 miles the Postmaster would charge one-third more than the Telephone Company; from 70 to 80 miles the charge would be the same; from 80 to 100 miles the Postmaster would charge 50 per cent. more than the Company; from 100 to 120 miles both charge the same; from 120 to 125 miles the Postmaster would charge one-fourth more than the Company; from 125 to 150 miles again the charge was alike; and from 150 to 160 miles the Company for the first time charged more than the Postmaster by one-fifth (2s. 6d. against 2s.); from 160 to 175 miles the charge would be the same; and from 200 miles upwards there would be on some distances a higher charge by the Company than by the Post Office. The increased charge made by the Postmaster over the Company was not entirely represented by the difference of rates he had quoted, because the Company at present did not charge for their inter-town service as high as they might charge according to their scale. Of the 2,330 rates which they quoted, 349 were at 3d; 683 at 6d., 727 at 9d., 414 at 1s., 145 at 1s. 6d., 9 at 2s. 6d., and 3 at 3s. The rates for short distances by the Company were much cheaper than would be charged by the Postmaster, and as most messages were for shorter distances, the increased charge would be a great hardship.

The CHAIRMAN pointed out that the Company's rates were for subscribers only, and that non-subscribers were charged double rates by the Company, whereas the Post Office would charge subscribers and non-subscribers equal rates.

The WITNESS said that the Post Office would never make anything at all of the non-subscribers. He objected to be charged an excessive rate in order that the Post Office might make a gift to other people who neither valued it nor used it. If the Post Office intended to do so, then it was another of the gross injustices which the Post Office practised upon the Committee. (This statement was received with loud laughter, in which the members of the Committee joined.)

The CHAIRMAN put instances to the Witness of the charge made by the Company in Scotland being 1s., while the Post Office charged 3d. or 6d. If those were facts, and he asked the Witness to accept it from him that they were, and they were for short distances, then they were entirely inconsistent with the statement which the Witness had made.

The WITNESS said he was not aware of those facts, and the information had not been supplied to him when he had asked questions in the House on the subject. He went on to complain of the inefficient character of the service in Glasgow, which, he suggested, was owing to the single-wire system, and to advocate the abolition of the terminal charges.

In reply to Sir J. Fergusson, he said that it was the case that the prices were raised in some instances, because otherwise, if the Government took over the telephone system, the charges would be less than for telegrams. Replying to further questions, he said that the terminal charges would mostly affect the inter-town communication, but he did not think they would afford a serious bar to the establishment of municipal systems.

Mr. W. H. PREECE, chief electrician to the Post Office, was recalled, and, in reply to the Chairman, described the various instruments used in telephonic communication. The first, he said, was the receiver, and there was very little difference between the style of instrument now in use and that which was used when the system was first brought over to England. The transmitter was that part of the instrument which converted the wave sounds of the air, and electrically conveyed the message to the receiver at the other end. The transmitter had passed through several stages of improvements, and had not yet approached perfection, for every day they were receiving suggestions for improvements. Those instruments were connected together with two wires, forming a metallic circuit, which wires were best twisted about each other. The use of one wire only made a defective system, led to innumerable troubles, caused imperfect and in fact was the principal cause of the great unpopularity of the telephone. In the Post Office they had always used the metallic circuit by means of the twin-wire system, but the introducers of the telephone system in England and America, for the sake of economy, used the single wire. The twin-wire system was being introduced rapidly into England; it was almost general in the United States, and over the Continent very largely. Proceeding to describe the switchboard, he said it derived its name really from the railway people. It was the machinery that shifted or directed the current from one circuit to another, and the operation was a very simple one. The switchboards had taken different forms. The members of the Committee saw on the previous day in Lime-street that which was called the panel or upright form, and in Gerard-street a modification of it which was called the table form. The one great advance or improvement which had been made in the switchboard was the introduction of the multiple switch, which gave every operator in the exchange complete command over every subscriber in the exchange, so that if they had 10,000 subscribers concentrated on one exchange every single operator would have under her control everyone of those 10,000 subscribers. But the introduction of the multiple switch, while it had facilitated very much the work of the exchange, had brought with it certain difficulties, one of which arose from the tremendous multiplicity of holes, or jacks, as they were called. The largest system had got about 6,000 subscribers; there was one in Paris, one in New York, and he was not quite sure whether the Telephone Company here were not fixing one. A switchboard for 10,000 subscribers meant 500,000 jacks, and everyone of those jacks involved some four or five joints, so that the fitting up of a switchboard for 10,000 subscribers meant three or four million joints being made; but the result would be that the whole of the 10,000 subscribers could be placed under the control of every operator.

The CHAIRMAN: Of course, the 10,000 subscribers would be divided up among a large number of operators, but by the multiple system each operator would have the means of communicating with the jack belonging to each subscriber?

The WITNESS: Yes; there would be 200 or 250 operators and two or three in charge of a section, there being 20 sections. The table system at once swept away half the number of jacks, so that instead of having half a-million jacks there would be only 250,000. In Chicago and one or two other places they were now trying what was called the divided board, which reduced the number of jacks to one-fifth, instead of half, and the divided board was extremely favourably reported upon. It was being worked out principally in Chicago. The department of the Post Office was constantly on the watch for improvements, and he had not only visited America and seen what was going on, but was in constant correspondence with the telephone companies there, and was kept fully alive as to all the progress that was made and the experiments that were going on. The Witness then proceeded to describe the operations which took place when one subscriber wished to have communication with another. Each subscriber must attract the attention of the exchange operator, and in turn the exchange operator must be able to call each local operator. That was generally done by raising an indicator at the exchange and in the subscriber's house by a wave of the hand. In the Post Office they had introduced a peculiar system which had attracted a great deal of attention, and which had been the subject of a Paper in the United States, where they were now commencing to introduce it. Instead of relying on the ringing of bells they had produced a system of individual signals which did not depend on the sound at all. There was a little indicator which moved, and that indicator gave different signals, which he would explain to the Committee. But first of all he wished to call their attention to another modification, known as the Law system of call, which was produced in Glasgow, and was now in work there. There was a call wire apart altogether from the talking wire, which went to every subscriber's house. At every station there was an operator who had always got a telephone at her head; the subscriber had to go to the talking wire, and say "I want No. 30," which, being heard by the operator, the operator then switched him on. Experts on the question were very much at variance as to the merits of the various systems of call. As the representative of the Post Office he considered that which they had in operation the best service in the world, but of course he might be prejudiced in that respect. He thought the Law system pretty near perfection, though it had not been received with favour in the United States. He liked the system, because it gave automatically and instantaneously notice to the operators that the wire was engaged or disengaged, and that the conversation was over as soon as it was over. The subscriber simply lifted the telephone off the hook—that was the signal; there was no ringing at all; the operator received the

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instructions and could see whether the line was engaged or disengaged; conversation would commence, and when it ceased the mere act of putting the telephone on the hook was an indication that the conversation was over. It was objected to the system that it involved the use of batteries, but they found in the Post Office that the cost of the batteries was so small that it did not even appear in their accounts.

Sir JULIAN GOLDSMID: Really, if the operator could see when the wire was being used and when it was not being used, there would be great saving of time?

The WITNESS: Yes; that was the object of the signal. In the American system and in the system used principally by the Telephone Company in England, which was called the busy test system, when the operator touched the instrument it gave a click if it was engaged, which the operator knew to be the signal. That took up about one-half of the operator's time, which was saved by the Law system as against the busy test system. Then changes had taken place with regard to the material for the conductors. At first the conductors were iron, but now they were of copper or sometimes bronze. Iron conductors were inherently bad and absolutely subversive of clear speech. There was some reaction between the current and the matters generally found in the earth which seemed to absorb a good deal of the energy that produced clear speech, and by speaking through an iron wire the voice became blurred, and it was difficult to distinguish one man's voice from another's.

Sir JULIAN GOLDSMID: Is there a great quantity of iron wire still used in England?

The WITNESS: No; a very small quantity. He doubted if there was any, with the exception of the telephones used upon the railways. He did not think the Telephone Company had any, and the Post Office now never put up any iron wire. Replying to the Chairman as to the comparative merits of underground and overhead wires, he said there was an advantage in having trunk wires overhead, and there was no disadvantage in having local wires underground. The reason was that an underground wire, like a cable, retarded the electric current; just like iron, it absorbed those minute electrical waves which enabled them to distinguish between one voice and another, and, in fact, it checked the speed of the current. It was not unlike speaking through a long speaking tube when the voice became blurred at the entrance. Where they had the wires underground it spoiled the articulation and the individual identification. That was due to an electrical quality which might be called the capacity of the wire for retaining its discharge. They could measure the capacity of every wire, and knew how to reduce it, but they could not remove it altogether. If they had to speak through from Plymouth, Leeds, Carlisle, Birmingham, and Bristol, and if all those places had underground wires, the sum of all those short lengths underground would retard the current. Taking each one by itself, its effect was not sufficiently large to blur the voice, but when they took the whole of them together it was sufficient to produce that result. For long distances the overhead system was distinctly superior to the underground, and it was absolutely essential that the wires should be taken overhead. There was not much difference in the cost. The London to Paris telephone, which was one of the best, was wholly overground, with the exception of the cable across the Channel. They were very rapidly reducing the capacity of underground wires which led to retardation, and in America they had succeeded in reducing it to one-fourth. The coating of the wires with paper had certainly good effects, and when applied to cables with a great number of wires it brought the price of the underground work so low that the difference between the underground work and overhead virtually disappeared. It reduced the price per mile per circuit for a double circuit of line of pipes filled with conductors to £18, as against £15 or £16 overhead, but it was only when they carried a great number of wires that there was great economy. It really came to this: that while it was impossible to put underground wires where they had only six or eight or ten wires, owing to the price, when they came to 100 or 200 wires it was cheaper to go underground than over ground.

The CHAIRMAN: Have you had sufficient use of paper, as compared with gutta-percha, to say what the life of the paper is?

The WITNESS: Yes. They had had quite 10 years' experience of using paper. It was adopted five years ago generally in the States, and he had experience himself of about five years, using it exclusively for trunk wires; and he had absolute confidence in its durability. There was not a single instance, either here or in the United States, of failure. Where the paper was kept dry it did not decay, and the whole secret of the success of the use of paper was in keeping it dry. Placed in lead pipes, hermetically closed, it would answer, but if water got in, it would decay, and break down the circuit.

The CHAIRMAN: Is it as durable as gutta-percha?

The WITNESS: More so; if the paper can be kept dry it will last for a thousand years.

In further reply to the Chairman, the WITNESS said that the twin-wire system was equally applicable to the overhead system as the single wire, but he agreed with the opinion expressed by the previous witness, that it was not possible to make a satisfactory metallic circuit except with twin wires.

The CHAIRMAN: The Committee have heard that the Department are taking over on July 1st the trunk-wire system of the Telephone Company. Would you describe the general system of trunk wires and the action the Department have taken since the Agreement was entered into between the parties.

The WITNESS first described, by means of a map, the system of trunk wires at present held by the Post Office, and stated that by next Tuesday it would be possible to complete another line from Leeds to London, which would give them a continuous line from London to Glasgow. As Leeds was the most central town in the country it was essential that it should be made the exchange for the trunk-wire system, and all trunk lines would centre at Leeds. The lines had been constructed quite up to date, at a cost of £800 per mile out of the half million voted by Parliament in 1892, and he had every reason to believe that the speaking through them would be as perfect as could be. They were also constructing a line from London to Salisbury, Southampton and Portsmouth, and to Bristol, which would connect the Plymouth and Exeter lines with Bristol, Southampton and Portsmouth. There was another line to Ipswich and Colchester, which they proposed to extend. They had already spoken from the outskirts of Hampstead (really from London) to Belfast and Dublin, and between London and Belfast the speaking was quite as good as it was between the City and Westminster. The officers of the Department had spoken from Plymouth through Bristol, Birmingham, Leeds and Glasgow, to Belfast, a distance of about 1,700 miles.

The CHAIRMAN: Is that a record performance as far as you know?

The WITNESS said that it certainly was on this side of the Atlantic; but he thought they had exceeded it on the other side. He had himself every confidence that there would be no difficulty whatever in every principal town in the country speaking perfectly easily with any other town, and more than that, he believed that the telephone would be enormously used, and that in about twelve months or two years there would be great demand for it. In the present year they intended to complete the system between London, Birmingham and Warwick to Liverpool. Speaking of the increase of telephone business in the United States, he said that between his two visits in 1884 and 1894 there had been the following advance. In 1884 the miles of wire were 115,000, in 1893, 444,000, and this year 557,000. The telephone service of America was entirely in the hands of private companies. In 1884 the miles of underground wire were nil; in 1893 there were 148,000 miles, and at the commencement of this year there were 325,000 miles. The telephones in use in 1884 were 325,000, and in 1895, 582,000. In America they called the receiver one instrument and the transmitter another instrument, so that to draw a comparison in the use of the telephone in America, that number should be divided by two, which would give 291,000 telephonists who now used it in America. In 1884 there were 123,000 subcribers, in 1893, 232,000, and now the number must be about 280,000. Everything had grown in the same ratio except the exchanges, the reason being that they were more centralised, there being a larger number of subscribers to each exchange. As showing the enormous use made of the telephone in America, he mentioned that on one day in Chicago there were 153,807 calls made and answered, and 307,000 persons were placed in communication with each other through 15 exchanges. In Glasgow and Liverpool it was not unusual to have two or three telephones working side by side, but in Chicago they had as many as six. Referring next to the extension and development of the telephone system in France, he said that on March 11th last he visited the Paris exchange, and found that a very considerable growth of business had taken place since 1889, when the business of the telephone company was transferred to the State, the total number of subscribers to the State telephones being now 28,108. At the time that the transfer was effected the business at once increased, and the subscription was reduced from £22 to £16. He did not know the terms on which the telephones were transferred in France, but it was invariably an underground service. There was a peculiarity about the system there, that they had enormous underground sewers along which the wires were carried without any disturbance of the streets; but the objections which he had mentioned to an underground system would equally apply to subways of that kind.

Sir JULIAN GOLDSMID: The cost would be a little less, would it not, of putting them in the subways?

The WITNESS: Yes. He next described the operations in the exchange of enabling subscribers to communicate over the local, junction, and trunk wires, and produced a chart which, by means of curves, showed how the work was spread over the different hours of the day. This showed that very little was done before 9 in the morning, and that from 11 to half-past 11 in the morning, and at 3 in the afternoon, there was always a large number of calls. The whole work of an exchange was concentrated in a few hours of the day, and in the early morning and at night there was nothing whatever done.

The CHAIRMAN: Is that the experience of the Post Office with the London and Paris telephone?

The WITNESS said that that would not apply so much to that service, because it was used so much at night for Press purposes. Speaking further of the operations in the exchange, he said that to place a subscriber in communication with his local correspondent involved three distinct operations, and the time occupied by them depended not only on the skill of the operator, but a great deal more on the attention of the subscriber. Half the troubles in telephone working were really due to the subscriber, and not to exchange operations. When they had to use the junction wire the number of complete operations was six, which meant that there was more delay in getting through. The trunk wire working involved, when it was through one exchange, 12 complete operations, through two exchanges 16 operations, and still more through three exchanges. The work, however, was done much more rapidly when the Law system was used, and although there might be 12 operations there was no reason why the time occupied should be more than was occupied in local working. He had a letter from the United States which said: "We are now certainly showing that it is just as easy to trunk a message as it is to make direct connection."

The CHAIRMAN: Is that partly due to the fact that in getting through an exchange on the trunk wire the operator is communicating with another skilled operator?

The WITNESS said that no doubt it was so. In England, if anything went wrong, the subscribers grumbled and growled, but did not do their best to assist the Company or the Post Office, while in America they looked upon themselves as part and parcel of the system, and all did their best to assist the Company. In any conceivable system there must be delays in getting through in the busy time of the day. If competing systems were established in the same area, that would mean an increased number of

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connections, and there must be increased delay. The general efficiency of the service would be injured, for the fewer the operations the better the work was done. The daily calls per circuit varied very much. The average per day over the whole of the United States in 1893 was 8·03, but at Chicago it reached as many as 34 at one exchange. At Boston the average was formerly 8·45, but now was 12·6; in Berlin in 1884 it was 12, and in Paris 5.

Sir JULIAN GOLDSMID: Berlin is on the single-wire system, is it not?

The WITNESS said he could not answer that. They had some peculiar system at work there which he did not quite understand. He was not quite sure that it was single-wire pure and simple, but was inclined to say that it was some combination. The number of lines per operator also varied very much on different systems at different places; but at an exchange, say, of 4,000 subscribers, it ought not to average more than for local work 50, for junction work 10, and for trunk work 5. With the view of showing that the larger the exchange the greater the number of talks per subscriber, and that the cost of working a large exchange was thereby increased, he quoted the following figures from the United States:—

Town.	Talks per day for each subscriber.	Customers per operator.	No. of subscribers.
Buffalo	6·0	100	2,240
Boston	12·6	75	3,545
New York	15·0	50	4,500

The increase in the number of operators was a very important element in the cost of working. At Buffalo the charge was made of an annual subscription and toll rate; there was an installation charge of $70, which covered the first 500 messages, and after that they paid 8c. a message of five minutes. At Boston the rate was $160, or £32; and in New York the subscription was $240, or nearly £50 a year, so that a larger number of subscribers was followed by a larger subscription in the case of those three towns, but he thought that was due to local circumstances altogether apart from the size of the exchange. The cost of fitting up an exchange with the multiple switchboard increased as the square to the number of subscribers. For instance, if they had a multiple board for 2,000 subscribers, and they doubled the number of the subscribers to 4,000, the cost of the switchboard would not be twice as much, but four times. It was that growth which rendered the multiple switchboard so expensive.

Mr. BENN: Is that the reason they gave up the multiple board in Chicago?

The WITNESS said he thought that must be the reason.

The CHAIRMAN: Does that fact make comparison between the charge for London and towns in Scotland somewhat inappropriate?

The WITNESS said he thought it ought to be taken into serious consideration. It was important that the Committee should take into account that whatever might be the annual rental, the working expenses must increase with the number of subscribers, and therefore that the balance between the revenue and the working cost must diminish; so that if the rental was too low and the number of subscribers too many, the working expenses would exceed the revenue, and rates would have to be increased. The average engineering expenses per subscriber was about £3 per annum; his estimate for an underground system for London was £55 per subscriber, and for the provinces £45. When Mr. Lamb was before the Committee he promised to put in a schedule of tariffs, &c., in other countries, and he had prepared a schedule (which the Witness handed in to the Committee) giving information with regard to Austria, Belgium, France, Germany, Hungary, Italy, Norway, Sweden, Switzerland, and the United States. It gave the fact whether the telephone was in the hands of public bodies or private companies; it described the system in use (and he saw that he put down a single wire for Berlin, but the Witness was not certain that Mr. Lamb was right); the area covered; the number of subscribers; the terms of subscription; statistics of profit and capital and trunk wire charges. He pointed out that there were three distinct bases of charge: first, fixed annual rental with unlimited service; second, a smaller annual rental with a limited service, and tolls for extra talks; and third, the system of charging tolls for everything, without any annual subscription. He read a letter from the Director-General of the Swedish system, stating that they were introducing, with considerable success, a system of charge measured by the amount of use made by each individual subscriber. In the first place they had an initial minimum, after which the subscriber paid a certain amount per message, on similar lines to the Buffalo system of charges, and the new plan seemed to take. One remarkable fact about Buffalo was that the number of calls per day had not increased, and now it was the lowest in the United States, which tended to show that the toll system took away the desire of subscribers to ask silly questions.

Replying to Sir James Fergusson, the WITNESS said that when the Agreement between the Post Office and the Company came into full working order he anticipated a great development of telephonic communication in this country. As to the question of having competing systems in London, there would be the difficulty of laying additional pipes under the streets, but that would not be insurmountable. There would, however, be enormous difficulty encountered in regard to way-leaves.

At the sitting of the Select Committee on Tuesday Mr. Arnold Morley again presided, and the examination of Mr. Preece was resumed. He described various attempts which had been made to do away with manual labour at the exchanges by electrical automatic switches, and especially a device which he saw at work in Brussels some years ago, and which was on exhibition at Chicago, by which an electric light indicated when the conversation commenced and ceased. Those devices were, however, based upon the assumption that the line was always in working order, always disengaged, and that the subscriber was always present. Such a system could only be used in very small exchanges, and would not be applicable to a large exchange like that of London.

Sir J. FERGUSSON: But, surely, you would be the last to say that it was impossible to apply such a system to London?

The WITNESS replied that the word "impossible" did not occur in the vocabulary of the electrician. Quoting towns in the United States in which, though the charges were high, the number of subscribers to the population was large, he said that he accounted for it by the fact that the telephone was essential to the conduct of business in the States. The habits of the people, the methods of locomotion, the temperature and climatic conditions, made it almost essential to them that they should conduct their business indoors. Referring to the toll system of charge now being adopted in Sweden, he said that it did not unduly check the use of the telephone; but he was rather an advocate for the combined system of a small rental and a small charge as toll. It would check the unnecessary use of the telephone, and he insisted that the intelligent use of the system was an important factor in its success. That was so much recognised in the States that not only did they look after the education of the staff, but had inspectors who went about to instruct the public in the use of the telephone. They also encouraged the subscribers to visit the exchange and see the work there, so that they might be able to grasp the working of the whole system.

The CHAIRMAN: Do you think there is need in this country for educational work of this kind?

The WITNESS said there was immense need for it. The Committee had had plenty of evidence from users of telephones, and if some of the witnesses who had appeared before the Committee had received such education he thought they would not have given such evidence. Asked to give his opinion upon the question of the municipalisation of telephones, he said he had five or six reasons against municipalisation. First, a public body like a town council would be at a disadvantage in conducting what to them would be a growing speculative and comparatively new industry, while they would not have that accumulation of experience which was necessary to maintain high efficiency. Secondly, high efficiency could only be maintained when the service paid. The active and energetic opposition of a determined company like the National Telephone Company, who could under-cut prices in one part of their system to maintain their position, would certainly prevent the possibility of local success, while at the same time they would penalise the other parts of the system by maintaining high prices in order to recoup the loss in the district where they were competing. Thirdly, financial failure on the part of a municipal system would speedily secure the opposition of the labouring and employed classes of the ratepayers who did not benefit by the use of the telephone, and who formed the majority, and were, therefore, the masters of the situation. Fourthly, high efficiency depended essentially on skilled labour and effective supervision. Small municipalities could not afford to pay high salaries to secure or maintain the services of highly-skilled technical men, nor had they the experience to develop effectually the education of the men they employed. They could not compete with the Post Office in its prospects of promotion and of pension on retirement. Fifthly, that in a small municipality (and he was dealing more with small municipalities than with large ones) not managed by skilled men, the service would be irregular. There was no difficulty in arranging for a local subscriber on one system to speak to another subscriber on another system in the same town, but that could not be done commercially where there were different practices, and where there was ill-feeling and determined opposition. In any case it would lead to additional switch operations, and consequent delay and loss of efficiency. He had a return showing the time occupied at one of the most prominent exchanges in New York, where it appeared that the extra time per exchange was over a minute, so it really meant that the insertion of each extra exchange meant a minute's delay between a subscriber in one area and a subscriber in another area. He wished further to point out that a perfect trunk service could be obtained only on one uniform system, and with one staff. Every additional system meant enhanced expense, divided responsibilities accumulated difficulties, and serious delays. Centralisation of membership. in one central spot like London secured the advantage and benefit of the widest experience; it encouraged experiment and observation, and prevented the repetition of errors; it checked the exercise of individual idiosyncracies; it enforced technical education, and implied the highest efficiency. Those ideas were carried out by the system as now adopted in England as well as by the Bell Telephone Company in the United States. Municipalities, however, might do much for the development of the telephone by providing subways and conduits, and facilitating the acquisition of way leaves, and generally in assisting the conduct of the business under proper control and supervision.

The CHAIRMAN: Would most, if not all these reasons apply equally to competition by private companies in the same area?

The WITNESS: They would. The question of way leaves was a very serious one, and was growing more and more serious every day. The Post Office was in the position that it was subject to law and the regulations of an Act of Parliament, but there were many wires which were run up without law. Cheapside, for instance, was one mass of wires, and he believed $\frac{99}{100}$ths of those wires belonged to the Telephone Company. The Post Office failed to get way leaves to King's Cross and St. Pancras for its Newcastle wires, and they were everywhere troubled with the difficulty that owners objected to their property being trespassed over and the roofs damaged. At New York there was a company which constructed a subway and let out space in it for telephone wires, but they charged an exorbitant rent for the use of it. As to the extension of the telephone in rural districts, that could be encouraged to a large extent by district councils giving the guarantee which was necessary to meet the demands of the Treasury. That was done to a large extent in some parts of Wales, where several small offices had

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been opened under guarantee by the District Council; but, as a rule, the rural people said they could communicate cheaper by telegraph than by telephone. The present number of telephones in use under the Post Office was: Exchange and call offices, 1,900; private wires, 3,000; public offices worked by telephone, 680; lifeboat stations and coastguard stations, 354; lighthouses, 39; lightships, 80; permanent wires, 1,025; making a total of 7,006 telephones worked on the Post Office system. He advocated an imperial monopoly for the postal, telegraph, and telephone services alike, because it secured uniformity, undivided responsibility, popular supervision, and public control, which meant not only the highest efficiency, but the greatest economy. The mail was quick, the telegraph was quicker, but the telephone was instantaneous, and they did not have to wait for an answer.

By Mr. GRANT LAWSON: Competing systems would be difficult to connect so as to be commercially successful. There would be the difficulty that subscribers would not know where to address their complaints, and there would also be the difficulty connected with having an innumerable list of subscribers. If there were three sets of subscribers—one to the Post Office, another to the National Telephone Company, and a third to a local company—each company would have to keep full lists of all three sets of subscribers.

By Mr. TULLY: He was not aware that the National Telephone Company sent round inspectors to instruct the people in the use of the telephone. In one instance, at Plymouth, the Company had succeeded in ousting the Post Office, and if they succeeded in doing that they would certainly succeed in ousting a municipal body. The conduct of telephone business was on a totally different footing to the supply of gas, water, tramways, and electric light by a municipality, because those matters were confined to the local areas, whereas the telephonic communication went far outside the local area.

Mr. TULLY: Supposing the municipality had a licence, and their system succeeded, would it not be better, when the State came to take over the telephones, that they should have the choice of taking over the better system of the two?

The WITNESS: That is a question of policy upon which I cannot give an opinion.

Mr. BENN cross-examined the Witness at some length as to his reasons for objecting to municipal telephones, and the Witness further urged that the Town Council being subject to election every three years prevented any continuity of policy; the fact that Parliament was also subject to re-election had not had any effect upon the Post Office policy. He did not know of any other way by which a municipality could get a cheaper telephone service, except by competition, unless by the intervention of the Postmaster-General. He understood that the new Telephone Company proposed to supply London at a lower price, but he could not accept the figures given in their prospectus. If they did not agree with his own figures he should say that they would probably be wrong. As to the letter which he had put in by the Director-General of the system at Switzerland he said he would not repudiate it, but he did not support it. If a municipality was willing to incur a loss there was no doubt that by obtaining a cheap service they would benefit those using the telephones. Asked what the Government would do in 1911, when the Agreement came to an end, he said it was too early to predicate what would occur at that time.

Mr. BENN: But we have to face that and to see what the effect of this Agreement would be upon the ratepayers of the country.

The WITNESS said those were questions of policy into which he could not go. He supposed they would either buy up the telephone companies or start a system of their own.

In reply to the Solicitor-General as to the circumstances under which the Post Office were ousted from Plymouth by the National Telephone Company, the WITNESS stated that the system was established by the Post Office there at the request of 40 subscribers. The Telephone Company, jealous of their starting, aided and abetted by one or two active men in Plymouth, went down there and started an opposition exchange; they went to all the Post Office subscribers and gave them telephones for nothing, and when the Agreement with the Post Office expired they gave up their telephones, and so continued to work on the Telephone Company's exchange. The Post Office had their hands tied by the Treasury, and so could not combat such competition.

Replying to Lord Stanley, he said he believed the National Telephone Company was doing its best to render its service as efficient as it could be made, and he was perfectly satisfied if in 1911 the Post Office took over that system it would be with first-class materials and everything up to date.

Mr. SNAPE stated that at Liverpool they had provided for 6,000 subscribers, had a multiple board, and had actually 3,500 subscribers. He asked if there was a board in London as large as that.

The WITNESS said that the board at Lime-street was constructed either for 5,000 or 6,000 subscribers. The multiple board was divided into sections, each section providing for 200 subscribers, so that a multiple board for 10,000 subscribers could be provided by dividing it into 50 sections. It would require four additional operators for each 200 subscribers, and the cost would be *pro rata* with the greater number of subscribers. Additional operators would be required for working the junction lines, and as they would have to provide for early and late duty, for sickness and for holidays, the extra cost would not be limited to the mere wages of the four operators.

Replying to Mr. Moulton as to the position of the public under the Agreement, in the event of the service of the Company being inefficient, and there being no penalty on the Company or restriction as to rates, the WITNESS said it could be met by the Post Office opening a competing exchange. Therefore competition was not impracticable, but it should not be engaged in by municipalities. If it was only one town which they had to consider then the Postmaster-General would not have much difficulty in inducing the Treasury to give its consent, even if it involved a loss.

Mr. MOULTON: That is the kindest word I have heard for the Treasury for a long time.

The CHAIRMAN: Especially if the town gave a guarantee.

The WITNESS: Just so.

Mr. R. E. CROMPTON, President of the Institute of Electrical Engineers, speaking for that body, said that their general views were that the effect of the monopoly which had existed up to the present time had been to entirely deaden the interest which the members of the Institute had taken in telephony, so that out of the total membership of over 2,000 there were only 45 who devoted themselves to telephony, 31 of whom were in the employ of the National Telephone Company, 10 held situations out of England, and there were only four in England who were independent.

The CHAIRMAN: I think without exception every witness has advocated taking over the system by the State; would not that have a more deadening influence?

The WITNESS said it was possible that it might have; but it could not be worse than at present. From the point of view of spreading and encouraging a knowledge of telephony over a larger number of persons than at present, he would oppose the State taking over the system, though from the point of view of convenience to the community it would, no doubt, have great advantages. He thought the balance of advantage would be in the State taking it over after more information and knowledge of the subject had been gained. By adopting a system of competition, a great stimulus would be given to invention, and great improvements would be introduced which do not exist at present. The progress of the telephone would be analogous to that of the electric light, which had made such great strides in consequence of its being free and open.

The CHAIRMAN: Do you think the telegraph service has become crystallised instead of having been in a state of improvement?

The WITNESS said that he considered telephony was very different to the telegraph. We were only on the way to finding out what was to be done in the way of transmitted speech. Probably the thing they were most looking forward to was telephony without wires, and that was a thing in which invention was discouraged by the present state of things. Asked if he suggested that his views were the views of the whole body and of Lord Kelvin in particular, the WITNESS said he did not know what Lord Kelvin's views were, but the views he had expressed were the views of the Committee and a great number of members with whom he had conversed. Professor Hughes, the inventor of the microphone and the transmitter, was strongly in favour of competition from the point of view of the development of the system.

The CHAIRMAN: Of course you are aware that the telephone in England has gone through a period of unlimited competition which has resulted, from causes which we need not go into, in the abolition of all competition and the amalgamation into one system?

The WITNESS replied that the patent lasted for twenty years, and that as long as that lasted there was really no competition. With competition in the electric light, the result had been lower prices and great improvement in the quality of the article. The telephone must be divided into two heads, the trunk lines and local lines, and he thought we in England especially wanted a development of the telephone without the trunk lines. Where we compared so unfavourably with other countries was the absolute want of telephony among the poorer classes in the villages and towns, as it was found in Sweden. He did not think there would be any real difficulty, from an engineering point of view, by having two competing systems in the same area, half the subscribers being on one system and half on the other; but in that matter he did not speak as an expert. What he was really speaking to was this: he was an educator of young men for the electrical profession, and he had had a large number of pupils, but the electric light and the transmission of power filled their thoughts, while telephony was a subject on which they did not wish to learn, and which they did not know. Electric light and electric power schemes were carried out by those young men going down into the country, starting local affairs, and getting local capital. He believed the same thing would be done with telephony by young men on the country-side getting small exchanges and fostering them all over the country.

The CHAIRMAN: So you advocate young men starting telephone systems throughout the country wherever there is sufficient capital?

The WITNESS said he did, and he thought there would be a great increase in that way. They would have nothing to do with the trunk lines, but would simply be small exchanges for local purposes.

Lord STANLEY asked what chance those young men would have starting in a small district against a powerful telephone company.

The WITNESS said it would not be against them, but would be filling a want that was not already filled. An exchange could be commenced with 20 or 30 subscribers very cheaply, and with very small capital, and the wayleaves could be arranged through the parish or district council.

Lord STANLEY: Have you any reason to suppose at the present moment the National Telephone Company would be indisposed to grant such an exchange where there was a sufficient number of subscribers to make it worth its while?

The WITNESS said that the reason was that £10 was too high, and that those young men starting an exchange on their own account would be able to do it cheaper than the National Telephone Company, or that at any rate we could do it as cheaply as was done in foreign countries. If such exchanges were then—if the demand justified it—on passing an examination by the Post Office and certified as being fit to be admitted to the trunk lines, they should have access to the trunk lines just the same as the National Telephone Company.

Replying to Mr. Snape, who pointed out that since the Government had taken over the telegraphs far greater progress had resulted than previously, the WITNESS urged that before the acquisition there was competition, and Prof. Hughes had declared that if there had not been that competition his type-printing telegraph would never have been taken up. Some of the members seemed to think that the telephone had got to a position

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at which much further improvement was not possible, and that also tended to deaden the interest in the subject, while naturally the Post Office servants did not say much about what was going on, and there were not so many discussions on matters of detail connected with telephony as there were on other electrical matters which were burning questions of the day. It was not the opinion of the members that the progress in the telegraph had been more rapid than it was before. If the choice remained between the State taking over the telephone or continuing the present arrangement with the National Telephone Company, he would prefer the former. He looked upon limited competition as a means of spreading telephony all over the country. He saw telephony spreading very slowly at present, partly on account of the high prices. He thought competition would lower the prices and educate the public in the use of the telephones, for users were not educated in other countries. He attributed that backward state to its being in the hands alone of the National Telephone Company and Post Office.

Prof. SILVANUS THOMPSON gave evidence in support of the view urged by Mr. Crompton, stating that he had acted as adviser to various companies in telephonic matters since 1881. He wished to emphasise the view derived from conversation with other members of the Institution, that there was a general feeling that there ought to be no monopoly in the telephone business, unless it was a monopoly for which the holders should be responsible to the public through Parliament; in other words, that unless the system were taken over by the State they regarded monopoly as a thing to be deplored.

The CHAIRMAN asked the witness whether he urged that view in the interests of the telephone users, or in the interests of the profession, as tending to open up a career for a larger number of students.

The WITNESS said he certainly urged it in the interests of the public, because a monopoly could not be good for the public. Competition, he thought, would bring about a more effective service to the public.

The CHAIRMAN: Admitting that the Company had a license for 17 years, you think there should be competition until the close of that license, and that then the State should take it over?

The WITNESS: Yes. He also wished to emphasize Mr. Crompton's view in relation to the effect that it had upon the training of young men. He had had to do with the training of young men for the last 10 or 12 years, and had had something like 4,000 young men who had attended his classes, but very few had come to be educated in telephony. It had been forced upon him that the education of the young telephonic engineer was not being conducted in this country upon really scientific grounds; that was to say, there did not appear to be much encouragement in that branch of the profession. Parents came to him about placing their sons, asking whether they should send them to such and such a firm, or put them to college for a couple of years with a view to their careers, but very seldom did it occur to them to ask whether telephony offered a career for young men. He sometimes suggested it, but the suggestion was seldom accepted. They enquired about careers as patent agents, submarine telegraph engineers, electric lighting, but the particular branch of telephony was very seldom asked about.

The CHAIRMAN: Then you suggest that the future policy should be adapted to opening careers for these young men.

The WITNESS said he considered that it was not an unimportant matter to bear in mind in framing the future policy; another thing which had tended to deaden interest in telephony was the enforcement of the patent, which had prevented anybody else doing anything in this country whatever, and had had a bad effect upon its progress and development.

In reply to Mr. Snape, the WITNESS said that he considered it would be quite as economical to take over the appliances of the Telephone Company now as at the end of the 17 years.

Replying to Lord Stanley as to the young men starting new exchanges being able to stand against the competition of a large company, the WITNESS said he thought they would have a good chance of success if they were acting as agents of the local authority; he would not prevent private enterprise but would prefer to have the local bodies as a backbone. Steps would have to be taken to prevent the National Telephone Company first cutting out the small exchanges by low prices, and then raising the price after they had swamped their competitors.

Replying to Mr. Tully as to the Plymouth case, he said he could not understand how the Post Office could give a licence to allow the licencee to interfere with their own business there. It seemed to him to be monstrous.

Mr. TULLY: There are many things we cannot understand.

In reply to Mr. Moulton, the WITNESS stated that he acted as the adviser of the London and Globe Company, which had litigation with regard to the patent. The idea of that Company was to have various exchanges for various trades—one exchange for tea-dealers and another for lawyers; but they would be able to have inter-communication between the several exchanges, so that the lawyer could communicate with the tea merchant, and *vice versa*. He agreed with the suggestion that municipalities might be expected to be the most efficient providers of a competitive local system. The question of inter-communication between competing systems would depend upon the terms upon which they held their licences: but he thought that such means ought to be arranged for.

The Committee then adjourned until Friday.

BOOKS RECEIVED.

"Electricity in our Homes and Workshops." By S. F. Walker. Third edition. (London: Whittaker and Co.) Price 6s.

"The Practical Telephone Handbook." By J. Poole. Second edition. (London: Whittaker and Co.) Price 5s.

"Extracts from the Private Letters of the late Sir William Fothergill Cooke." Edited by F. H. Webb. (London: E. and F. N. Spon.)

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *April 26, 1895.*

Newspaper Amalgamation.—The publishers of the *Electrical World* have purchased the *Street Railway Gazette*, which will hereafter be issued from the office of the former publication. The *Gazette* was founded in 1886 as a monthly, and changed to a weekly in 1892, being the only weekly publication in the United States devoted entirely to street railway interests.

The Metropolitan Elevated Street Railway of Chicago.—The first extensive electrically-operated elevated street railway in the United States was formally opened last week. This railway, which is 13½ miles in length, is built on private right of way, the expenditure for land and construction amounting to $12,000,000. There are two motors to each motor car, hauling from four to six trailers. The speed of express trains is to be over 30 miles per hour. The motor cars resemble the passenger cars in external appearance. At each end there is a compartment one-half the width of the car for the motorman, the remainder of the car being used as a smoker. The present generating equipment consists of four units, two of 1,000 H.P. and two of 2,000 H.P. The dynamos are similar to those used on the Intramural road at Chicago. Each motor is equipped with a sliding shoe on either side; only one of these is ordinarily used, but in passing cross-overs the shoe employed on the return trip on the other track is temporarily in use, being thrown in automatically.

The Westinghouse and General Electric Companies.—The negotiations between the General Electric and the Westinghouse Companies in regard to an agreement as to the common use of patents have been suspended, at the instance of the executive officers, it is generally believed. Mr. George Westinghouse, it is known, was opposed to the proposed arrangement, which was suggested by those representing the financial interest of the two companies. The general opinion is, that the difficulty which brought the negotiations to a standstill probably occurred when the valuation of the Tesla patents came under consideration.

CORRESPONDENCE.

EARTHING THE MIDDLE WIRE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The subject of the leading article in your issue of April 26th is one worthy of discussion, and one that will probably receive much attention in the near future.

In their report (given in your paper of the above date) to the Municipality of Altenburg on the question of a bare middle conductor in a three-wire distribution system, Messrs. Slaby and Gisbert Kapp dwell on the difference of potential which will exist between several points of the earthed middle conductor when a considerable current is flowing in the cable, and the consequent electrolytic action and disturbance of telegraphs and telephones by wandering currents between the different points. The report leads one to suppose that the middle cable will be earthed throughout from the central station to all parts of the district, with a considerable loss in the conductor when the current in the two outer cables is not balanced.

The most sensible means of overcoming this difficulty is by protecting with slight insulation the middle conductor of the several sets of feeders issuing from the central station, and also the middle conductor of the distributing network; let the middle conductor be earthed, not at the generating station, but only at the points where the feeders are connected to it, and whence pilot wires are carried back to the station, and at which points the difference of potential between the middle and outside cables is, or should be, always kept similar and constant. Thus, there being no difference of potential between these

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earthed feeding points, the injury from electrolytic action, or disturbance to telegraphs and telephones, will not occur.

The authors of the report enlarged on the benefit of an earthed middle conductor for discovering leaks on the outer cable, and the automatic discovery of weak spots by the fusing of cut-outs. In your article you question whether fuses will act so obligingly for the tracing of leaks, and you admit that on both the outer mains—positive and negative—leakage will still occur. Concentric cables, with the outer conductor earthed at the points as suggested above, together with concentric wiring in buildings, will remedy this evil. With this arrangement the positive and negative conductors, hitherto called the outside cables, are now each enclosed in an outer sheathing of stranded wires and well insulated from it. The sheathing of each cable forms the "middle or neutral conductor"; is slightly insulated, and earthed at the feeding points. The sheathing of each cable is connected at frequent intervals. As the positive and negative conductors are enclosed within the "middle or neutral conductor" from the generating station right through to the lamps, the possibility of leakage to earth does not occur.

There are other benefits which I cannot introduce into this letter, owing to its length already, but they all point to the probability of this method of cable laying and wiring being one that will be largely used in the future.—Yours, &c.,

SIDNEY SHARP.

34, Victoria-street, S.W., May 8, 1895.

SLIDING SCALE CHARGING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to charging for electric lighting on a sliding scale, I think I can claim priority in this. In 1882 I had charge of one of the pioneer stations of the Metropolitan Brush Company, in High Holborn.

Some of the customers complained at paying the same annual rental for their arc lamps while closing at 8 p.m., as the public-houses, hotels, music halls, &c., who had the light till 12:30 a.m. I pointed out that the plant (which was about 100 per cent. higher then than now) had to be provided for them whether they used it or not. To meet them, I took the first cost of the plant, added a percentage for management, and divided it by the lamp output (arc lamps). From this I got a fixed sum per lamp, and in addition charged so much per hour for the time they burned the light. I had some difficulty in persuading the Company to adopt my suggestion, but succeeded in a few instances where the people refused to accept any other terms. I have always maintained that a sliding scale charge was the only one that would meet our requirements, and for years was ridiculed for thinking that any but the orthodox pattern, such as the gas or water meter, would be accepted.

It is now an accomplished fact. As regards the systems, Mr. Wright rather under-estimates the value of the long-hour customer, while Mr. Ward Leonard's example of the generator and fan is over-stated. I think it possible (while fully admitting the beauty of Mr. Wright's apparatus) without such apparatus to hit a fair mean.

The electric light is the poor man's light; that is, the lower and middle class. Their consumption is steady and regular, they are rarely away from home, and use their full requirements from 1,600 to 1,700 hours per year. Had stations started with dense residential neighbourhoods, instead of shops, electric lighting stations would have doubled their progress by now.—Yours, &c.,

ERNEST G. PINK.

Electricity Works, Ayr, May 7, 1895.

CURIOUS VACUUM TUBE PHENOMENA.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should be glad if any of your readers could furnish me with an explanation of the undermentioned effect, to which I have been unable to find any reference in either text-books or in researches on kindred subjects. After a vacuum tube had been caused to glow by means of a Wimshurst machine, it was observed that on stopping the machine, and removing the tube to a distance of several feet, or in fact taking it out of the room altogether, the tube still continued to glow for a space of a minute or two. In some cases the tube appeared dead, but on placing the hand directly round the centre bulb, a sudden glow shot through the tube, and by changing the hand round so as to encircle a further part of the bulb, yet a second and third glowing discharge occurred. Also, if one extremity of the tube be connected to one terminal of the machine, while the tube is held in the hand, the usual brush-like glow occurs, but terminates at the hand. If, after stopping the machine and removing the tube, the other hand is allowed to touch either extremity, a sharp shock is felt. The whole of these effects are exceedingly beautiful when seen in a perfectly dark room. Often the waves of light go surging instantaneously from both ends of the tube to its centre. On several occasions I have noticed a small cloudy film of light swirling round the inside of the centre bulb of the tube, accompanied by a feeble but distinct crackling sound. The tube can also be held to the prime conductor of the machine in such a manner that a discharge (like that of a Leyden jar) takes place at regular intervals between one extremity and that outside portion of it which is in contact with the machine.

The cause of the phenomenon appears to be that the glass of the tube in some way acts as a dielectric, but I should be glad if someone would furnish a complete explanation.—Yours, &c.,

W. LOMAS.

LEGAL INTELLIGENCE.

Elton v. St. Pancras Vestry.

On Wednesday, in the Bloomsbury County Court, London, W.C., this case came before Judge Bacon. It was a claim for £40 for damage to a wall and lamp outside the premises of the plaintiff by an explosion which occurred in the electric mains belonging to the defendants in December last.

Mr. Elton, the plaintiff, said the wall was an old one, and was bulged before the explosion. When he went there he had it pointed with cement, but he thought it would have lasted 10 to 14 years longer but for the explosion. Inside the wall the earth was higher than the footpath on the outside, and that would have a tendency to bulge it. Water would run away from the wall in consequence of the fall of the ground. The Vestry shored the wall up when they excavated to lay the mains.

Witnesses were called who proved that the cracks were due to shock, and that the wall was now dangerous. The wall was probably 40 years old.

For the defence it was admitted that something was due to plaintiff, and any bona-fide claim would be paid and the Vestry would square affairs after with the Gas Company. They had paid 10s. into Court which they were of opinion was ample to cover the damage to the lamp. As to the wall, the Vestry alleged that the damage was due to the pressure of earth, old age and other causes, but there was absolutely no damage done to it by the explosion.

Evidence to this effect was called, and his Honour reserved his judgment, as he was desirous of seeing the wall.

On Thursday he gave judgment, and said there being no dispute about the lamp, and it being proved that 43s. was paid for repairing it, plaintiff would recover that amount with costs thereon. In his opinion the wall was dilapidated, and the explosion did not damage it. He thought the wall had sunk in consequence of the sinking of the subsoil.

Judgment for the plaintiff for £2 3s. and costs thereon.

Planet Electrical Engineering Company (Limited) v. Railway Clearing House Committee.

This case came before Mr. Justice Mills and Mr. Justice Charles in the Queen's Bench on Saturday last, in the form of a special case on certain findings of Mr. J. Fletcher Moulton, Q.C., M.P., in his award in an arbitration between the plaintiffs and defendants. The plaintiffs, under agreement with defendants, undertook to do certain work in putting up an electrical installation in the defendants' offices at King's Cross. After the plaintiffs had carried out the work, disputes arose as to the sum which they were entitled to be paid, and the matter was referred to arbitration in accordance with a clause in the specification. After the plaintiffs had completed the work, the contract sum, together with the agreed price of certain extras, for which orders in writing were given by the defendants, were paid to the plaintiffs; but the plaintiffs claimed to be paid further sums for certain departures from the work of the specification directed by the consulting engineer to the defendants, to whose satisfaction the whole of the work was to be done. The provisions of the specification as to extra or altered work and to the settlement of disputes was as follows:—

> "Any extra work or any deviation from the work, as laid down in this specification and the schedules attached thereto, is to be entirely subject to the direction of the consulting engineer to the committee. Extras will not be allowed for unless an order is obtained from the consulting engineer to the committee in writing, specifying the nature of the work and his approval thereof, together with the cost which may attend the same."

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The arbitrator found (*a*)—That there were no extra works required by the engineer or executed by the plaintiffs (other than those under written orders which had been paid for), with the exception of nine distributing switchboards, which he found not to have been included in the tender of the plaintiffs or estimated for in their price, but which were included in the specification, and were required to be executed by the engineer on that ground.

(*b*) That there were departures from the work of the specification directed by the engineer, and carried out by the plaintiffs, consisting mainly in requisitions by the engineer that the work described in the specification should be carried out in an unusual and more costly manner, not within a true or a reasonable interpretation of the specification and not implied thereby, but which the engineer insisted upon as being within the same. He (the learned arbitrator) found that this opinion of the engineer was erroneous.

(*c*) That the engineer required the contractors to do work in the nature of cutting away and making good which was under the contract to be done by the architect to the committee and not by the plaintiffs, and that he did so by reason of his erroneously interpreting the terms of the contract in that respect.

The questions for the Court therefore were whether the plaintiffs were entitled to be paid for any or all of the work referred to in these three heads, and their Lordships, after hearing arguments by Mr. Roger Wallace for the plaintiffs, and Mr. Montague Lush for the defendants, gave judgment for the plaintiffs on all the deviations, with costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NOW READY.

SPECIAL NOTICE—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Although about 100 pages are added to the book, no addition is made to the price, which is 7s. 6d., post free 8s. 3d., abroad 9s.

"THE ELECTRICIAN."—A special notice concerning certain changes in the price, &c., of this journal will be found on page 52.

TENDERS INVITED.—The Corporation of Birkenhead invite tenders for the supply and erection of apparatus and plant for their electric supply works. Some further particulars will be found in our advertisement columns. The requirements include boilers, engines, dynamos, a battery of storage cells, instruments, cables, street boxes, &c. Plans will be ready after the 8th inst., and all further information can be obtained at the office of Mr. Alfred Gill, town clerk, Town Hall, Birkenhead; or at the office of Mr. J. N. Shoolbred, C.E., 47, Victoria-street, London, S.W. The contract is in five sections, which can be tendered for separately. Tenders must be in by 12 noon of the 23rd inst.

——— The Directors of the Great Eastern Railway Company invite tenders for telegraph materials, bolts, screws, rivets, cast-iron pipes, tools, &c. Tenders to be in by the 16th inst.

TENDERS ACCEPTED.—The Worcester Board of Guardians have accepted the tender of Mr. J. F. Santonna for the supply of fittings for the installation of the electric light in a portion of the workhouse.

——— The Brighton Town Council at their last meeting accepted the tender of Messrs. A. W. Field and Co. for the extension of the electricity station.

——— The St. Pancras Vestry have accepted the tender of of Mr. J. Steed, of Chalk Farm-road, N.W., for building the sub-station in St. Andrew's-gardens, for £415. 8s. 5d.

——— The Gas and Electricity Committee of the Bolton Corporation have accepted the tender of Messrs. S. Z. de Ferranti and Co. (Limited) for the supply of an alternator for their electricity works.

SALE BY AUCTION.—Messrs. Wheatley Kirk, Price and Goulty will sell by auction at the works of the Leeds Machinery Stores Company, Kirkstall-road, Leeds, on Tuesday and Wednesday, the 21st and 22nd instant, the entire stock of new and second-hand machinery detailed in our advertisement columns. Particular attention is called by the auctioneers to the large number of valuable machines to be disposed of. Further particulars and catalogues can be obtained at the stores, Kirkstall-road, Leeds, or of the auctioneers, 49, Queen Victoria-street, London, E.C., and Albert-chambers, Albert-square, Manchester.

DISSOLUTIONS OF PARTNERSHIP.—The partnership heretofore subsisting between A. G. Pope, G. M. Body, and C. F. Barker, electrical and sanitary engineers, trading under the style of Pope, Body and Co., of 26, Pall-mall, Liverpool, was dissolved by mutual consent on the 7th inst.

——— The partnership hitherto existing between G. H. Hardman, H. C. Ashworth, and C. H. Lomax, under the style of H. Ashworth and Co., electrical and heating engineers, 8, Fleet-street, Bury, has been dissolved. Debts by H. C. Ashworth and C. H. Lomax, who continue the business.

APPOINTMENTS VACANT.—The Governors of the Woolwich Polytechnic invite applications for the following appointments:—(1) Principal of the Polytechnic, (2) Head of Social and Recreative Department, (3) Clerk to the Governors. Some particulars are given in our advertisement columns, and all further information can be obtained with forms of application from the office of Mr. W. Garnett, the hon. secretary, 13, Spring-gardens, S.W. Applications have to be in by 10 a.m. of May 25th.

——— The Governors of the Wandsworth Technical Institute are prepared to receive applications for the post of Principal of the Institute. The salary commences at £350. Particulars can be obtained from the Hon. Secretary, 4, Galveston-road, Putney, London, S.W., and applications must be in by the 15th instant.

APPOINTMENT.—At the last meeting of the Commission of Sewers, Mr. A. A. Voysey, the electrical inspector, was appointed consulting electrician to the Corporation.

BUSINESS CHANGES.—Owing to a large increase in their business and the intention to extend the firm's field of manufacture, the Nalder and Harrison Construction Syndicate (Limited) have purchased the lease of extensive premises at Bow Common-lane, London, E., known as the "Invicta" Works, together with the complete and efficient engineering plant and machinery situated therein. By this arrangement the firm will be enabled to carry out work of the very largest and heaviest description in addition to their present extensive output of electrical measuring and testing instruments, switchboards, &c. The Syndicate intends to produce as soon as possible standard types of dynamos, motors, transformers, steam engines, &c. As the work of transferring the existing plant at Trafalgar House, and completing the new arrangements is of considerable magnitude, the works at Trafalgar House will be kept open until the new works are as nearly as possible complete. Due notice of the final removal will be given, and in the meantime it is requested that all communications be addressed to the head offices at 47, Victoria-street, London, S.W.

LIQUIDATIONS.—Notice is given that the creditors of the Akester Electric Syndicate (Limited) must send in their names and addresses, with particulars of their debts or claims to the liquidator, Mr. J. Durie Pattullo, 30 and 31, St. Swithin's-lane, London, E.C., by June 10th next.

——— A meeting is to be held at 41, Piccadilly, Bradford, on June 10th next, at 2 p.m., for the purpose of receiving an account of the winding-up of the Crossley Telephone Company (Limited).

BANKRUPTCIES.—A receiving order has been made against Philip Crosby Pope, electrical engineer, of 6, Castle-street, Hapton, near Burnley.

——— In the failure of D. and G. Graham, of Douglas-street, Glasgow, a meeting of creditors is to be held on the 16th inst., at 12 o'clock at the Religious Institution Rooms, 200, Buchanan-street, Glasgow.

ALLGEMEINE ELECTRICITÄTS-GESELLSCHAFT, BERLIN.—We have received from this firm the English edition of a brochure on tramway traction, giving full information on the subject, with illustrations and diagrams of lines equipped by the Company. Twelve of these lines are already in operation and thirteen are in course of erection, with a total length of 372 kilometres (about 225 miles), and 627 motor cars. The most noticeable are the lines at Halle, Breslau, Essen, Chemnitz, Christiania, Dortmund and Lübeck. In all cases the overhead trolley system is employed. The working pressure is 500 volts. The album is nicely got up, and the illustrations are very good.

AWARD.—Messrs. Crompton and Co. have received the gold medal and diploma for their exhibits of cooking and heating apparatus at the Universal Food and Cookery Exhibition, held this week at Portman Rooms, London, W. This is the highest award possible, and makes 5 diplomas and 4 gold medals awarded to the firm during the past two years.

MACHINERY USERS' ASSOCIATION.—The annual report of the Committee of this Association to March 31st is issued, in which reference is made to the steps taken to bring the objects of the Association before machinery users. The Bill for exempting tenants' machinery and tools from rating, which was read a second time by a considerable majority in 1894, has again passed its second reading in the present Session, and now only awaits third reading, which has been put down for June 19th. The Committee ask for the continued support of all interested in the movement.

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Cooking and Heating Apparatus.—Messrs. Crompton and Co. are keeping fully abreast of the demand for apparatus required for cooking and heating by electricity, and in their latest price list show several additional items recently completed. The illustrations include a neat-looking breakfast cooker with hot plate and oven, several ornamental electric urns, a bronchitis kettle on stand, hot cupboard, &c. Accompanying the list are some useful hints on the use of the apparatus. The same firm are also issuing a pamphlet containing a lecture by Mr. H. J. Dowsing, entitled "Cooking by Electricity," of which copies can be obtained, price 2d.

Electric Machinery for Battleships.—The new battleship "Renown," which was launched from Pembroke Dockyard on Wednesday, has been so fitted as to provide for the guns on board to be operated entirely by hand (which is unusual in large vessels), by steam power, or by the aid of electric motors. In the case of the battleship "Barfleur," for one of the mounts electric motors were fitted with the view of testing their power for working the guns, and the results are stated to have proved eminently satisfactory. It is, we learn, in contemplation to fit electrical mechanism to the other mount on the same ship, and also on the "Centurion." The whole of the machinery for the "Renown" has been constructed by Messrs. Maudslay, Son and Field, of London, S.W., including the electric motors.

Automatic Injectors.—Messrs. Green and Boulding, of Featherstone-street, City-road, E.C., send us a copy of their latest price list of the "Buffalo" automatic injector, for which the makers claim that it is an efficient and economical boiler feeder, being operated entirely by a single lever under all conditions, whether lifting its supply water up to 12ft. or receiving it under pressure from overhead or from a main supply, no regulating valve or other regulation being needed. The B class injector, it is stated, is specially suitable for stationary boilers and can be graded for 50 per cent.

Electro-Medical Instruments.—Messrs. A. Hurst and Co. have just issued a catalogue of electro-medical apparatus manufactured by them, in which is illustrated and described a large variety of instruments, including batteries, induction coils, sledge coils, handles, electrodes, controlling and measuring instruments, and other accessories, the prices for all of which are given.

"The Engineering Magazine."—The May issue of this magazine fully maintains its usual high standard of excellence both as regards matter and illustrations. Its contents include:—"Meaning of the Recent U. S. Patent Decision"; "The Proposal to License Architects"; "How Holland was Made"; "The Educational Influence of Machinery"; "The Great Steamers of Long Island Sound"; "Practical Hints for City Officials"; "Economy in Railway Operation"; "A Marvel of Mechanical Achievement"; "The Modern Science of Electric Heating"; "Mine Reports and Mine Salting," and the increasingly useful Review of the Industrial Press. The new number, and nearly all back issues, may be obtained at the office of the European Edition, 1, 2, and 3, Salisbury-court, Fleet-street, London, E.C.

"Shipping."—This is the title of an enterprising contemporary issued monthly, and which enters on its second year's existence with the issue for May, 1895. *Shipping* is well printed on good paper, and contains a mass of very interesting matter, and those interested in things nautical will appreciate a fully-illustrated description of the "Scott," the famous South African liner. Other fully-illustrated articles include "The Coaling Stations of the World" and "A Visit to the Engineering Works of Messrs. J. and C. Hall (Limited) at Dartford."

"Daily Tenders and Contracts."—No. 1 of a new daily journal, under the above heading, was published on Tuesday last. The paper is started with the object of keeping business men in touch with the requirements of Government departments, the local authorities, railway and shipping companies, and other large trading concerns throughout the world. That there is ample room for such a journal there can be no doubt, and when once the staff get fairly into work a very useful publication will be added to the large number of periodicals now seeking public support. The publishing offices are Temple-chambers, London, E.C. The price of the paper is 2d.

Aberystwyth.—The Town Council at its next meeting will consider a recommendation of the Public Works Committee that £900 be borrowed for electric lamp pillars out of a total of £13,000 for which application for borrowing powers is to be made to the Local Government Board.

Artistic Electric Lighting.—The *Art Amateur* for May contains an interesting article on "Designs for Electric Lighting for the House."

A New Electrolytic Process.—On Saturday last the officials of the General Electrolytic Company explained to a gathering of persons interested in their new process for obtaining alkali the particulars of the process at their experimental works at Farnworth. The apparatus has been very much simplified, and there is now no alkali waste to dispose of.

Aberdeen.—At Tuesday's meeting of the Corporation a report from the Sub-Committee specially appointed to consider the question of the supply of electric motors was discussed. The report contained a proposal that the charge for current for motive power should be fixed at 4d. per unit for day supply. The report was adopted. The following list, showing the price per unit charged for lighting and power purposes by a number of Local Authorities and supply companies, accompanied the Sub-Committee's report:—

Local Authorities.

	For lighting.	For power.		For lighting.	For power.
Brighton	7d.	4d.	Coventry	6d.	4d.
Bristol	6d.	4d.	Blackburn	7d.	5d.
Belfast	7d.	4d.	Bolton	8d.	5½d.
Manchester	8d.	sliding scale to 2¾d.	Bradford	5d.	3½d.
			Lancaster	7d.	4½d.
			Leeds	6d.	3d.
Hull	6½d.	5d.	Nelson	5d.	4d.
Halifax	6d.	4d.	St. Pancras Vestry	6d.	3d.
Sunderland	6d.	3½d.			

Supply Companies.

	For lighting.	For power.		For lighting.	For power.
Hove	8d.	6d.	Norwich	8d.	4d.
Newport	6d.	4d.	Scarboro'	6½d.	5¾d.
Cheltenham	6d.	3½d.	Southampton	8d.	6d.
Derby	6d.	3d.	Thetford	7d.	6d.
Galway	6d.	3d.			

Bangor.—The Town Council, at their meeting on Wednesday, decided to appoint an Electric Lighting Committee.

Bolton.—The Board of Guardians have appointed a sub-committee to obtain the necessary tenders for lighting the Board's offices, &c., by electricity.

Bootle.—At the meeting of the Town Council on Wednesday, the Electric Lighting (Special) Committee was dissolved, and the work of lighting by electricity of the Town Hall and municipal buildings placed under the control of the Parks and Baths Committee. Information has been received that the Board of Trade have decided to grant the Provisional Order applied for by the Corporation.

Cable Schemes.—The Under-Secretary for the Colonies, in reply to questions in the House of Commons, said that her Majesty's Government had not received any request from or through the Government of Canada to call a conference of the Colonies interested with a view to arranging the details of the laying and maintaining a cable across the Pacific Ocean between Canada and Australasia. The Postmaster-General also stated that about four years ago a request was made that a telegraph cable should be laid to the Island of Sark, but as the estimate of revenue fell far short of the estimate of expenditure, the Treasury did not see their way to sanction the extension.

Chiswick (London, W.).—The contractors for the electric lighting of this district expect to have the mains completed by August next.

Coventry.—It is now a couple of years since the steam trams ceased running, and definite arrangements have been completed for the equipment of a service of electric tramways by the overhead system between Coventry and Bedworth. Mr. Charles Haywood, the local contractor, has commenced operations at the depot, Foleshill, for the requisite buildings.

Dowlais.—The agitation against the exorbitant charge for gas made by the local gas company has culminated in a demand for the electric light. The president of the Chamber of Trade at a recent meeting complained of the unfair treatment to which tradesmen were subjected by the gas company, and called attention to the fact that the Dowlais Iron Company were about to supply all their officials with the electric light, and he hoped they would be able to induce the Company to extend the installation to the town.

Ealing.—An accident having occurred to one of the transformer stations in consequence of some work which was being carried out by the Grand Junction Waterworks Company, the clerk to the District Council informed the Company that it would be held responsible for the damage caused. The Company's engineer, in reply, wishes to know "how the Company and the Council stand in regard to this new invention."

Edinburgh.—Prof. Kennedy has advised the Electric Lighting Committee of the Town Council that the use of change-over switches is dangerous, may cause accidents, and should not be sanctioned. On this subject a notice of motion has been given, "That it be remitted to the Lord Provost's Committee to consider the advisability of granting the use and privilege of the city electric light to those parties who possess and use private electric plant, and to report."

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ELECTRIC LIGHTING IN FRANCE.—La Société Normande d'Electricité has just given out a contract for four Willans triple-expansion engines, each of 180 H.P., for use at the electric supply station at Rouen. The engines will be connected to four Alioth dynamos.

FAIRFIELD (BUXTON).—The Urban District Council at their last meeting decided to appoint an electric lighting committee to report to the Council on electrical matters generally.

FULHAM (LONDON, S.W.).—At the last meeting of the Lighting Committee of the Vestry a Sub-Committee was appointed to consider and report upon (1) the desirability or otherwise of lighting the Town Hall with electric light; (2) the existing facilities in the hall for providing such electric light by means of duplicate gas engines, dynamos, and, if possible, accumulators; and (3) the probable cost of such provision and also of wiring, switching, incandescent lamps, and all extra wages for skilled supervision or attendance. Mr. Cranfield said it would be a great improvement if they had the electric light installed, and would save the decorations of the Town Hall.

GALATZ (ROUMANIA).—A concession has just been granted to a French company for the construction and operation during a period of 38 years of a line of electric tramway in this town on the accumulator system.

HAMPSTEAD.—The large number of applicants for the post of Chief Electrical Engineer to the Vestry have been examined by the Electric Lighting Committee, and the following six names have been left, from which the final selection will be made:—C. H. Cottam (Hanley), G. B. Dunn (Sardinia-street Station, Metropolitan Electric Supply Company), E. Sayer (Hampstead Vestry Supply Station), A. M. Sillar (chief engineer to Messrs. J. G. Statter and Co.), J. E. Stewart (Derby), and H. D. Munro (Exeter Electric Lighting Company).

HANLEY.—Mr. R. Walton, C.E., Local Government Board inspector, recently held an inquiry into an application by the Corporation for sanction to borrow a further £5,000 for electric lighting extension in the borough. The town clerk (Mr. A Challinor) stated that the Corporation had authorised an application for sanction to raise a further loan of £20,000 for extending the electric lighting mains and appliances, and he asked the inspector if the matter could be taken into consideration now. Mr. Walton said that he was limited to the terms of the notice, but the subject might be mentioned incidentally. Mr. Challinor explained the details of the extensions for which the present loan of £5,000 was required, and the borough surveyor and electrical engineer also gave evidence. The Mayor said the Council were unanimous in this application, and they were supported by the town. The applications from customers were so numerous that there were already 2,000 lamps applied for which they were unable to supply, and during the coming winter applications would much increase this number.

IPSWICH.—In reference to the decision come to by the Town Council to apply for an Electric Lighting Order, the Electric Lighting Committee report that they have consulted Prof. Kennedy on the subject of a suitable site for an electricity supply station and the cost of the necessary works and plant, but, in view of the large expenditure involved, recommends that no further steps be yet taken to obtain a Provisional Order. The discussion on the report is to be taken at the next meeting of the Council.

JOHANNESBURG (SOUTH AFRICA).—A copy of the bi-annual report of Mr. Charles Aburrow, the town engineer of Johannesburg, has been sent us. This report gives a detailed account of the work done for the period ended December 31st last, and it would appear that at Jeppe Town electricity is used for street lighting, 48-c.p. lamps being selected. Current is supplied by the Johannesburg Lighting Company, whose report for the period is to the effect that considerable additions have been made to the generating plant by the putting down of a new 60-H P. Ruston-Proctor multitubular boiler and a large Willans compound engine coupled direct to an Elwell-Parker dynamo. The report states that this was the first Willans engine of this type erected in South Africa, and that its complete success has resulted in the putting down of a number of similar engines in the locality. Four new lightning arresters have been erected, and have been tested by several severe thunderstorms and proved very effective. The suggestion that the town authorities should purchase the Lighting Company's undertaking has resulted in a proposal that the concession and works be purchased for the sum of £160,000 being approved at a public meeting of ratepayers.

KENDAL.—At the last meeting of the Urban District Council a letter was read from the Chamber of Commerce enclosing a resolution asking the Council to consider the question of supplying the town with electricity for power purposes. The Council reply that the matter is under consideration.

LANCASTER.—An interesting discussion took place at the last meeting of the Town Council on the report of the Electric Lighting Committee. Mr. Alderman Smith pointed out that unless some alteration was made in the method of charging for current, their electric lighting enterprise would never pay. It was not sufficient to make an all-round reduction, but he recommended that the charge for current should be reduced from 7d. to 6d. per unit for the first two hours' consumption, and after this time to 4d. per unit, and he announced that in this proposal he had the support, amongst others, of the surveyor and electrician. This proposal was in lieu of the recommendation of the Committee to make the price an all-round 5d. per unit. After considerable discussion the Committee's report was adopted, the amendment of Alderman Smith being negatived by 10 votes to 5.

LONDON CHAMBER OF COMMERCE.—The thirteenth annual general meeting of the Chamber will be held in the Council Room, Botolph House, Eastcheap, London, E.C., on Tuesday, the 21st inst., at 2.30 p.m. The chief business is the adoption of the report and accounts for the past year, the election of officers, and other routine matters. The annual dinner is announced to take place on Wednesday, May 29th, at the Hotel Métropole, London, W.C., at 6.30 for 7 p.m.

MANCHESTER.—At Wednesday's meeting of the City Council, in presenting the reports of the Gas Committee and the Electric Lighting Sub-Committee, Mr. Ald. Higginbottom stated that the total contribution the Committees expected to make to the City funds was between £52,000 and £53,000.

METROPOLITAN TELEPHONES.—The much enduring subscriber to the telephone has this week received more attention than is usual. The London County Council, the City Commissioners of Sewers, and the National Company have each sought his vote and interest on the question of the efficiency of the telephone service and the excess or otherwise of the subscription charge. The circular from the County Council states that the Highways Committee of that body are of opinion that the telephone service in the metropolis should be rendered cheaper and more efficient, and are anxious to know accurately what is the opinion of users of telephones in London as regards the efficiency of the present service. The subscriber is asked to give his views on the existing telephone service of the National Company, to state in what respects, if any, it is unsatisfactory, and to make what suggestions he can in the matter of improving the service generally. The circular from the Commissioners of Sewers states that evidence has been given on their behalf as to the inefficiency and costliness of the existing service of the National Company, and telephone users are invited to reply to similar questions to those set out by the County Council. Finally, the National Company asks its subscribers to say that they "do not approve of the service of the metropolis being undertaken by the London County Council, and that the service given by the National Company is reasonable, having regard to the efforts which are being made by the Company to improve it by the adoption of the twin-wire system." Very skilfully the National Company has hastened the collection of its circular, which was issued on Tuesday and collected on Wednesday. Following this, many of the unfortunate subscribers were notified yesterday (Thursday) of the imminent alteration of their telephone numbers. We strongly protest against this step being taken. It is a serious matter for business houses, many of whom are as well known by their telephone number as by their name. The most important matter of stationery has also to be considered, and if it is for the convenience of the National Company that its subscribers should be re-numbered, the least they can offer is to bear the expense of either supplying fresh stationery or some portion of its cost. In many cases this will mean a heavy outlay, and in addition the subscriber may be annoyed by finding his old number taken by a rival in trade, or that his new number has previously been owned by a subscriber with whom he wishes to have no business or other connection. Of course, the National Company will at once see that a new list of subscribers is published with the old and new telephone numbers grouped. Truly, the lot of the metropolitan telephone subscriber is not a happy one.

OLDHAM.—The Town Council have agreed to the recommendation of Prof. Kennedy referred to in our last issue, under which considerable extensions of the electric lighting scheme are to be carried out. Application is to be made to the Local Government Board for power to borrow £10,200 for these extensions. The Electric Lighting Committee are considering further applications for the supply of current from Park-road and Queen's-road.

OWENS COLLEGE (MANCHESTER).—Some particulars are given in our advertisement columns of fellowships offered by Owens College to students in arts, science and medicine.

PORTSMOUTH.—A Local Government Board inquiry was held at Portsmouth last week, and the application of the Town Council for powers to borrow a further £21,000 for the extension of their electric lighting works. There is stated to be a general outcry for an extension of the lighting area, and the Council, therefore, propose to make very considerable extensions in preference to waiting for additional applications to come in,

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PRESTWICH.—At a meeting of the Urban District Council on Wednesday, Mr J. Cottrill said the lighting of the district had been improved, but a question had arisen as to whether the Council should adopt electric lighting for the whole of the township. If anything was to be done in the matter for next season it was not too early to begin. It was decided to refer the question to the General Purposes Committee.

PROVISIONAL ORDERS.—The applications made to the Board of Trade by the County of London Company and the Charing Cross and Strand Company for Provisional Orders, for the district of the St. Olave's Board of Works and the district of the Strand Board of Works respectively, have been granted. The Board of Trade has also approved the applications for Orders for the Kensington district, New Windsor and Eton, Salisbury and Southampton. Confirmatory Bills are now before Parliament.

ROCHDALE.—Some time back, Mr. Platt, the borough surveyor, was requested to prepare a report on the subject of the lighting of the Town Hall and other public buildings by electricity. This report is now published, and Mr. Platt recommends that no scheme should be hastily adopted which will not, when required, adapt itself to the general supply of electric current for public and private purposes. Owing to the fact that the probable area of supply in the town would be limited to within a radius of a mile of the sanitary works, where a considerable amount of surplus power is available, Mr. Platt recommends a low-pressure system. About 200 I.H.P. surplus steam power is available, and 100 I.H.P. can be guaranteed continuously without materially increasing the staff. Ample ground is available for the erection of buildings, and for a suitable extension if this should be ultimately found necessary. As the position of the sanitary works is not central, Mr. Platt advises that it may not be economical to use this site, especially as the cost of steam production does not form an important element in regard to the total cost of supplying electric current. The report contains several alternative schemes, estimated maintenance costs of which are given.

SANITARY CONFERENCE.—At the Conference recently held at Manchester on Sanitary Progress various questions of public interest were discussed, amongst which was the best means of lighting public schools. Dr. E. Jones read a Paper in which he strongly urged the adoption of the electric light.

ST. PANCRAS.—At their last meeting the Vestry decided to lay an electric light main from University-street along Gower-street to the parish boundary, at a cost of about £214, and at the same time the Electrical Committee were instructed to consider the question of extending the mains along Highgate-road and West Hill. At the last meeting of the London County Council, on the recommendation of the Finance Committee, it was decided to lend the St. Pancras Vestry £14,300, at £3½ per cent., for electric lighting extensions in the parish. The loan to be for a term of 42 years.

THE TELEGRAPH CLERKS.—At a conference of the Telegraph Clerks' Association in Glasgow the following resolution was carried:

"That, as the clerical and scientific duties of the Telegraph department are entirely distinct from those of the letter-sorting branch; and that as the placing of the two departments on the same level operates to the grievous disadvantage of the telegraph clerk, firstly by reducing the value of his work to that of letter-sorting; secondly by the inequitable division between the two departments of any concessions hitherto gained by the telegraph clerks; and, thirdly, the question of cost, which, when the telegraph clerk shows reason for improvements, is unduly increased by the inclusion of the letter-sorter, who has not the same grounds for consideration, we therefore claim to be treated as a separate department of the Post Office.

"TELEGRAPHY BY INDUCTION."—Mr. W. H. Preece is announced to deliver an address on this subject in the hall of the Carpenters' Company, London-wall, E.C., on Thursday, the 23rd inst., at 2:30 p.m. The chair is to be taken by Sir Albert K. Rollit, M.P., President of the London Chamber of Commerce.

TORQUAY.—The Town Council have received a report from the Electric Lighting Committee which states that many of the large ratepayers in the district proposed to be dealt with under the Council's electric lighting scheme, had intimated their willingness to take current for private lighting if it was introduced by the Corporation, but the Committee consider it will be preferable to adopt the scheme originally recommended by the Committee in August, 1893. They recommend that the refuse destructor works be dealt with separately, and not in conjunction with the electric lighting scheme, and that the necessary steps be taken for obtaining sanction to borrow £18,000 for the purpose of providing a supply station with plant and machinery under the Bath Saloons, for the lighting of the compulsory area set out in Section 17 of the Torquay Electric Lighting Order of 1891. An amendment was moved that the subject be referred back to the Committee, and that application be made to the Board of Trade for an extension of time for which provisional powers were granted, and this amendment was carried.

TOTTENHAM (MIDDLESEX).—The District Council have taken a further step in regard to the electric light by referring the consideration of the matter to the General Purposes Committee, who are to prepare a report for the consideration of the Council at an early date. With a population of nearly 100,000, it is surely time Tottenham did something to bring itself into line with the other important metropolitan districts.

TRINIDAD (PORT OF SPAIN).—The capital of Trinidad is now lighted by electricity, to the entire satisfaction of the residents. The electric light takes the place of oil lamps.

WORCESTER.—At the last meeting of the City Council it was decided to reduce the salary of the city engineer (Mr. T. Caink) from £450 to £350 a year, with annual increments of £10 until £400 is reached. This reduction is made in consequence of the appointment of an electrical engineer (Mr. E. T. Ruthven-Murray), who will relieve Mr. Caink of certain duties in connection with the installation of the electric light in the city.

WELLS.—At the recent meeting of the Town Council and Urban Sanitary Authority the electric light question was again discussed at great length, and finally the tender of Mr. A. Dixon Brown, for the public lighting of the city by electricity at £350 per annum, was accepted for three years, from June, 1896.

WEST HAM.—The Town Clerk has been instructed by the Corporation to communicate with the largest ratepayers in the district with a view of ascertaining the amount of support likely to be given to the Corporation in its proposed electric lighting undertaking.

WESTON SUPER-MARE.—At the meeting of the Urban District Council on Wednesday, a resolution was proposed "That this Council do hereby instruct their clerk to at once take the initial proceedings for a renewal or extension of the Electric Lighting Provisional Order which has been obtained for the lighting of the town by electricity." The motion was carried, there being only two dissentients.

COMPANIES' MEETINGS AND REPORTS.

Brazilian Submarine Telegraph Company (Limited).

The following is the report of the Directors of this Company for the half-year ended December 31st last, which is to be submitted to the forty-third ordinary general meeting, to be held at Winchester House, London, E.C., on Wednesday, the 15th inst., at 12 o'clock.

The revenue for the period amounted to £104,926. 0s. 7d., and the working expenses to £36,771. 18s. 2d. After providing £4,841. 6s. 8d. for debenture interest and sinking funds, and £1,490. 0s. 9d. for income tax, there remains a balance of £61,822. 15s.; to this is added the sum of £1,501. 5s. 9d. brought forward from June 30th last, making a total of £63,324. 0s. 9d. First and second interim dividends, amounting to £39,000, have been paid, and £20,000 transferred to the reserve fund, leaving the sum of £4,324. 0s. 9d. to be carried to the next account. The receipts for the half-year include the sum of £1,500 dividend to June 30th, 1894, on the Company's shares in the African Direct Telegraph Company (Limited).

The Directors with much regret have to report the death, on 3rd inst., of their esteemed colleague, Mr. Thomas Fuller, who has been Managing Director of the Company from the date of its formation.

The various sections of the Company's lines are in good working order.

NEW COMPANIES, STATUTORY RETURNS, &c.

BLACKPOOL ELECTRO-HYDROPATHIC (LIMITED).—A Company, with this title, was registered on May 6th, with a capital of £10,000, in 8,000 Ordinary shares and 2,000 £5 per cent. Preference shares of £1 each, to carry into effect an agreement between Louis Cohen, electrician, Blackpool, and Henry B. Sharples (as trustee for the Company), to acquire, by lease or otherwise, the Trevelyan Hotel, Victoria-street, Blackpool, and to carry on the business of electro-hydropathic practitioners, proprietors of electric and health appliances, baths, &c.

COUNTY OF LONDON TRAMWAYS SYNDICATE (LIMITED).—This Company was registered on May 6th, with a capital of £5,000, in £10 shares, to acquire by purchase or otherwise, and carry out contracts and concessions or other grants for making, purchasing or working railways, tramways, telegraph and telephone lines, electric and other lighting works, and for the equipment of such undertakings with electric or other plant.

MILVER PORTABLE ELECTRIC BATTERY SYNDICATE (LIMITED).—This Company was registered on May 4th, with a capital of £20,000, in £5 shares, to acquire and work certain inventions, for which provisional protection has been granted to H. Levetus, manufacturer, of Birmingham, E. M. Levetus and W. Rowbotham, electricians, of Manchester, and entitled "improvements in primary batteries" and "improvements in and relating to primary batteries," Nos. 106, 107, 231, 2,394, and 7,600; to enter into an agreement between H. Levetus, E. M. Levetus, and W. Rowbotham, and Edward A. Eaden (as representative of the Company), and to carry on

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the business of electricians, electrical and mechanical engineers, suppliers of electricity for the purposes of light, heat, and motive power, and manufacturers of and dealers in electrical apparatus of every description. The subscribers, with one share each, are :—Hymen Levetus, Henry Pyton, J.P., Jacob Jacobs, J.P., Henry Headley, Frank Moss, Walter Rowbotham, and George Y. Iliffe. The first Directors are :—H. Levetus, W. Rowbotham, G. Y. Iliffe, J. Hedley, and F. O. S. Leak. H. Levetus is Managing Director, and W. Rowbotham is general manager.

T. PIERPOINT AND COMPANY (LIMITED).—This Company was registered on May 6th, with a capital of £5,000, in £1 shares, to acquire and take over the business carried on by P. T. Pierpoint, under the style of T. Pierpoint and Company, at 81, Newhall-street, Birmingham, and to carry on the business of gas and electric light fittings manufacturers, reflector manufacturers, &c.

PORT LOUIS GAS WORKS COMPANY (LIMITED).—This Company was registered on April 30th, with a capital of £35,000, in £1 shares, to acquire the gas works at Port Louis, in the Mauritius, to carry on the business of supplying gas and other light in all its branches; to construct, lay down, and fix all necessary cables, wires, lines, accumulators, lamps and works, to generate, accumulate, distribute and supply electricity, and to carry on the business of an electric lighting company, electricians, mechanical and electrical engineers, suppliers of electricity, and manufacturers of electrical apparatus and appliances.

MEXICAN GAS AND ELECTRIC LIGHT COMPANY (LIMITED).—The annual return of this Company to October 31, 1894, was filed on April 17th last. The whole of the nominal capital of £100,000, in £20 shares, has been taken up and issued as fully paid. Alban H. Gibbs, M.P., merchant, of 15, Bishopsgate-street Within, London, holds all but six shares.

MIDLAND ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return of this Company, to April 10th, has been filed. The nominal capital is £50,000, in £10 shares. 3,139 shares have been taken up, and 3,132 of these have been issued as fully paid, the full amount having been paid on the remaining seven shares.

OGMORE VALLEY ELECTRIC LIGHT AND POWER SUPPLY COMPANY (LIMITED).—The annual return of this Company to April 3rd has been filed. The nominal capital is £10,000, in £5 shares, of which 710 have been subscribed for and allotted, and upon these the full amount has been called, resulting in the payment of £3,353, and leaving £197 in arrears.

ORME'S ELECTRIC SIGNAL SYNDICATE (LIMITED).—The annual return of this Company to January 14th has been filed. The nominal capital of the Company is £7,500, in £1 shares; 6,350 shares have been taken up, and 6,000 of these have been issued as fully paid. The full amount has been called and paid on the remainder.

OXFORD ELECTRIC COMPANY (LIMITED).—The annual return of this Company, to April 19th, has been filed. The nominal capital is £100,000, in £5 shares, of which 6,586 have been subscribed for and allotted. The full amount per share has been called.

PHOSPHOR BRONZE COMPANY (LIMITED).—The annual return of this Company to April 12th has been filed. The nominal capital is £150,000, divided into 15,000 £5 Ordinary and a like number of Preference shares; 8,375 Preference and 7,335 Ordinary shares have been subscribed for and allotted, and the full amount per share called. The calls paid have realised £78,550; 1,156 shares in the Company have been forfeited.

PRINTING TELEGRAPH AND CONSTRUCTION COMPANY OF THE AGENCE HAVAS (LIMITED).—The annual return of this Company to January 1st was filed on March 28th. The nominal capital is £115,000, in £5 shares; 20,030 shares have been taken up, and of these 10,823 have been issued as fully paid. Calls of £3 per share have been made on the remainder, resulting in the payment of £9,554, and leaving £18,067 in arrears.

PUTNEY ELECTRIC SUPPLY COMPANY (LIMITED).—In reply to official requests for the filing of the statutory returns, the solicitors, on May 3rd, wrote stating that the Company was formed for the purpose of promoting an Electric Lighting Provisional Order. Nothing was done beyond giving the notice provided by the Standing Orders of the Board of Trade. The concern was registered on June 27, 1894, with a capital of £1,000.

RAILWAY ELECTRIC FOG SIGNAL SYNDICATE (LIMITED).—The annual return of this Company to September 4, 1894, was filed on April 27th. 18,000 shares, out of a capital of £25,000, in £1 shares, have been taken up, all of which have been issued as fully paid.

RANSOMES, SIMS AND JEFFERIES (LIMITED).—The annual return of this Company to April 25th is filed. The nominal capital is £500,000, in £100 shares. Of these 3,087 have been subscribed for, and a call of £50 per share has been made on 726 shares, and the full amount has been called on the remaining 2,361.

CITY NOTES.

AFRICAN DIRECT TELEGRAPH COMPANY (LIMITED).—Particulars will be found in our advertisement columns of the fourth drawing of Four per Cent. Mortgage Debenture bonds of this Company (115 in number) of £100 each. These debentures will be paid off at par on July 1st next, at Parr's Banking Company, and the Alliance Bank (Limited), Bartholomew-lane, London, E.C.

ALLGEMEINE ELEKTRICITATS GESELLSCHAFT (BERLIN).—The general meeting of shareholders of this Company voted unanimously for the increase of the original capital by two million marks (£100,000). This money is to be used for the building of new works. How rapidly this firm has grown is shown by the fact that at the end of 1889 only 664 hands were employed, whereas at present there are 2,200.

BLAKE AND KNOWLES STEAM PUMP WORKS (LIMITED).—It is announced that a drawing of 100 First Mortgage Debentures in this Company for redemption on July 1st next will take place at the offices of the Trustees, Executors, and Securities Insurance Corporation, on Friday, the 17th inst., at 11 o'clock.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended May 5th were £864, as against £887 in the corresponding period of 1894, being a decrease of £23. The total receipts for the half-year amount to £16,983, against £16,401 for the corresponding period of 18.4, an increase of £582.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of April, 1895, amounted to £1,942, against £1,742 in the corresponding period of last year.

ELECTRIC TRACTION.—In the prospectus of the Twin City Rapid Transit Company (Minneapolis and St. Paul, Minn., U.S.A.), for which subscription for $370,800 in Seven per Cent. Cumulative Preference shares is now offered to British investors, it is stated that the system of tramways consist of 225 miles, of which 219 miles are electric, and the remainder cable. During the last 10 years the growth of the system has been rapid and continuous, and the recent change of motive power from horse to electricity has brought increasingly satisfactory results, both to the public and to the Company. The total capital of the Company is $18,010,000. Lists close this day (Friday). The issuing house is Morton, Rose and Co., Bartholomew-lane, E.C.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of April amounted to £27,600. The total receipts from January 1st to April 30, 1895, were £95,600, as compared with £84,000 and £83,000 in the corresponding periods of 1893 and 1894 respectively.

ILLINOIS (U.S.A.).—It is stated that a new company has recently been incorporated in this State, with a capital of $5,000,000, under the title of the Metropolitan Electric Street Railway Company. The offices are at Chicago.

LIVERPOOL GAS FITTINGS COMPANY (LIMITED).—At the meeting of the shareholders of this Company, on Wednesday, Mr. J. Barkeley Smith, the Chairman, in proposing that a dividend for the year at the rate of £10 per cent. per annum, with a bonus of 1s. per share, free of income tax, be declared, said business had been comparatively quiet during the year. In regard to gas fittings, their business was undoubtedly quiet, and even dull, but they had an unusual number of orders on hand for electrical fittings. Mr. J. Lister repeated the statement he had made at former meetings, to the effect that the electric supply company, so far from injuring the gas company, had really increased the consumption of gas, and this statement was confirmed by Col. Robinson.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 5th inst. amounted to £1,148. The amount for the corresponding week last year was £874.

LONDON PLATINO-BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The seventeenth ordinary general meeting of the shareholders of this Company was held at the offices, Blomfield House, London-wall, on Monday, under the presidency of Mr. W. S. Andrews. The chairman formally proposed the adoption of the report. Mr. C. W. Earle seconded the motion, which was carried; and resolutions were afterwards passed declaring a dividend at the rate of £1. 5s. per cent. per annum (2s. 6d. per share) for the year, and re-electing the retiring Directors, Mr. John Coppen and Mr. Earle, and the auditors, Messrs. Deloitte, Dever, Griffiths and Co.

MORECAMBE ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The fourth annual meeting of the shareholders of this Company was held on Saturday, in private. The report showed a loss of £424. 14s. 5d., stated to be due to loss on supply of current consequent on the "scale system" of annual charges per lamp being found unremunerative. This has been (the Chairman stated) a serious mistake, and is to be abandoned forthwith in favour of supply by meter. The recent conviction for nuisance had necessitated the removal of the Company's premises to a non-residential part of the town, and for this it was proposed to raise £1,800 in preferential capital. The report and balance-sheet were adopted.

SOUTH AMERICAN CABLE COMPANY (LIMITED).—Notice is given that 63 Five per Cent. Mortgage Debentures of this Company were drawn on May 7th, and will be paid on or after June 30th next at the National Bank of Scotland, 37, Nicholas-lane, E.C.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee appointed yesterday (Thursday) a special settling-day in 2,475 Ordinary shares (Nos. 20,001 to 22,475) and 10,000 Six per Cent. Cumulative Preference shares (Nos. 40,001 to 50,000) in the County of London and Brush Provincial Electric Lighting Company (Limited), and have ordered the Ordinary shares (Nos. 1 to 22,475) and 10,000 Six per Cent. Cumulative Preference shares to be quoted in the Official List.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended 3rd inst., after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,891.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this Company for the half month ended April 30th are £2,607, as compared with £2,501 in the corresponding period of 1894. The transfer books of this Company will be closed from May 9th to May 22nd, inclusive.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, Apr. 30.		Price Wednesday, May 8.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending May 8. Highest	Lowest
			TELEGRAPHS.								
£1,012,880	Stock	10 0	Anglo-American	44	46	45	47	4 5 1	Jan., Apr., July, Oct.	44½	44
£2,993,560	Stock	20 0	Do. Preferred	81½	82½	81	85	4 14 2	,, ,,	84¾	81⅝
£2,993,560	Stock	5/0	Do. Deferred	7¾	8¼	8½	9	..	..	8	7⅞
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	101	104	3 17 10	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	12½	13	12½	13	5 0 0	Mar., June, Oct., Dec.	13	12 9/16
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	110	114	110	114	4 9 1	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	148	152	148	152	4 12 1	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	13½	13⅜
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	,, ,,	..	..
12,931	5	2/0	Direct Spanish (fully paid)	3½	4½	3½	4½	4 8 11	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10¼	9¾	10¼	4 7 7	,, ,,	—	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	9	9½	9¼	9¾	4 0 5	Jan., Apr., July, Oct.	9⅝	9
400,000	10	2/6	Eastern	16½	16⅝	16¼	16½	3 18 9	,, ,,	16¾	16⅛
70,000	10	6%	Do. 6 per Cent. Preference	17¼	17¾	17¼	17¾	3 7 7	,, ,,	17½	..
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	124	127	124	127	3 4 0	May and November	125	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105	108	105	108	4 14 1	February & August	..	..
250,000	10	2/6	Eastern Extension	17⅛	17⅜	17⅛	17⅜	4 0 8	Jan., Apr., July, Oct.	17⅜	17⅛
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	123	126	123	126	3 3 6	February & August	124	123½
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	104	107	103	107	4 15 0	January and July ..	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	104	107	103	107	4 15 0	,, ,,	106	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106	109	106	109	3 14 1	February & August	..	—
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	110%	113%	3 10 10	May and November	..	..
180,227	10	2/3	Globe Telegraph and Trust	9⅞	10⅛	9⅞	10⅛	4 8 11	Jan., Apr., July, Oct.	10⅛	9 15/16
180,042	10	6%	Do. 6 per Cent. Preference	16⅝	16⅞	16⅝	16⅞	3 11 3	,, ,,	16⅞	16⅝
150,000	10	7/2	Great Northern	21¾	22¼	21¾	22¼	3 15 7	Jan., April, and July	21 15/16	21⅞
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	..	..
17,000	25	12/6	Indo-European	51	53	50	52	4 16 2	May and November	51½	50½
37,548	10	5/0	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	105	109	105	109	5 11 1	March & September	..	—
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	108	105	108	3 15 2	..	..	—
11,839	8	4/0	Reuter's	4	5	3½	4½	..	April and October	3½	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	122	127	123	128	4 13 9	,, ,,	125	123
15,609	10	5/0	West African Telegraph	4	5	4	5	..	January and July ..	4⅝	—
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	102	105	102	105	4 15 11	March & September	102½	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July ..	..	—
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	103	98	103	7 15 4	June and December	—	..
88,321	10	6d.	West India and Panama	⅞	1⅛	⅞	1⅛	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	11	11½	11	11½	5 4 4	May and November	11⅜	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	9½	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	109	112	109	112	4 10 11	June and December	..	..
64,242	15	3/0	Western and Brazilian	9¾	10¼	9¾	10¼	4 9 5	May and November	10½	..
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6½	6¾	6½	7	..	—	6 13/16	6½
33,129	7½	4/6	Do. 5 per Cent. Deferred	3¾	4¼	3¾	4¼	..	—	..	..
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	102	106	5 14 10	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	102	106	5 14 10	,, ,,	..	—
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	115	120	113	118	5 18 8	May and November	..	—
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	101	103	101	103	5 17 8	March & September	..	—
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	—	..	..	..
224,850	10/0	2⅔d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	—	May and November	⅛	—
171,504	£1	..	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	..	..
484,597	5	2/6	National	5¼	5⅜	5¼	5⅜	4 13 0	June and December	5⅜	5 3/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15½	16½	15½	16½	3 12 9	,, ,,	16½	16
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	,, ,,	15⅜	15 1/16
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¾	6	5¼	6	4 3 4	—	6	5 15/16
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	104	106	3 6 0	January and July	105¾	104½
58,000	5	1/0	United River Plate	1	2	1	2	..	,, ,,	..	—
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	85	90	85	90	5 9 11	,, ,,	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	13	14	13	14	1 15 8	—	13⅞	13 11/16
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15	15½	15½	15¾	3 16 2	..	15½	15⅛
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	—	5 9/16	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	..
8,322	£5	..	House-to-House Electric	..		..		..	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		..	—	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	—	—
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7⅝	7⅞	7⅝	7⅞	..	—	..	—
111,000	5	..	London Electric Supply	..		..		..	—	..	—
49,900	£10	6/0	Metropolitan Electric Supply (fully paid) xd	10	10½	10	10½	2 17 2	..	10½	10½
£150,000	Stock	4½%	* Do. 4½% Debs.	118	120	118	120	3 16 3	June and December	..	—
6,452	£10	2/0	Notting Hill Electric	7½	7¾	7½	8	..	..	7¾	..
19,980	£5	4/6	St. James and Pall Mall	7½	8	7¾	8¼	..	—	8 1/16	7 13/16
20,000	£5	7%	Do. 7 per Cent. Preference	8½	9	8¾	9¼	3 15 8	—	..	..
59,900	5	5%	Westminster Electric Supply (fully paid)	7¼	8	7¾	8	3 2 6	—	..	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅜	2⅝	2⅜	2⅝	5 14 3	—	2 9/16	2 7/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2¼	2½	4 16 0	—	2 7/16	2⅜
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	113	116	113	116	3 18 1	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2½	3	2½	3	..	January and July	..	..
12,139	5	—	Edison and Swan United	1⅝	1⅞	1⅝	1⅞	—	..	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		—		—	..	—	—
120,000	2	..	Electric Construction	¼	½	⅝	⅞	..	..	—	..
12,845	2	2/9½	Do. 7 per Cent. Cumulative Pref.	1¼	1¾	1¼	1¾	—	..	..	—
91,195	2	10/0	Elmore's Patent Copper Depositing	1	1¼	1	1¼	—	..	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	—	..	1 1/16	1
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	..	..	..	..
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	101	103	101	103	4 8 11	February & August	22½	22
15,995	£10	..	International Okonite Ordinary	..		..		4 7 10	March & September	..	..
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	—	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	⅛	—	⅛	..	December and June	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	39	41	39	41	8 15 7	March and July	41	40½
£150,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4 11 9	January and July	108½	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,870	10	12/0	W. T. Henley's Telegraph Works Ordinary	9½	10½	9½	10½	5 11 3	..	10¾	10 1/16
£30,000	10	..	Do. Preference	..		..		..	..	..	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1¼%	City and South London Railway	45	47	45	47	2 13 2	May and November	46¾	45½
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	..	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture xd	128	131	131	133	3 0 2	May and November	132½	132
37,500	£10	2%	Liverpool Overhead Railway	8½	8⅝	8⅞	9	2 5 1	..	..	..
6,295	10	5%	Do. 5% Preference	14	14½	14	14½	3 11 5	..	..	..
125,000	Stock	4%	Do. 4% Debenture	110	112	110	112	3 10 2	January and July	—	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 887. [No. 3. Vol. XXXV.] FRIDAY, MAY 17, 1895. PRICE SIXPENCE.

NOTES.

No doubt it is one of those things which could not be helped; but it is nevertheless to be regretted that when the Institution of Electrical Engineers is in possession of that extremely rare product, a good Paper by a good man, it should only be possible to devote a little over an hour and a-half to its discussion. Mr. MARK ROBINSON'S Paper, "On the Recent Development of the Single-Acting High-Speed Engine for Central-Station Work," literally teems with debatable matter, and throws down the gauntlet, although not with undue provocation, to the advocates of all other systems of steam practice. We hope, therefore, to see the supporters of and makers of slow-speed, horizontal, and ultra-high-speed engines do valiant battle next Thursday on behalf of their respective *protégés*. Unless, however, the ten-minutes rule is rigidly adhered to, it will be impossible to properly bring out all the various aspects of the other side of the question. Much as speeches filled with humorous irrelevancies contribute to the gaiety of nations and the enlivenment of debates which are as a rule none too inspiriting, the regular development of a good joke requires time, and we would suggest that on this occasion, being the last evening before the adjournment for the vacation, all jocularities be taken as said or sent in in writing to the Secretary of the Institution.

IN our "Correspondence" columns this week will be found a letter from Mr. MUSGRAVE HEAPHY, in which he states that the Phœnix Fire Office learn with surprise and amazement that the Institution of Electrical Engineers propose to revise their installation rules, and announces that the Phœnix Fire Office will have nothing to do with any rules, revised or unrevised, other than their own. We fail to see that there is any urgent call for this pronouncement. No one questions that the Phœnix Office, in common with other fire insurance offices, is the party most concerned in good house-wiring—more so even than the electrical industry in general, or the electric supply companies in particular. Again, no one questions the necessity for rules, or the many excellencies of those drawn up by the Phœnix Office. Indeed, if the proof of the pudding be in the eating, the Phœnix rules, judging by the absence of fires, are beyond criticism. Nevertheless they are, have been, and will be criticised, and there exist numerous other regulations mostly differing, it is true, but slightly from those of Mr. MUSGRAVE HEAPHY; and we may be permitted to anticipate that a Hybrid Committee composed of representatives of the fire offices, supply companies, Council of the Institution of Electrical Engineers, and Committee of the Electrical Trades' Section could draw up a more generally acceptable set of rules. It seems to us that the time has come when a single set of simple rules should suffice for such a territorially small portion of the globe as the United Kingdom. At any rate an attempt might be made. All the same it seems to us that too much noise is being made about wiring rules. One would think electricity were akin to dynamite.

OUR "Legal Intelligence" columns record the fact that the long fight between the Commercial Cable Company and Messrs. MUIRHEAD has ended in a victory for the latter, the Company agreeing to pay the patentees a considerable sum for the use of the American duplex patent during the remainder of its existence. By this result, it seems to us, substantial justice has been done.

THE universal electrodynamometer of Prof. KARL ZICKLER, a description of which we give in another column, appears to be one of the most successful attempts hitherto made to produce a single instrument which can be used as an ammeter, voltmeter, or a wattmeter, under very variable conditions. It is, however, questionable whether, in adapting the instrument to so many different functions, a sacrifice of convenience has not been made, which will more than counter balance the advantages secured. Of its utility as an ammeter, either for direct or alternating currents, there can be no doubt; and by the use of a number of coils a large range of sensitiveness is secured and a multiplication of instruments avoided.

WHEN, however, Prof. ZICKLER attempts to use the same instrument as a wattmeter, and, more especially, as a voltmeter, the sacrifice to compactness seems to us to be carried too far. In order to make his instrument suitable for current measurement up to 100 amperes, the torsion spring must be somewhat powerful, and this necessitates a large current when the instrument is used as a voltmeter, and there is consequently a large waste of power. This disadvantage is in itself a serious one; but it is of small importance compared with the effect it has on the accuracy of the instrument. A powerful spring demands a large turning moment of the coils, which, in turn, requires a large self-induction in the instrument. The

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self-induction being high, and the resistance comparatively low, on account of the large current, the correction for self-induction becomes very high, at high rates of alternation; the volts in this instance for a given torsion angle varying from 600 with steady currents to over 900 at a periodicity of 100. With a periodicity of 133, such as is often used in America, the corresponding value of the volts would be 1,100, or nearly double the steady value. At this frequency, also, an error of 1 per cent. in the frequency would make about 0·7 per cent. error in the potential difference, which would render the instrument useless for accurate work.

The essential point to be borne in mind in designing a voltmeter on this principle is that the force between the coils must be very small. Under these circumstances the self-induction of the instrument can be made so small, and the resistance used with it so large, that the correction for self-induction becomes almost inappreciable at any ordinary periodicity. Two other important advantages are also secured, namely, the reduction of the power wasted in heating the coils, and the consequent admissibility of a resistance material of high specific resistance and low temperature coefficient, such as platinoid or manganin, thus greatly reducing the bulk of the resistance and the temperature correction. The same remarks apply to the wattmeter with even greater force so far as the self-induction of the voltmeter coil is concerned. As is stated in the Paper, the correction factor for alternate currents is dependent on the lag in both the voltmeter and main circuits, the latter of which cannot easily be determined. All this complexity could be practically eliminated by reducing the self-induction of the voltmeter coil.

At a recent meeting of the Liverpool Engineering Society Dr. Oliver Lodge read a Paper on "The Second Law of Thermodynamics," which we reprint this week, and he undertook to show that this law "is, after all, nothing more than enlightened common sense." But mechanical engineers, and with them our esteemed contemporary the *Engineer*, are not quite disposed to regard the matter in this light. In the discussion on Dr. Lodge's Paper, Prof. Hele-Shaw stated that he thought that physicists and engineers had different ways of regarding the same question; another speaker referred to Clerk Maxwell's little book on heat as an example of "what a physicist can do to fog an engineer"; and a third speaker thought that physicists ought to "let themselves down a little," so as to become intelligible to engineers. And yet Prof. Lodge had raised no new hypothesis, but had merely stated a well-established generalisation in clear and accurate language. All this pother raised by the engineers arises from the mistake of supposing that the second law of thermodynamics applies to the actual, realisable efficiencies of actual engines. It applies only to an ideal engine, which has not, and never can, be made. In the real engines it is all important what sort of working substance is used; in the ideal engine all substances are equally effective—just as in an ideal city it would not matter where one went out to lunch, while in cities as they are it matters much. Although with the most judicious management we can never raise the actual to the level of the ideal, it is none the less useful to know what the ideally best really is.

Some engineers think that the actual efficiency of heat engines is already often as high as, or higher than, the ideal set by the second law. Prof. Hele-Shaw asserts that "a good boiler will give an efficiency of more than 70 per cent.," and another engineer, while stating that "engineers reckon the efficiency of a steam engine differently from a physicist," confesses that the engineer's way is to "start with the temperature of *the steam in the boiler*, and so obtain the maximum efficiency possible in that way." The first of these gentlemen has surely forgotten that a boiler is only half a steam engine, and wants to ignore the part where the real thermodynamic work is done, while the second is just as anxious to have nothing to do with the furnace. Makers of steam engines and boilers have, of course, a perfect right to do this if they choose, but then they must not expect to be allowed by physicists to compare the "efficiencies" thus obtained with the efficiency given by the law of thermodynamics.

At a meeting of the Lighting Committee of the Liverpool Town Council on Monday, Sir Frederick Bramwell reported in favour of purchasing the undertaking of the Liverpool Electric Supply Company for £400,000. The paid-up capital of this concern amounts to some £250,000, and as its £5 shares stand at about 7⅝ their market value is over £380,000. So that when the loss of the 5 per cent. dividends and the voluntary nature of the surrender are taken into consideration, it will be seen that the shareholders will not be made rich beyond the dreams of avarice, though they will have been fairly dealt with.

Politics and sectarianism, especially of the village order, have done not a little in their time to embroil peace-loving folk. But if a Fareham ratepayer is to believed, electric lighting promises to become an equally potent cause of disturbance. Speaking at a recent meeting of ratepayers, held to discuss what steps should be taken to bring the pending litigation between the Fareham District Council and the Fareham Electric Light Company to an amicable termination, Mr. Dodds is reported to have said that "the electric light question had torn asunder friendships that had lasted for years, and men now passed each other in the street like dogs." What an excellent advertisement this sad state of things would make for, say, incandescent gas: Warranted to give n candles for n^{-x} cubic feet of gas and to destroy no friendships.

Cable Interruptions:

	Date of Interruption.
Latakia—Cyprus	Nov. 27, 1894.
Gibraltar—Tangier	April 24, 1895.

Institution of Electrical Engineers.—The following new members were admitted to the Institution at the last meeting:—Foreign member: Don R. Casado. Member: S. Bright. Associates: C. F. Fielding, A. Rutherford, and R. Wason.

Electricity on Board an Austrian War Ship.—The new Austrian coast defence vessel "Monarch," which was recently launched, is on the most modern principles. All movements

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of the turret, as well as the supply of ammunition to the guns, are carried out electrically.

Lectures at the Electrical Standardising, Testing, and Training Institution.—On Tuesday, the 28th inst., Mr. James Swinburne will commence his usual course of lectures on "The Construction of Dynamos, Alternators, and Transformers" to the students of the above Institution.

The Meaning of the Recent United States Patent Decision. An extremely lucid and interesting article by Dr. Park Benjamin on the recent decision of the United States Courts as to the limitation of American patents by the expiry of *previously granted* foreign patents is to be found in the current number of the *Engineering Magazine*.

The Utilisation of Old Insulators.—The Belgian Postal Telegraph Department, not content with offering its discarded insulators for sale, offers suggestions for their use. An advertisement posted on the walls runs as follows, at least, so says our contemporary *L'Industrie Electrique* :—The insulators will be sold all together or in lots, as desired; they may be advantageously employed as park or garden-path borders.

Royal Society.—The following were some of the Papers down for reading before the Royal Society yesterday:—Prof. Ewing, F.R.S.: "On Measurements of Small Strains in the Testing of Materials and Structures." Prof. G. M. Minchin: "The Electrical Measurement of Starlight. Observations made at the Observatory of Daramona House, Co. Westmeath, in April, 1895. Preliminary Report."

Electrical Communication with Lightships.—In the *Standard* of the 14th inst., Mr. F. Higgins, of the Exchange Telegraph Company, writing on the "Sunk" system, claims that the method in question was one designed and recommended by himself, and described and illustrated in December, 1881, at which time numerous petitions were being presented to the Government from coast towns for the establishment of telegraphic communication with lightships.

More Electric Traction for Budapest.—The Budapester-Strassenbahn-Gesellschaft, which now works its lines by horses, is proposing to work its lines by electricity, and the Hungarian Board of Trade has given its provisional consent. The Company is required to build two generating stations and acquire 200 cars, which are to be so arranged that they can run with either overhead or conduit conductors. The overhead system will be provisionally permitted, but will have to be converted into a conduit system if the authorities require it. The capital required for the rebuilding of the lines is estimated at £1,050,000.

Southwark Bridge Explosion.—In the House of Commons, last week, Mr. Howard asked the President of the Board of Trade whether, having regard to the serious character of Major Cardew's report on the explosions which occurred on February 1st last on Southwark Bridge, he would state whether the City of London Electric Lighting Company had now taken the necessary measures so as fully to comply with the regulations imposed on them by the Board of Trade for the protection of the public. Mr. Bryce replied that the Company stated that on receipt of Major Cardew's report they at once began to take the measures recommended in the report.

Berlin Industrial Exhibition, 1896.—The contract for the lighting and the supply of current for power purposes of this exhibition has been placed with the "Verband Deutscher Elektrotechniker." The Verband, which has all the most important electrical engineering firms as members, undertakes the work at cost price, in accordance with a resolution passed some two years ago at the annual meeting at Cologne. A syndicate has been formed for the execution of the contract, and the following firms are on the Board:—Siemens and Halske, Allgemeine Elektricitäts-Gesellschaft, Gebrüder Naglo, Berliner-Maschinenbau Aktien-Gesellschaft and Union Elektricitäts-Gesellschaft.

Electric Track Welding Tests.—According to the *Electrical Engineer* of New York, the Johnson Company, of Johnstown, Pa., is making tests of a new process of rail welding. Formerly the work of making welds on street rail joints was accomplished from one car, which was burdened with all the machinery required for that kind of work. The Company, now, however, has a train of four cars. In one of these is placed a large dynamo, which is operated by the current taken from the trolley wire. The second car is known as the welding car, and the third as the grinding car. The fourth contains a storage battery. Formerly the great difficulty in making heavy welds on street roads was in procuring sufficient current. It is thought the storage battery will facilitate matters and serve to aid in doing the work better and with more dispatch.

Obituary.—At the last meeting of the Institution of Electrical Engineers reference was made to the death of Major-Gen. R. H. Stotherd, R.E., C.B., who was one of the original members of the Society of Telegraph Engineers, and served on its first Council. He was intimately connected with the early development of military telegraphy, and did a good deal of work in connection with torpedoes and other means of coast defence. Gen. Stotherd obtained his commission in the Royal Engineers in 1847, and from 1866 to 1871 he was Instructor in Electricity at Chatham. From 1873 to 1876 he was specially employed at the War Office as a member of a committee on torpedoes. For the last 32 years of his active service he was Director-General of the Ordnance Survey, and during that time took great interest in electrical matters. By his initiative, improvements were made in the method of depositing copper electrically.

Three-Phase Water Works at Canandaigua.—The *Electrical Engineer* of New York states that the village of Canandaigua, in New York State, has let recently the contract for the construction of a new water works system. The pumps will be operated by means of power electrically transmitted on the three-phase system of the General Electric Company, which Company will supply all the electrical apparatus. The power house will be located on the shore of Canandaigua Lake, and will contain one 100-kilowatt three-phase generator delivering current at 2,080 volts. The current will be transmitted to the pumping station nearly four miles distant, on the shores of the lake. The pump house will be occupied by two one-million gallon pumps, directly geared to 100 H.P. induction motors, wound for 2,080 volts, and revolving at 600 revolutions. The duplication of the pumping system has been determined upon in order that the work may be carried on continuously even should one pumping equipment break down. An automatic signal alarm will indicate at the power house when the reservoir is full.

The Periodic Law of the Chemical Elements—As the law of periodicity of the elements has been specially noticeable of late, in connection with argon, it may be of interest to mention three new points of discovery, in 1894, by which the probability of this law has become strengthened. The points are referred to in an article on "Progress in Physical Chemistry During 1894," by J. W. Rodgers, in *Science Progress* for the current month. (1) Töpler has found that the volume-change observed when a metal melts is a periodic function of the atomic weight; (2) Bailey has discovered that in an *even* series of elements the temperature of decomposition of an oxide is higher the higher the atomic weight, in *odd* series the reverse rule holds; and (3) Deeley observed that if the density of an oxide is divided by the atomic weight of the contained metal the quotient is a periodic function of the atomic weight. It is interesting to observe the steadiness with which the pile of evidence in support of one of Nature's most beautiful laws grows higher and higher every year.

Electric Traction for the Mersey Railway.—The Mersey Railway Bill was on Monday under the consideration of a Select Committee of the House of Lords, presided over by Lord Harris. The object of the Bill was to empower the Company to work their line by electricity and to raise additional capital to the extent of £200,000. The case for the promoters was that the line so far had not been a financial success. In order to rescue the Company from its present financial position it would be necessary to work the line by electricity. It was estimated that the working of the line by electricity would effect a saving of £14,000 per annum, and that the extra traffic would represent at least £10,000, making an increase of £24,000 in the present revenue. Mr. Allen Searle, for the last four years official receiver of the Company, anticipated that

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they would get an increase of traffic if the railway was worked by electricity. Evidence was also given by Mr. A. Siemens and Sir D. Fox. The Chairman said the Committee would pass the preamble of the Bill On Wednesday the bill was ordered to be reported to the House.

Results of Electric Railway Operation in Connecticut.—At a recent hearing before the Railroad Committee of the Connecticut Legislature, counsel for the New York, New Haven and Hartford Railroad Company submitted a statement showing the losses in local passenger traffic, due to the competition of parallel electric lines. The falling off in traffic, says the *Street Railway Gazette* of New York, is even greater than has been generally realised, and in view of the fact the opposition to the further construction of competing electric roads is not surprising. The comparative statement shows the number of strictly local passengers carried by the steam road between the stations named during the period of the six months ending with February, 1894 and 1895, with the percentage of decrease for 1895, as compared with 1894; together with figures showing the approximate distance between these places:—

Six months.	1894.	1895.	Dec. per cent.	Miles.
Bridgeport and Stratford	23,547	7,068	69	3
N. Haven and West Haven	8,234	6,649	19	2
N. Haven and East Haven	5,619	2,203	60	5
Meriden and Yalesville	13,768	3,002	78	3
Hartford and Rocky Hill	7,558	6,567	13	9
Union City and Waterbury	23,124	3,107	86	4
Naugatuck and Waterbury	48,672	6,051	87	5
New Haven and Woodmont	8,580	3,275	61	6
Bridgeport and Southport	20,748	15,617	24	7
Meriden and Wallingford	34,237	24,548	28	6
South Norwalk and Rowayton	33,606	21,814	35	3
South Norwalk and Winnepauk	808	102	87	4
Derby and Ansonia	2,479	2,225	10	2

Municipal Purchase of Tramways.—Last week the case of the North Metropolitan Tramways Company v. the London County Council came before Mr. Justice Romer. In opening the case, Sir R. Webster said the action was brought to raise two important questions of law with reference to the rights of the Council to acquire the tramways of the North Metropolitan Company. The first point was whether the period of time had arrived when the Council could give the notice. A variety of undertakings and extensions had been amalgamated into one concern. The plaintiffs contended that the time for purchase did not run until 21 years from the last of the extensions which were amalgamated with and made part of the undertaking which the defendants had sought to buy. The next point, he said, was whether the defendants had a right to buy certain depots. The defendants' contention was that they were entitled to buy each part as it fell in. Mr. Finlay, on the other side, submitted that Section 43 showed that the plaintiffs' contentions could not be supported. The result of allowing the contention of the plaintiffs would be that each extension would repeal the period of purchase fixed with reference to the undertaking, which would be an absurdity. Mr. Justice Romer said he would reserve his judgment, but he did not feel any doubt as to what his decision would be. Judgment wili be delivered to-day (Friday).—The Bill promoted by the London County Council for powers to work London tramways has been passed by the Examiner of the House of Lords on all questions relating to standing orders. It is stated that the London tramway companies, who failed to defeat this measure in the Commons, intend to renew their opposition when the Bill comes before the Select Committee of the Lords.

Electric Power in Mexican Mines.—An interesting electric power installation is now under construction for the Cia. Anonima de Transmision Electrica de Potencia, located in the State of Hidalgo, some 100 miles north of the City of Mexico. The water is taken from the Arroyo de Regla, a mountain stream having a minimum supply of 1,500 cubic ft. per minute. A natural rock dam at a favourable point in the canyon impounds the water sufficiently to admit of its being diverted by a cut through the bluff into a canal, which follows mostly the contour of the mountain, a distance of a mile and a-half, a work which involved the cutting of seven tunnels, aggregating a total length of 1,200ft. through solid rock. From the terminus of the canal the water is carried to the power station through 1,700ft. of 30in. pipe, which affords a vertical head of 800ft., this being of varying thickness to correspond to the pressure at various points on the line, the lower portion being made of steel ⅜in. thick. The pipe line discharges into a receiver 40in. diameter by 75ft. long, with which the wheels are connected by lateral branches. The power station consists of five 40in. Pelton wheels of 400 H.P. each, coupled direct to the same number of 12-pole, three-phase generators at a speed of 600 revolutions, giving current at a pressure of 700 volts. Also two 24in. Pelton wheels, running at 1,700 revolutions, for driving the exciters. The step-up transformers are wound for a ratio of 1 to 15, making the line potential a little over 10,000 volts at the generator end. There are three transformer sub-stations in which air-blast transformers are to be used. Pelton differential governors are attached to each wheel for the purpose of regulation. This station is to supply power to the mines of the Rio del Monte Company, a most extensive mining organisation employing upwards of 8,000 men. The power is to be used for operating mining machinery, such as stamp mills, crushers, pumps, hoists, ventilators, &c., &c. The mines of this Company are located within a radius of 20 miles, the maximum distance of power transmission being 23 miles, and the mean distance about 18 miles. Various other mines in the vicinity will also be supplied with power from this station, and the City of Pachuca also furnished with light.

Royal Society Candidates.—The following are the qualifications of those of the 15 candidates recommended by the Council of the Royal Society for election who have done work of electrical interest. We are indebted to *Nature* for these particulars:—

Ernest Howard Griffiths, M.A., Private Tutor. Author of the following Papers:—"On the Comparison of Platinum Temperatures with the Kew Standard" (Rept. of Committee on Electrical Measurements, Brit. Assoc., 1890); "On the Determination of Certain Boiling and Freezing Points" (*Phil. Trans.*, 1891 A); "The Electrical Resistance of Platinum Wire at Absolute Zero" (*Phil. Mag.*, December, 1892); "On the Determination of Low Temperatures by Platinum Thermometers" (*Proc. Camb. Phil. Soc.*, Vol. VIII., Part I.); "On the Increase in Resistance of a Conductor when Transmitting a Current" (*ibid.*, Vol. VIII., Part I.); "The Mechanical Equivalent of Heat, together with an Investigation into the Changes in the Capacity for Heat of Water" (*Phil. Trans.*, 1893 A); "The Boiling Point of Sulphur, together with a Method of Standardising Platinum Thermometers," jointly with Mr. Callendar (*Phil. Trans.*, 1891 A). *Supplementary Certificate.*—Appendix to the communication entitled "The Mechanical Equivalent of Heat" (*Proc. Roy. Soc.*, Vol. LV., 1893); "A Method of Joining Glass and Metal Tubes" (*Proc. Phil. Soc. Camb.*, 1893); "The Measurement of Temperature" (*Science Progress*, 1894); "The Influence of Temperature on the Specific Heat of Aniline" (*Phil. Mag.*, 1895); "The Latent Heat of Evaporation of Water" (read Royal Society, January, 1895).——Henry Capel Lofft Holden, Major, Royal Artillery. In India, from 1877-84, he carried out a number of experiments in telephony and telegraphy for the Indian Government. Since 1885 he has been in charge of the Department for the proofs of Naval and Land Service Ordnance, and Gunpowders, and for experiment work connected therewith, and has invented and constructed many pieces of apparatus connected with the science of artillery, as well as with electrical and scientific research. Amongst those which have been publicly exhibited are his devices in connection with the chronograph, for measuring the velocity of projectiles; an extremely accurate and sensitive hydrometer for measuring the variations of the density of the acids in the electrolyte accumulator cells (exhibited Royal Society, 1887; *see* also Paper before Iron and Steel Institute, 1891); a high-speed chronographic pen for recording minute intervals of time by electromagnetic means; various instruments for making accurate and rapid tests of the pressure and current in direct-current circuits, and in alternating-current circuits of both high and low frequency (some exhibited Royal Society, 1892); an instrument for rapidly ascertaining the E.M.F. and resistance of a galvanic cell (exhibited Royal Society, 1893); a compact moving coil galvanometer adapted to universal purposes, which was employed by Profs. Dewar and Fleming in their researches on the resistance of metals, and is used in the recording pyrometer of Prof. Roberts-Austen. He was deputed by the Commander-in-Chief to write the electrical sections of the Paris Exhibition of 1889, the Frankfort Exhibition of 1891, and the Chicago Exhibition of 1893, and furnished the Government with most valuable reports.——George M. Minchin, M.A. (Dubl.), Professor of Mathematics in the Royal Indian Engineering College, Cooper's Hill. Author of the following treatises:—"Statics," "Uniplanar Kinematics," and "Hydrostatics." Also of the following Papers:—"Astatic Equilibrium of any System of Forces, treated by Quaternions" (*Proc. Lond. Math. Soc.*); "The Absolute Sine Electrometer" (*Nature*, *Electrical Review*, &c.); "Researches in Photo-Electricity" (*Proc. Phys. Soc.* and *Phil. Mag.*); "Impulsion Cells" (*Electrician*, *Proc. Phil. Soc.*); "Seleno-Aluminium Cells and the Electromotive Forces of Starlight" (*Astronomy and Astro-Physics*); "The Magnetic Field of a Circular Current"; "The Magnetic Field close to the Surface of a Wire Carrying a Current" (*Phil. Mag.*, *Proc. Phys. Soc.*)

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THE ZICKLER UNIVERSAL ELECTRO DYNAMOMETER.

The principal measurements which the electrician requires to make are those of resistance, current, potential difference, and electrical power. For the measurement of the three last quantities a large number of instruments are required when the measurements are made with any accuracy. This multiplication of instruments arises, in the first place, from their limitations of range; secondly, from the different quantities measured; and lastly, from the nature of the currents employed, continuous and alternating.

The foregoing facts, says Prof. Karl Zickler in a pamphlet, of which this is an abstract, induced him to devise an instrument which should be capable of measuring current strength, potential difference, and electrical power, either continuous or alternating, between wide limits. This instrument he calls a universal electrodynamometer.

The principle of this instrument, as in most other standard instruments, is the measurement of the force due to the mutual action of two currents. The author remarks that Lord Kelvin has devised a modification of his ampere balance, known as the composite balance, which measures current potential difference and watts between wide limits. This instrument, however, requires an auxiliary current in the movable coil, and hence is unsuitable for alternating currents. It is also desirable that in any standard measuring instrument for alternating currents the mutual induction between the coils should be negligible, otherwise the corrections, when using the instrument as a voltmeter or wattmeter, become very complicated.

The instrument, therefore, consists essentially of two coils at right angles to each other, the moment of the force between them being measured by the torsion of a spring. For current measurements the fixed and movable coils are connected in series and the current passed through them. Then

$$J^2 = C^2\phi, \text{ or } J = C\sqrt{\phi},$$

where J is the current, ϕ the torsion angle, and C the dynamometer constant. The same formula holds for alternating currents where $J = \sqrt{\text{mean-square}}$ of the current.

For potential difference measurements the fixed and movable windings are connected in series with each other, and with an external non-inductive resistance to the points whose potential difference is to be measured.

In this case $\delta = C_1\sqrt{\phi}$, where δ is the potential difference and C_1 the dynamometer constant.

For alternating currents

$$\sqrt{\text{mean } \delta^2} = C_1\sqrt{1+\lambda^2}\sqrt{\phi} = C_1{}^1\sqrt{\phi},$$

where

$$\lambda = \frac{\pi p L}{W},$$

p being the number of alternations per second,
L the self-induction of the instrument in henrys.
W the total resistance of the circuit.

The quantity λ can be reduced by making L small, in which case the correction factor $\sqrt{1+\lambda^2}$ will be nearly unity. For power measurements one of the windings is connected to the main circuit, so that the whole current passes through it. The other winding is connected in series with a non-inductive resistance, to the points between which the power is to be measured.

In this case power $= J\,\delta = C_2\,\phi$.

For alternating currents it has been shown that

$$\text{Mean }(J\,\delta) = C_2\,\frac{1+\lambda_1{}^2}{1+\lambda_1\lambda_2}\,\phi,$$

where

$$\lambda_1 = \frac{\pi p L_1}{W_1} \text{ and } \lambda_2 = \frac{\pi p L_2}{W_2},$$

L_1 and W_1 being the self-induction and resistance of the voltmeter circuit, L_2 and W_2 those of the main circuit.

The correction factor $\dfrac{1+\lambda_1{}^2}{1+\lambda_1\lambda_2}$ can in this case be reduced to unity when $\lambda_1 = 0$ or $\lambda_1 = \lambda_2$.

Description of the Instrument.

A general view of the instrument is given in Fig. 1. The movable windings which surround the fixed coils consist of two parts, one of which is a copper frame of 35 sq. mm. cross-section, the ends of which dip into mercury cups i_1 (Fig. 2). The second part of the winding consists of 60 turns of 1·15mm. insulated wire wound on the copper frame, the ends of which dip into the mercury cups a_1. The movable coils can be raised and clamped by a lever which lifts the coils against a cone.

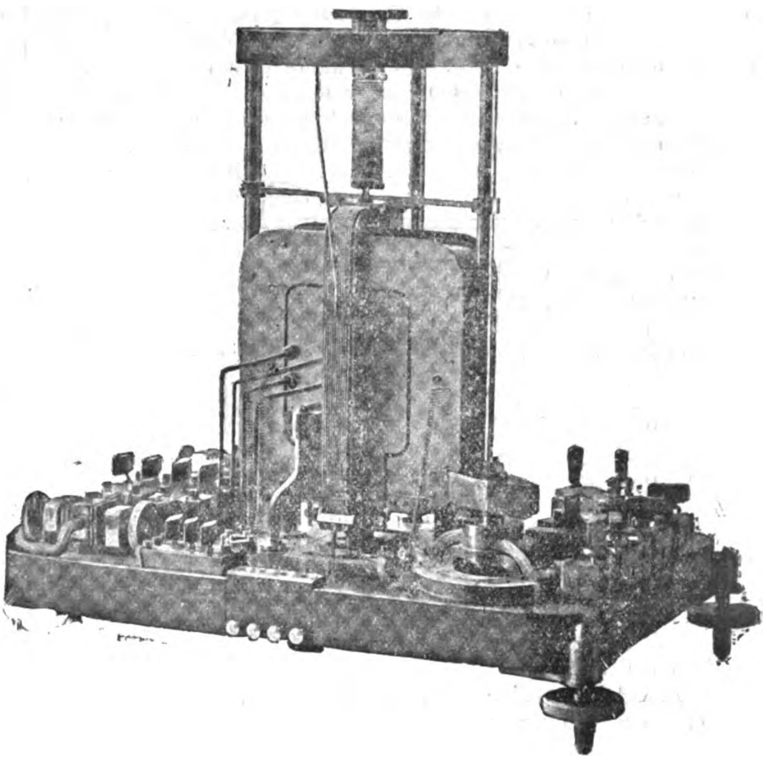

Fig. 1.

The coils, instead of being suspended by a filament (as in a Siemens dynamometer) which is liable to break and alter the constant of the instrument, rest on a pivot, thus securing perfect constancy of control. A pointer is also attached to the coil. The torsion spring is attached to the coil, and to a torsion

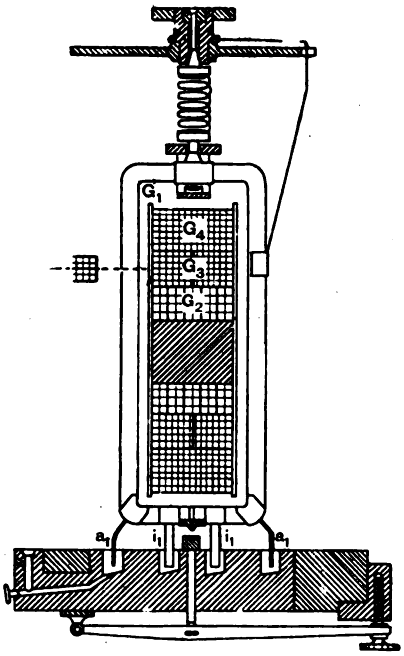

Fig. 2.

head and pointer moving over a dial in the usual way. The mercury cups, shown in plan in Fig. 3, are of such dimensions as to carry the maximum current without heating, and have a device for filling and emptying them without disturbing the instrument. This is effected by holes drilled horizontally in the base to the bottoms of the cups, the external openings

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being closed when required by small iron stoppers, i_2 and a_2. Vertical holes, with cups i and a, are also made, communicating with the former tubes. The cups can be filled by pouring mercury into the cups i or a, and emptied by withdrawing the plugs. The level of the mercury in the cups is kept constant by small overflow openings into the cups i and a. The current passes to the mercury cups by a commutator K (Fig. 3), which is capable of short-circuiting or reversing the movable coil circuit. In all direct-current measurements the readings of the torsion angle are taken with the current flowing in the two directions in the moving coil. The mean of these readings is taken as the true reading of the instrument.

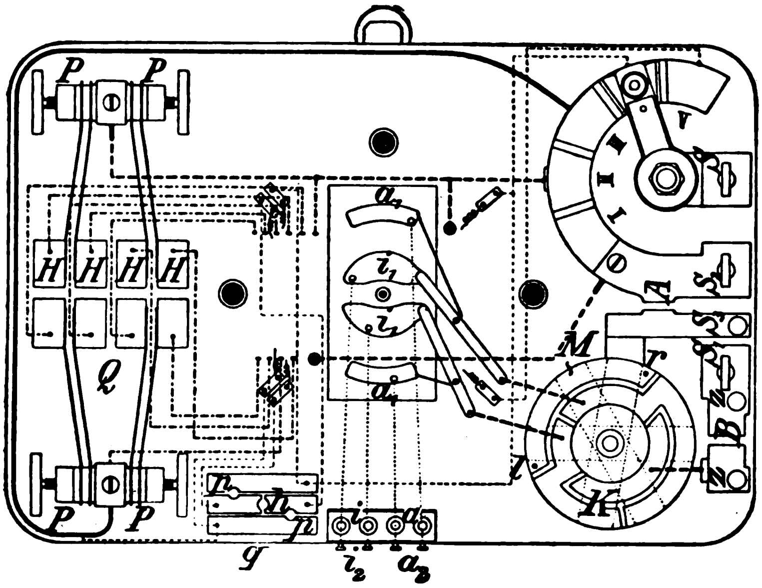

Fig. 3.

The fixed circuits consist of several windings of different cross-sections and different numbers of turns. The first part, G (Fig. 2), consists of four turns of copper tape, 1·5mm. thick and 35mm. broad, which form the flanges of the coils. The ends of this circuit are connected to the contacts I. and II. of the five-way switch, shown in Fig. 3. On the interior of the coils there are first five coils, G_2, each of 30 turns of copper strip 2mm. by 2·7mm. wound side by side, the ends of which are connected to the plug switches H (Fig. 3). By altering the arrangement of the plugs the coils can be put all in series, or, by contact pieces from the terminals P, in parallel. The terminals P are connected to the contacts II. and III. of the switch.

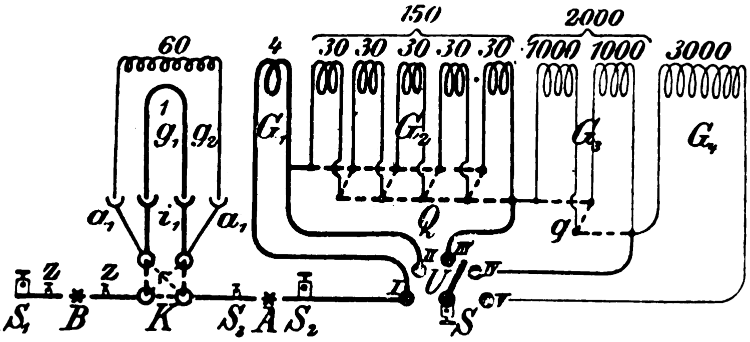

Fig. 4.

In this manner the coils can be arranged so as to give 30 turns of a total cross-section of 27 sq. mm, or 150 turns of 5·4 sq. mm. Outside these coils are two, G_3, of 1,000 turns of 0·45 mm. double silk covered wire, which can be put in series or parallel by a small plug switch q, and connected to contacts III. and IV. of the main switch. Lastly, there is a single coil, G_4, of 3,000 turns of the same wire, connected to contacts IV. and V. The connections are made to the instrument by a number of terminals, S, S_1, S_2, S_3, $z_1 z$, the arrangement of which can be seen on the diagram.

In using the instrument for current measurements the commutator is set to the position M (Fig. 3), the switch on contact I., and plugs are inserted in the positions A and B. The circuit is then joined to the terminals S and S_1. The current (*see* Fig. 4) then flows from S to I, A, K, B, and leaves by S_1, no coil of the instrument having been traversed. One pair of mercury cups having been filled, according to the magnitude of the current to be measured, the switch is set to one of the contacts I. to V., until a convenient sensitiveness is obtained, when the commutator is set in one direction. The reading is taken in this direction, and also when the commutator is reversed, and the current known from the mean of these readings and a constant depending on the arrangement of the coils used. There are eight constants, varying from 0·0211 to 5·97, which, for limits of angle of from 20deg. to 360deg., give as the range of the instrument, for direct and alternating currents, 0·094 ampere up to 113·3 amperes.

For potential difference measurements the commutator is set to the mark M, the switch on contact V., and the plug switches in series. The mercury cups a are filled, the plug removed from the point B, and the terminals $z z$ connected to the terminals of one of the non-inductive resistances used with the instrument. The number of turns in the circuits consists then of 5,154 turns on the fixed coil, and 60 turns on the movable coil, the total resistance of which is 223·43 ohms, which is made up to 250 ohms by one of the resistance coils. Five other resistance coils are used, each of 250 ohms. By the use of different combinations of these coils, and of the fixed dynamometer coils, a range of from 4·3 to 600·5 volts is obtained with continuous currents. The current when measuring 600 volts is 0·4 ampere. A correction has in this case to be made for temperature, which correction varies from 0·38 per cent. per 1°C. for the copper coils to 0·068 per cent. for the material used for the resistance coils. The coils are so arranged that no observable heating is caused by the current.

For alternating currents the correction for self-induction has also to be made, the value of which for the whole arrangement of coils is 2·76 henrys. The potential difference required for a to torsion angle of 360deg. alters from 600·5 with steady currents 661·6 at 80 alternations per second, and 917·8 at 200 alternations.

For power measurements the mercury cups a are filled, the plugs withdrawn from A and B, and the resistance connected to $z z$. The switch is set at contact I., the main circuit connected to the terminals S and S_2, and the points between which the power is to be measured to the terminals S_1 and S_3. Greater sensitiveness can be obtained by altering the position of the switch. The readings are then taken in the same manner as with a Ganz wattmeter, the corrections for temperature and self-induction having to be made. The instrument is then capable of measuring power between the limits of 14 and 56,376 watts.

When the 60 turns on the movable coil are used in the shunt circuit, with the smallest possible external resistance and highest periodicity (200 alternations per second), the value of λ_1 is 0·002 and of λ_2 0·000004. Hence, in this case, the value of λ_2 must be 5, in order that the correction factor should differ 1 per cent. from unity, which will be seldom the case.

The foregoing remarks show that this universal instrument is capable of measuring current, potential difference, and power both for direct and alternating currents, under a great variety of circumstances. The construction of the instrument precludes the possibility of any alteration of the constant with time, and during the eight months the instrument has been in use no variation of any kind has been detected. The reversing of the current in the moving coil eliminates any errors which might arise from external magnetic fields. Any change in the direction of the instrument relatively to the earth's magnetic meridian produces no appreciable change, the field of the instrument being exceedingly strong compared to that of the earth.

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THE EDMONDSON "ZERO-TORQUE" METER.

At the last meeting of the Institution of Electrical Engineers Mr. Joseph Edmondson, of Bradford, exhibited and explained an ingenious electricity meter of the dynamometer type.

The meter, a general view of which is given in Fig. 1, is nothing more than the well-known Siemens dynamometer, combined with mechanism for measuring and integrating at short intervals the torque excited on the moving coil by the current going to the lamps. The motion of the moving coil is limited to an arc of less than 1deg., and the use of a durable steel-wire suspension, instead of the delicate suspension of the ordinary dynamometer, is thus rendered possible. A torque of about 90deg. is given to the usual spiral spring every two minutes by a reciprocating quadrant, or "mangle-wheel," driven by a vibrating motor consisting of a magnet and its armature, the motor being controlled by a small gravity-driven pendulum, starting automatically and having a sparkless contact, due to the use of a condenser and a resistance, as in the Oulton-Edmondson clock meter of 1893. The action of the instrument is made plain by Figs. 2 and 3, in which A is an arm pivoted at G, carrying a click working into a ratchet-wheel, and driving the registering train. It receives a reciprocating motion

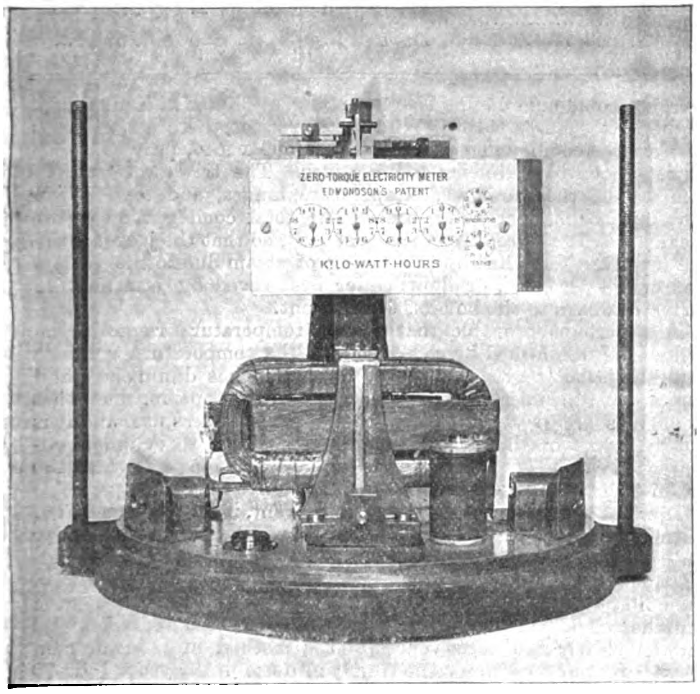

Fig. 1.—General View of the Edmondson Meter with Case removed.

from the vibrating motor. Fixed on its arbor is the arm B carrying the steel pin C. The flat steel stop D, which is on an arm projecting from the moving coil of the dynamometer, is free to move between the stops E and F. When the current is *nil* the stop D remains against the stop E, as in Fig. 2. In this position the pin C comes down upon it at each vibration, and the arm A is thus prevented from vibrating far enough to take a tooth of the ratchet-wheel. The registering is therefore *nil.* But when the moving coil of the dynamometer is deflected by the current the stop D moves to the right, and it assumes the position shown in Fig. 3. The pin C can now descend into the space between the stops D and E, and the arm A can vibrate to its full extent, and the registering proceeds. This continues until the reciprocating quadrant, or "mangle-wheel," in its motion to the left, acting through the spiral spring, exerts on the moving coil of the dynamometer a torque equal to that exerted by the current, brings the stop D back to the position shown in Fig. 2, and stops the registering. This action is repeated with each reciprocation of the "mangle-wheel." As the period during which the registering proceeds is *exactly proportional* to the torque exerted by the current on the moving coil of the dynamometer, the diagram of registration is a straight line. A 25-ampere meter will register from one-tenth ampere upwards. The total current required for the

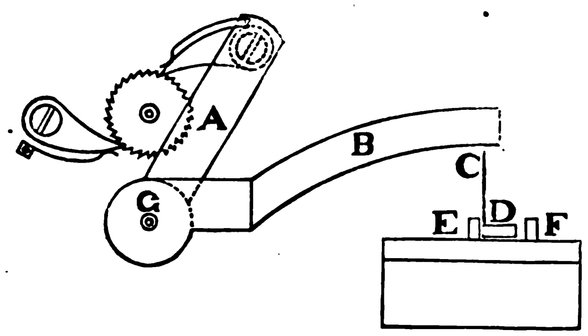

Fig. 2.

shunt circuit and the vibrating motor never exceeds, and is generally less than, two-hundredths of an ampere. The moving coil of the dynamometer, being in the centre of a cylindrical

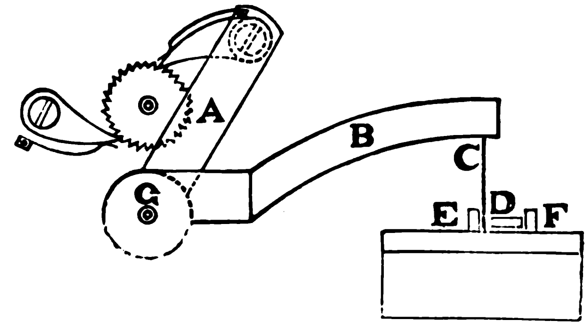

Fig. 3.

iron case, is shielded from external magnetic influence. The meter is calibrated to read direct in kilowatt-hours with a constant of 1.

THE DEVELOPMENT OF THE EXPERIMENTAL STUDY OF HEAT-ENGINES.*

BY PROF. W. C. UNWIN, F.R.S.

(*Concluded from page 50.*)

The Experimental Theory.

Hirn and the Alsatian School.

A year or two before Isherwood began his experiments, an Alsatian engineer, M. Hirn, had discovered and measured cylinder condensation. Hirn's father was artistic designer to a factory where printed calicos were made, and Hirn was at first in charge of the chemical laboratory of the factory. His first independent commercial adventure was in 1855, when he introduced mineral oil obtained in Alsace for lubricating purposes. One of his earliest scientific Papers was an account of researches on the friction of lubricated surfaces, which was refused by more than one scientific society, and since its publication remained little noticed. In this Paper results quite recently obtained are anticipated, and it is still one of the most valuable treatises on friction. The chief interest of Hirn's life was in purely scientific research, especially investigations of some of the most abstruse physical problems. The study of the steam engine, begun with a view of verifying Joule's discovery, was merely an interlude in a series of investigations, mostly dealing with more abstract departments of science. But Hirn formed a school of engineers devoted to the carrying out of experiments on the steam engine. He formulated the methods of engine testing adopted almost without change ever since. He brought to the analysis of the results an extremely acute intellect. He was the first to realise that the complexity of the actions in a steam engine was so great that a purely rational theory was

* The "James Forrest" Lecture, delivered before the Institution of Civil Engineers, May 2nd.

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impossible, and that the engine could only be studied usefully by (to use a phrase of Prof. Cotterill) checking theoretical conclusions step by step by reference to experiment.

Joule's discovery attracted Hirn's attention, and he set to work in 1854 to verify by an exact engine test, whether the difference between the heat received by an engine and discarded in the condenser was the equivalent of the work done. His two most important memoirs relating to the steam engine are, a memoir on the utility of steam jackets in 1855 to 1856, and another on the use of superheated steam in 1857. In these researches he devised a method of accurate engine tests, involving the measurement of all the quantities of heat received by or rejected from the engine, which, with hardly any change at all, is the method of accurate engine testing adopted ever since. Under his influence and direction, engine tests were carried out in Alsace for many years, and the results exactly analysed. It may be recalled that the admirable series of engine tests, the first tests in which the heat quantities were accurately measured in this country, which were made by Mr. Mair Rumley, and described in three Papers on "Independent Engine Tests" in the *Proceedings* of this Society in 1882, 1885 and 1886, were trials carried out strictly in accordance with Hirn's methods.

As with Lord Kelvin, so with Hirn. It was the recognition of an apparent conflict of Joule's discovery with Carnot's law which first attracted his attention. It was the attempt to determine whether part of the heat supplied to an engine disappeared as work which determined the form of his trials. His experiments of 1854 showed that "heat in a steam motor is not only dispersed, but actually disappears, and the power obtained is exactly proportional to the heat which disappears as heat to reappear as motive power." Some rather later and more careful experiments enabled him to verify Joule's equivalent by the actual results of a large engine test to an accuracy of about 1 per cent.

Hirn's heat measurements in the engine trials of 1854-6 showed the important and even unaccountably large influence of the steam jacket on the steam consumption. Its effects could not in any way be explained, as merely the arrest of external radiation for the decrease of heat losses in the engine proved to be larger than the heat yielded to the cylinder by the jacket. It was in studying the action of the jacket that Hirn came to perceive, and before anyone else, to directly measure the initial condensation of steam in the cylinder.

The following are some results obtained a few years later by Hirn and Hallauer on a Corliss engine. Working without a jacket, the initial condensation was 62·3 per cent. The proportion of water in the steam at release is as 41·4 per cent., so that 20·9 per cent. at least was re-evaporated during expansion. Working with a jacket the initial condensation was 46·5 per cent., or 16 per cent. less than in the unjacketed trial. Further, the proportion of water present at release was only 15·3 per cent., so that 31·2 per cent. had been evaporated during expansion. Hence the gain from the jacket in those cases where it produces a considerable effect arises in two ways. The prejudicial initial condensation is considerably diminished, and more heat is given back from the cylinder wall during expansion when it is partially used in doing work, and less during exhaust when it does no useful work.

The discovery of initial condensation and the proof of the powerful action of a small amount of heat transmitted from the jacket both pointed to the conductivity of the cylinder wall as the cause of the large waste of steam which the constructors of the rational theory had neglected. The cylinder is cooled during expansion, and stil more during exhaust by an action analogous to internal radiation to the condenser. Before any work can be done in the next stroke, the wall has to be re-heated by condensing fresh steam. The extreme facility with which steam yields or abstracts steam by condensing and evaporating, accounted for the rapidity of the action. The magnitude of the condensation increases with the range of temperature to which the cylinder wall is subjected. It is larger in condensing than in non-condensing engines, and larger with high ratios of expansion.

Some time ago I ventured to say that there was no trustworthy engine test which showed that the consumption of steam with a jacket is greater than without a jacket. I believe that is still true, but undoubtedly the economy due to the jacket varies in different cases from 30 per cent. to very nearly zero. Roughly, the jacket is more useful with small engines than with large; with slow engines than with fast engines; but all this amounts to little more than saying that the jacket is most useful in those cases where the initial condensation is largest. Just in proportion as the engine, whatever its type, is of the highest class and most scientific design, the jacket is less useful. No one probably designed better simple engines than Corliss, and Corliss did not use jackets. In an experiment by Delafond on a large Corliss engine at Creusot, the jacket effected an economy of only 2 per cent. The same rule holds with compound engines. Hirn found an economy of 25 per cent. due to the jackets in a Woolf engine tested in 1855, but since

Hirn's Experiments 1873-75. *Thermal Units per Stroke.*

—	Saturated.		Superheated.		
Ratio of expansion ...	4·0	7·0	2·0	4·0	7·0
Heat in dry steam admitted	144·1	101·7	110·2	119·7	87·5
„ „ entrained water or as superheat	0·3	0·3	6·2	7·4	3·5
Heat carried to engine ...	144·4	102·0	116·4	127·1	91·0
Heat in condensed steam discharged from condenser	7·5	5·1	6·0	5·7	4·1
Heat expended per stroke	136·9	96·9	110·4	121·4	88·9
Heat accounted for in work done and radiation	16·6	12·7	14·6	17·7	13·5
Difference, or heat which should be found in condensing water ...	120·3	84·2	95·8	103·7	73·4
Actual heat found in condensing water	121·4	84·0	96·5	104·6	73·5

Hirn's Experiments, 1873-75.

—	Saturated.		Superheated.		
Rates of expansion	4	7·0	2	4·0	7
Per cent. of water in steam admitted	1	0·8	0	0·0	0
Per cent. of water at end of admission	31	37·0	0	6·5	25
Per cent. condensed during admission	30	36·0	0	6·5	25
Per cent. of water at release	25	35·0	13	12·0	21
Per cent. re-evaporated during expansion	5	1·0	...	...	4
Per cent. condensed during expansion	...	...	13	5·5	...

then the compound engine has been improved, and the advantage of the jacket is less. Prof. Witz made very accurate experiments with a large compound engine of about 600 I.H.P., provided with jackets both to cylinders and receiver. The trials were strictly comparable, the pressures, temperature ranges, and total power developed being nearly the same. The total condensation in the jackets was 12 per cent. of the steam used, so that the jackets were not inactive. Yet the absolute saving of steam due to the jackets was only 4 per cent., or allowing for heat saved by returning the jacket drainage to the boilers, 6·6 per cent.

It is perhaps probable that as the temperature range in the cylinder is diminished by compounding, the temperature gradient from the jacket to the interior of the cylinder is diminished, and the rate of transmission of heat decreased. It appears, then, that as engines are better designed, the jacket is of less use, and it is not by means of the jacket that the waste due to cylinder condensation can be got rid of, or the highest economy of which the steam engine is capable reached.

The jacket reduces, but it does not prevent, initial condensation. Hirn looked for some more powerful way of heating the cylinder wall without causing condensation; he found it in superheating. He constructed in 1855 a superheating apparatus in the flues of the boiler at Logelbach, which still exists. The experiments with superheated steam were carried out between 1855 and 1856, and showed clearly the effectiveness of the method in reducing condensation. Superheating came largely into use in the years 1860-70 in this country in marine engineering practice, having been introduced here by John Penn. In every case in which it was used an economy of coal was realised. Generally the economy amounted to from 15 per cent. to 20 per cent. It was ascertained that this was due strictly to economy of steam, and not to the utilisation in the boiler of heat previously wasted. But the use of superheated steam in this country was gradually abandoned, partly, no doubt, from some practical difficulties, but chiefly, I believe, because practical engineers had no clear idea why superheating should produce so large an economy, and they were not indisposed to abandon a complication the action of which they could not satisfactorily explain to themselves.

In Alsace, superheating has never been entirely abandoned, and during the last ten years hundreds of boilers have been supplied with superheaters. So far as I can ascertain, no difficulty arises in using steam superheated to 500°F., and in good and large engines the steam consumption is reduced when the superheating amounts to 100deg. by 15 per cent. on the average. I have no doubt myself that superheating will be largely used again. The practical difficulties exist, but they are not insuperable.

No possible improvement of the steam engine, of which we have any knowledge at this moment, offers anything like so great a chance of important economy as the re-introduction of superheating, and especially of superheating to at least 100deg. or more above the saturation temperature of the steam. I obtained in Alsace, on a very good 500-H.P. compound mill engine, with jackets and every appliance for economical working, an economy of 15 per cent. Mr. Mair Rumley has fitted a superheater to a Babcock

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boiler supplying a triple engine, and has obtained an economy of 10 per cent. In both cases the economy is economy of steam, and therefore is not due to any increase of boiler surface or increase of efficiency in generating the steam. Lately Prof. Schröter, of Munich, has been experimenting with a small special compound condensing engine of only 60 I.H.P. running at the moderate piston speed of 380ft. per minute, and with the not excessive boiler pressure of 165lb. per square inch. The high-pressure cylinder is not jacketed. The low pressure is jacketed with receiver steam. In this case, in a tube superheater of a rather special construction, in the uptake of the boiler the steam is superheated to 670°F., or nearly 300deg. above the saturation temperature corresponding to the pressure. In two trials of six and eight hours' duration, periods quite long enough for accurate determination of results with so accomplished an observer as Prof. Schröter, the consumption of steam was only 10·2lb. per indicated horse-power-hour, and the consumption of German coal of moderate quality only 1¼lb. per indicated horse-power-hour. The steam consumption is the lowest on record for any engine of any type or size, and is very remarkable for so small an engine.

It is often argued that as very little heat is required to superheat steam it cannot produce much effect. The answer is that a small amount of heat rightly applied in preventing initial condensation produces a disproportionately large effect. That is consistent with the strictest principles of thermodynamics. In the Schmidt engine only 8 per cent. of the heat was used in superheating the steam, and to this 8 per cent. the remarkable economy is due. In a steam-jacket acting well, about 12 per cent. of the steam used is condensed, and to this 12 per cent. the advantage of the jacket which often reduces the amount of steam used in the cylinder by 20 to 30 per cent. is due. But the heat from a jacket is much less efficiently applied than the heat taken direct to the interior of the cylinder by superheated steam and used primarily in maintaining the temperature of the admission surface. Further, the quantity of superheat brought into the cylinder in a given time increases with the speed of the engine while jacket-heat diminishes in effect as the speed is greater. The action of the superheated steam is shown clearly enough on the indicator diagrams. In my own trials in Alsace the wetness of the steam at cut-off in the horse-power cylinder with jacket, but without superheating, was 35 per cent., with steam superheated 100deg. it was only 15 per cent. In the trial with the Schmidt engine there was no moisture at cut-off in the horse-power cylinder, and the steam remained dry nearly to the end of the stroke.

Conflict of the Rational and Experimental Theories.—Zeuner, Hirn, and Hillauer.

On the appearance of Isherwood's researches, in 1863, the discrepancy between the rational theory and the results of experiment was recognised by Rankine and others. But the conditions of cylinder condensation are so complex that for a long time the more theoretical writers practically ignored both Hirn's and Isherwood's results. Zeuner, perhaps, had pushed the rational theory to the furthest limit of detail and with the greatest insight into practical conditions. But it was not till 1881 that he began to explicitly admit the largeness and importance of the condensing action in the cylinder. Zeuner then was disposed to attribute initial condensation to the presence of a permanent and not inconsiderable mass of water in the clearance space of the engine. No doubt it is simple analytically to deal with the thermal changes of the steam plus a given mass of water than with the thermal changes of steam, water, and a varying area of solid cylinder wall. In opening a discussion with Hirn, in 1881, Zeuner wrote that if the presence of water in the clearance space was conceded the Alsatian calculations would be greatly shaken, and "the enormous influence which they attributed to the cylinder wall would in future be attributed in part, perhaps chiefly, to the water in the clearance space." He thought it conceivable that in certain cases the whole of the initial condensation was due to water in the clearance space. There thus arose a rather angry controversy which has been summed up in the question, "Is it water or iron?" I do not know that this controversy has been as yet completely decided, or that perhaps an absolute decision is possible. I cannot help thinking that Hirn, with the clearness of view due to his experimental work, had on the whole the best of the controversy, and I do not know that anything better or more instructive can be said than the words in which he finally summed up his position. "We recognise," said he, "that the interpretation of the Alsatians differs from that of M. Zeuner, not at all in that it denies the possible presence of water in the cylinder (we are not so hydrophobic), but in that it admits that that water varying in quantity is presented only temporarily, is carried away and renewed stroke by stroke, and acts chiefly as the medium between the steam and the cylinder wall. In the Alsatian explanation the action of the water raises the thermal action of the sides. In Prof. Zeuner's view the water is permanently present and acts independently of the cylinder sides."

We may note that Mr. Donkin has been able to show, by direct thermometric observations, a considerable fluctuation of temperature in the innermost layer of the cylinder wall, and that, more lately, Prof. Carpenter, of Sibley College, has obtained photographic records of the fluctuation of temperature by using a thermopile and a recording galvanometer.

Recent Experiments—Willans.

It has been quite impossible in this lecture to do more than select one or two of the most important of the experimental investigations during the last 50 years. But I should not like to omit all reference to the two series of experiments of the late Mr. P. W. Willans. Mr. Willans' work is, no doubt, well known to all steam engineers, and needs no detailed description. However purely practical the object Mr. Willans had in view, his experiments were made in the true spirit of scientific research. No trouble was too much to secure accuracy to the last decimal, no possible cause of error was so trivial that its investigation was reckoned unnecessary. A few experimenters—Isherwood, Gately and Kletsch, and others—had made experiments on a methodical system; varying a single factor at a time. Willans carried out the method of experiments in series, on a scale which, till he proved that it could be done, no one would have supposed possible. There is a series of non-condensing, and a series of condensing trials; in each there are trials of simple, compound, and triple engines; and for each of these again, trials with initial pressure varied, with expansion varied, and with speed varied. The results tabulated in the clearest way form a quarry of scientific data, but at present in the main an unworked quarry. Perhaps that statement will seem surprising, and of course I am expressing only my own view, for which I claim no infallibility. What Mr. Willans might have done had he been spared, it is impossible to say. He had the most active mind and the widest experience devoted perhaps at any time to the study of steam problems. But so far as his Papers go, they are confined to the description of his experiments. On the causes and laws of cylinder condensation, there is little in his Papers except some acute observations on special anomalies observed. Willans himself said that "he was unwilling to suggest any theory to account for the various results shown in these tables." But without a theory they remain as individual results for a particular engine, of a particular size and type, in particular conditions. Without a theory no one can use these results, say, to predetermine the steam consumption of any other engine of a different size, or in other conditions. What they do make clear is that the variation of steam consumption in different cases is exceedingly complex, so complex as sometimes to seem capricious.

Let me protest as strongly as possible, again with the reservation that I am stating my personal view, against the tendency to suppose that the great work of Willans' can be summed up in a so-called Willans' law, or that that law, handy as it may be for practical steam engineers, is more than a quite subordinate part of Willans' work. The Willans' law is nothing more than the empirical descriptive statement that the relation of total steam consumption and indicated or effective horse-power can be very approximately expressed by a linear equation, for the case of an unjacketed engine working with a fixed cut-off. Further, nothing is done in Willans' Papers to fix what is the linear equation for any given engine. So far as those Papers go, and until some kind of theory taking account of initial condensation is discovered, we can only find the relation of steam consumption and horse-power for any given engine by making two accurate trials of the engine itself. Willans' law leaves us in regard to any given engine in the same position as an astronomer with a new comet. When the comet has been observed for a sufficient period and some of its positions fixed, a probable orbit can be calculated. The straight line law leaves the steam consumption of a new engine as unknown as the elliptic law the orbit of a new comet.

Willans' law is being used, I am afraid, by many engineers with little discretion. I find engineers who assure me that they plot tests of automatic expansion engines in straight lines and that they find nothing wrong. But if Willans was right that the relation of steam consumption and horse-power for a throttled engine was linear, then it is demonstrable that the relation for an engine with varying expansion or varying speed must be of a more complex kind. I am driven to conclude that as to steam consumption with varying load engineers are content with rough approximations.

Willans himself says nothing whatever as to any possible rational basis for the Willans' law. He put it forward purely as the result of plotting his experiments. Later, Capt. Sankey showed that the total steam consumption of an engine working adiabatically with fixed ratio of expansion would also follow nearly but not exactly a straight line law if all clearance losses, radiation and exhaust waste and back-pressure loss were neglected. The adiabatic law is inconvenient in forming an equation for the relation of steam consumption and horse-power, and the actual expansion curve of

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an engine is much more nearly an isothermal* than an adiabatic, because the steam receives heat from the cylinder wall. If we assume isothermal expansion (and really so far as the area of the diagram is concerned, it matters little what law of expansion is assumed) it is easy to find a formula for the total steam consumption of an engine working without clearance loss or exhaust waste. I have found such a formula and plotted the results both for a condensing and a non-condensing engine. The lines plotted are not exactly but very nearly straight lines. That carries us a certain way, but it is an enormous jump to assume without examination that the steam wastes in the engine, amounting to from 20 per cent. to 50 per cent. of the steam used and arising from causes of the most complex kind, depending on the volume of the clearance, the action of the cylinder wall, the loss of the toe of the diagram, the waste expansion between the cylinders, and other causes of loss, that this also can be expressed as a simple linear function of the horse-power.

Now in the first edition of his "Treatise on the Steam Engine," which appeared in 1878, Prof. Cotterill had seriously attacked the problem of cylinder condensation from the theoretical side. After Hirn, he was one of the first to recognise that the action of the cylinder wall was a superficial action, and further, what had not before been recognised, that it depends in some way on the admission surface reckoned per pound of steam used. He therefore studied the action of a plate of metal in the cylinder so thin that it would follow exactly the temperature changes of the steam. On comparing the results of this assumption with the data obtained in engine tests it appears that the temperature cycle in the cylinder wall cannot be, except in limiting cases, identical with temperature cycle of the steam, and this introduces a complication. Nevertheless, Prof. Cotterill found it possible to give a partly rational, partly empirical formula for cylinder condensation. The ratio of the water present to steam present at cut-off is

$$Y_1 = C \frac{\log_e r}{d \sqrt{N}},$$

where C is a constant for any given engine, and has only a limited range of values for engines of widely different sizes and proportions. But according to this formula for unjacketed simple engines the initial condensation has a fixed ratio to the steam present at cut-off. In the diagram lines for steam present at cut-off are given calculated in the manner already described. Above these has been set up the condensation by Cotterill's law, and the total steam consumption at various loads is then given by a line very nearly straight and closely agreeing with a Willans line.

But now if Cotterill's formula is trustworthy for determining the condensation in a throttled engine working at various pressures, there is no reason why with the same restrictions as before it should not apply to an automatic expansion engine. Another diagram shows first the curves of steam consumption, calculated by the formula mentioned before, which gives the steam present at cut-off, and above them curves of total steam consumption obtained by adding values of condensation calculated from Prof. Cotterill's formula.

The curves on the two diagrams agree well with Willans' results, and they differ from Willans' lines in being obtained entirely by calculation without experimenting on the engine. It would not be right to make too much of the coincidence, but I thought it would be interesting to show that theory and experiment converge. A good deal has yet to be done, but the discussion in Prof. Cotterill's treatise has done more than anything else to throw light on the conditions which promote or hinder cylinder condensation, and on the means useful in securing economy of working.

I should have liked, had time permitted, to mention another direction of experimental research which promises to be useful.

The purely dynamical actions in the engine like the thermal actions have proved too complex for any purely rational treatment. Here also it is necessary to check the results of theory step by step by reference to experiment. The total friction of engines has been determined by various methods and proves to be more nearly independent of the load than the earlier writers assumed. Hirn converted the beam of his engine into a flexion dynamometer which drew a diagram of the effective work of the engine, and some method of this kind might be revived with much advantage. Prof. Carpenter and Mr. Preston have attempted experiment on the friction of different parts of the engine, with the striking result that the crank-shaft bearings absorb nearly half the frictional work of the engine and the piston about one-fourth. Mr. Ransome has studied experimentally the action of governors, and lastly Prof. Dwelshauvers Dery has attempted a general experimental study of all the dynamical actions which affect the motion of the engine.

Since 1845 purely scientific men, scientific experimenters, and practical engineers have all been engaged in the study of the steam engine. I do not believe that any one of the three can claim all the credit for the improvement of the steam engine to the exclusion of either of the others.

What has been achieved is shown in the following table :—

Lowest Steam Consumption.

—	I.H.P.	Boiler pressure.	Piston speed.	Steam per I.H.P.-hour.
Simple—				
Sulzer	284	87	372	18·4
Corliss	137	62	...	17·5
Compound—				
Dujardin	548	90	570	13·46
Sulzer	247	85	493	13·35
Wheelock	590	160	612	12·84
Leavitt	643	135	371	12·16
Triple -				
Sulzer	615	141	516	11·85
Allis	574	120	203	11·68
Compound superheating—				
Schmidt	76	180	380	10·17

Representing, perhaps, rather the scientific than the practical interest, I do not think that the mathematical and physical researches of which I have tried to give an account have had no influence on the practical business of the engineer.

Of a few only of the more salient points in the history of the steam engine has it been possible in this lecture to give even a brief and imperfect account. The omissions I know are almost innumerable. I can only hope that no fault or omission of mine obscures the lesson that science and practice go hand in hand.

* [Prof. Unwin evidently means here :—*According to the law pv constant, the isothermal for a perfect gas.* The isothermal for steam is *p* constant.—Ed. *E.*]

THE SECOND LAW OF THERMODYNAMICS.*

BY PROF. OLIVER J. LODGE, F.R.S.

The science of thermodynamics is one that has been built up largely by engineers. Its pioneer was James Watt; its founder was Carnot; and of other illustrious names I need only mention Rankine, Clapeyron, Hirn, and James Thomson; while of non-engineers we are not likely to forget the names of Joule, Mayer, Clausius, and Kelvin. It is a very recent branch of science. Fifty years ago it had not been definitely proved that heat was a form of energy; in other words, its first and fundamental law was unknown. At that time a heat engine was thought to act on the same lines as a turbine or an electric motor, receiving heat, water, or electricity at one temperature, level, or potential, and discharging the same quantity at a lower temperature, level, or potential, its work being due solely to the drop in temperature without consumption of heat. Carnot struggled against the fallacy of this idea unsuccessfully (his work lay in the detection of the second law, not the first). Joule finally emancipated us from it, though not without a struggle on the part of the conservative upholders of the older and more simple doctrine.

We take it, then, as now established that heat is one of the forms of energy, and that when work is done by a thermal engine heat disappears, is actually consumed as heat, ceases to be heat, and reappears as some other form of energy. There is a real transformation of heat into work, using the term *work*, as is often popularly, though not quite accurately, done, as short for the longer term "mechanical energy." And heat is energy in a very concentrated form. The energy in a pint of boiling water, if it could be all utilised, amounts to more than half a million foot-pounds, and even if water were quite cold and on the point of freezing, it would still contain energy equal to 350,000 foot-pounds of work, or one-sixth of a horse-power-hour, in every pint. These numbers are only approximate, for lack of data; but, supposing the energy is anything approaching this, how comes it that we can utilise so little of it? How comes it that practically we can utilise none of it?

The second law of thermodynamics, as is well known, tells us the precise fact concerning possible utilisation; it asserts that if a working substance receives heat from a source T degrees above absolute zero of temperature, while the coldest of surrounding objects is t degrees above absolute zero, then the fraction $(T - t)/T$ of the whole heat received can be utilised under the most favourable possible circumstances, and the remainder, viz., t/T of the whole, must remain uselessly in the form of heat. This is a remarkable generalisation, since it is independent of the specific properties of any working substance; it asserts that the maximum possible efficiency of any heat engine whatever is limited by the range of temperature between which it works, being equal in fact to that range of temperature divided by the distance of

* Paper read before the Liverpool Engineering Society.

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absolute zero, on the thermometric scale, below the highest temperature of the range; and it further asserts that this maximum possible efficiency is independent of all other things whatsoever.

But though the second law is scientifically precise and incontrovertible, it is hard at first to realise how and why it can be true that the temperature at which heat exists in bodies so entirely controls its availability or working power. The object of my Paper is to make this matter plain, by showing the heat energy is in this respect similar to all other forms of energy, and that the second law of thermodynamics is, after all, nothing more than enlightened common sense.

I will first adduce certain consequences of the law of efficiency which are frequently overlooked, or at any rate not emphasised so much as they might be, even if they are not occasionally disbelieved. (1) Since the higher the temperature of supply, and the lower the temperature of refrigeration, the higher is the attainable efficiency, it follows that all the heat should be supplied at the highest available temperature, whatever that may be, and the waste heat be withdrawn at the lowest available temperature. The highest temperature commonly available is that of a furnace, hence the heat should be supplied to the working substance in the cylinder at furnace temperature. This condition is roughly satisfied in internal combustion engines, though they have at present many other defects which almost compensate this great advantage, but in the steam engine it is not even attempted. Heat is supplied to the cylinder (by convection), from the boiler, and when discussing efficiency the boiler is treated as if that were the highest temperature available. The range of temperature practically attended to is the range between boiler and condenser, a range of some hundred or two degrees, while the immense drop of some thousand degrees between furnace and boiler is wholly ignored.

In contemplating boiler efficiency it is considered satisfactory if all the heat generated in the furnace is received by the boiler, and if the amount which goes up the chimney is only enough to maintain a draught. But this is ignoring two vital considerations: (1) that energy may be lost otherwise than as heat, (2) that the availability of heat energy depends upon temperature. The first of these considerations, indeed, is frequently attended to, and it will be readily admitted that it is not enough to utilise all the heat produced by the burning fuel, it is also necessary to ensure that all the fuel shall be burnt. Many furnaces and stoves are competent to distil their fuel up the chimney in an unburnt or partially burnt state, acting, in fact, like gas retorts. Deficiency of air and plentiful admixture with carbonic acid are the two prime causes of this waste—waste of fuel and of energy, though not of heat. The waste may occur although no *heat* passes up the chimney unutilised; the energy which escapes may be the chemical energy of unburnt gases not yet converted into heat. But it may be said that this is an obvious point, always attended to in firebox construction and in stoking. If so, very good; but there is another.

The heat is generated in the furnace at a high temperature, say 2,000deg. above absolute zero, or 1,500°F.; it is then communicated to the boiler at a much lower temperature, say 800deg. above absolute zero, or 300°F. What is the outcome of this 1,200deg. drop? All the heat may be economised, let us grant; we will suppose the furnace and flues and air inlets so constructed and arranged that all the fuel is thoroughly burnt, and that all the heat enters the boiler, the draught being maintained mechanically or in some other way, nothing but thoroughly burnt cool gases passing up the chimney; still there is a tremendous loss; $\frac{12}{20}$ths, or 60 per cent. of the whole *available* energy, is thrown away in the mere act of conduction through the walls and tubes of the firebox, and only $\frac{8}{20}$ths is transmitted to the working substance. With this saved 40 per cent. the engine now has to deal, and if it is a perfect engine, with its condenser at, say, 600deg. above absolute zero (110°F.), it can utilise one-quarter of it. That is to say, one-tenth of the energy developed by the combustion of the fuel is all that an absolutely perfect steam engine and boiler, working with boiler at 310°F. and condenser at 110°F., is able to develop in the form of gross or indicated work. Whereas, the theoretically possible proportion of heat energy, developed at 1,500°F. and utilised at 110°F., is 70 per cent. of the whole.

The higher the temperature at which heat can be imparted to a working substance, the greater the portion of that heat which is available for useful purposes.

It has been pointed out by Lord Kelvin, though at first it may sound a rather surprising fact, that even when the object to be gained is mere heat, when, for instance, the object is to warm a building, the lighting of a fire and direct supply of heat at a high temperature by combustion is not the most economical way. The heat needed to warm a building is low-temperature heat. The heat produced by a furnace is high-temperature heat. Hence even though every trace of heat is collected and applied to warming the building, the process is not economical, simply because it ignores and wastes the great drop of temperature which might have been utilised. It must always be freely admitted that economy is only one of many considerations, and that the directness and simplicity of obtaining by combustion the heat which is to be directly applied to warm a building may be sufficient to counterbalance all considerations of wastefulness. It is not practicable or wise always to push considerations of economy into practice; but that does not affect the principle, and if a principle is ignored it should be ignored knowingly, with full appreciation of what is being done, else sometimes it may happen that some old-fashioned process is continued through mere blind habit, when circumstances have so altered that a change is both permissible and desirable. In the present instance it is unlikely that the indication of theory need be put into practice at present or for some time to come; economy of fuel is not at present considered a vital matter—witness the ordinary open fire-place for warming and ventilating rooms—but, nevertheless, it may be perceived and admitted that by suitable mechanism more warmth could be imparted to a building by means of a furnace than ever was produced in that furnace.

In other words, a small quantity of heat at a high temperature may be so directed and utilised as to cause the supply of a much larger quantity of heat at a low temperature.

Suppose, for instance, it is required to warm a building by the combustion of gas. Let the gas be burned in a gas engine, and let the gas engine drive a reversed engine, a freezing machine, so as to receive heat from surrounding bodies, and deliver it up where required, raised 10deg. or 20deg. or 30deg. in temperature. If the arrangements were perfect an immense quantity of heat could be obtained from surrounding objects, raised the requisite few degrees and supplied to the building, by means of the small quantity developed in the gas engine by combustion at high temperature. One may illustrate the matter by an analogy. Suppose a reservoir a few feet above a lake were wanted to be filled with water, and suppose that on a neighbouring hill top a small supply of water could be had with a head of some hundreds of feet; it would be wasteful to try to fill the reservoir with the high-pressure water, even if there were enough of it. The right plan would be to utilise the high-pressure water to work a turbine and pumps, whereby the low-level water could be elevated the necessary few feet and supplied to the reservoir. If arrangements were perfect, the fall of a ton of water down 500ft. should elevate something less than 50 tons of water a height of 10ft.; so that the high-level water might be the means of indirectly filling a reservoir fifty times bigger than it could fill directly. I have spent some needless time over this illustration, because the moral is closely applicable to the case of heat. The difference between energy and available energy is a nice point, seldom fully appreciated; plenty of energy is useless, as useless for all working purposes as if it were non-existent.

As an example, we may take the case of compressed air. A pound and a quarter of atmospheric air occupies 100 gallons (or 16 cubic ft.), and if compressed to 20 atmospheres, say, by 680ft. head of water, or 300lb. to the square inch, it can be squeezed into 5 gallons by an expenditure of 48 foot-tons of work. But in the compressed state it has in itself no more thermal energy than it had in its expanded state, except in so far as it is heated by the compression, which heat will soon disappear on standing. At the same temperature the thermal energy of a given weight of air is constant—no matter what its pressure may be; in other words, if allowed to expand infinitely without receiving heat, it can do the same amount of work at whatever pressure it starts, provided it starts always at the same temperature. But though this is true for total intrinsic energy it is manifestly false for available energy. The available energy of the air under compression is considerable; while of the free air the available energy is none at all. And the reason is, that we have no practically available method of allowing infinite expansion—that is, expansion into a vacuum, except by expensively producing a vacuum beforehand. If we lived on the moon we might do it, but here we are submerged in a high-pressure atmosphere (a ton to the square foot) and nothing can expand automatically to a less pressure than that. Every cubic foot of ordinary air contains 2½ foot-tons of unavailable mechanical energy. Hence the work to be obtained from the compressed air must be got while it expands from its 300lb. pressure to 15lb. pressure (using round numbers), *i.e.*, while its pressure is falling in the ratio of 1:20. This can take place either slowly or else in two stages; if in two stages the volume might first change from 5 gallons to 42 5 gallons, during which the temperature falls 300°F., and work is done equal to 21 foot-tons; while in the second stage the air will warm itself up to its original temperature, doing nine foot-tons more work. Or the whole expansion may take place slowly at constant temperature; in which case 48 foot-tons of work can be got, the same as was needed for slow compression. But this energy is not really obtained from the air; it is extracted from surrounding objects by the expanding air. The energy of the air continues constant and unavailable so long as its temperature is not raised; all the work done in slowly compressing it went to warm surrounding objects, and when the air slowly expands this amount of energy is recovered. The compressed air constitutes a sort of machine for extracting this otherwise waste energy. Thus whereas both the high-pressure and

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low-pressure air contain in themselves 40 foot-tons of unavailable energy, the high-pressure enables you to extract and utilise 48 foot-tons of otherwise useless heat energy under the most favourable conditions (or under the worst conditions it will part temporarily with 21 foot-tons of its own energy and then enable you to extract 9 more foot-tons, making 30 altogether obtainable under the worst conditions of expansion), whereas with the low-pressure air none of its energy at all is available.

The essence of all this is true of heat. A small body at a high temperature and a large body at a low temperature may contain equal quantities of heat, but the available portion of that heat will be quite different. Because in the one case there are other accessible bodies at a much lower temperature, in the other case all bodies are at the same temperature and no transfer is possible. High temperature heat is efficient because the other bodies into which it can flow are at so much lower a temperature—there is thus great activity of transfer. An analogy of a commercial kind could also be worked out. The purchasing power of a sovereign depends greatly on the need of sovereigns on the part of the person to whom it is going to be transferred. A lot of work can be got out of the transfer of a sovereign if it be transferred to a man whose need for it is very great. Thus we see that, whereas a small body at a high temperature above surrounding objects may contain as much heat or total energy as a large body at a low temperature, the heat will be available for use in one case and not available in the other. Whenever temperature drops, by reason of increased capacity of the body possessing it, the availability of its heat diminishes. And the reason is the same as in the case of the compressed air allowed to expand from a small vessel into one of large capacity—the practically available range of pressure or temperature has diminished.

The whole matter may be summarised thus. Energy is only useful when transferred, it is during transferences of energy that work is done, hence any condition that prevents or lessens the transferability of energy prevents or lessens the performance of work by means of it, *i.e.*, makes it more or less useless.

The mechanical energy of air at ordinary pressure is useless, because there is no way of letting it expand and transfer its energy to other bodies—say to a piston. The thermal energy of matter at average temperature is useless, because there is no way of passing it on, there is nothing to make the heat flow into other bodies. Whenever heat will transfer *itself*, as it will if bodies exist at different temperatures, then some work can be got out of the transfer; and the more transferable the heat—that is, the greater the difference of temperature—the more work can be got. *The transferable portion of heat is to the whole heat as the available difference of temperature is to the whole temperature above absolute zero. Hence the efficiency of transfer, which means the ratio of the transferable to the total heat, is equal to the ratio of the available difference of temperature to the maximum absolute temperature.* And this is the second law of thermodynamics.

The following pressure-volume diagram illustrates the second law of thermodynamics in the simplest possible way, if the two curved lines are any pair of adiabatics, corresponding to the range of entropy through which it is convenient to take the working substance, and if the two crossing lines are isothermals as labelled. The areas then represent the proportion which the useful energy bears to the whole; and show clearly why a Carnot cycle between the highest and lowest available temperatures is the best possible cycle for economy.

I would especially call attention to Fig. 1, as summarising compactly all the chief general doctrines about heat engines. Though, to complete it, it should be understood that a set of isothermals crossing the adiabatics constitute the rungs of a temperature ladder, the steps corresponding to equal degrees if the areas partitioned off are equal, and the bottom rung corresponding to absolute zero.

To sum up this portion of our subject:—A working substance above average pressure has some available mechanical energy. A working substance below average temperature has some available thermal energy. But a working substance at average pressure and temperature is in equilibrium with surrounding bodies, and whatever energy it possesses is then useless.

By the use of a refrigerator and an air pump it may be possible to allow expansion into a vacuum, and in that case to get much more energy of a substance used; in fact, with a perfect air pump the *whole* of the energy of a body could be utilised, because expansion could go on indefinitely; but then the work done in maintaining the vacuum must be taken into account, and it very soon attains an amount as great as, or greater than, what could be gained. This is sometimes apparently forgotten in engine trials. Allowance is not always made for the work required in pumping. That a gas engine has to do pumping, and that its cycle is, therefore, a double one, everybody knows. But that a steam-engine cycle is also essentially a double one is often ignored. Yet it is true. There is both the air pump and the feed pump to be subtracted. It may be that these are worked by separate engines, but that does not prevent the need for subtracting the work of these auxiliary engines from the output of the main engine, in reckoning its actual efficiency. It would otherwise be possible to propel the main engine solely by aid of the auxiliary engine working its air pump, and thus its efficiency might be made obviously artificial and absurd. The working substance must always be taken round a complete cycle, and its consideration must not be abandoned till its cycle is complete, else the engine is not a heat engine alone, but is consuming substance as well, like a voltaic battery or a horse or a gunpowder engine. These chemical machines may have far higher efficiency than steam engines; they are not controlled by considerations of temperature. The cycle of a steam engine is a double one; the working substance must be put back into the boiler before the series of operations is complete.

I have now displayed the reason why a heat engine is so entirely controlled by considerations of temperature, and why the maximum efficiency is $T-t/T$, where T is the highest and t the lowest temperature available. It is because (1) temperature determines transfer of heat, and heat will only flow "downhill"; (2) because every kind of energy is only useful for working purposes when automatically transferred.

Observe that in the fact that it will only flow "downhill" as regards temperature, *i.e.*, from hot to cold, conduction of heat differs from other processes which are in many respects analogous.

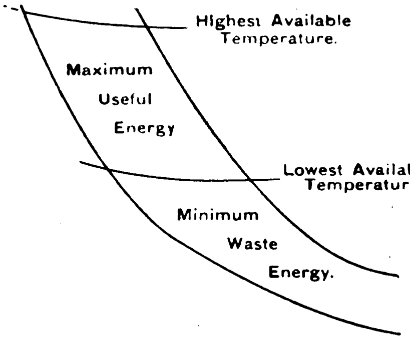

FIG. .

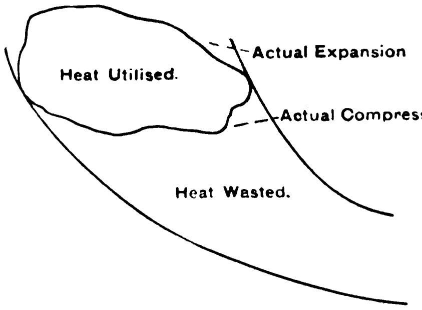

FIG. 2.

Thus, although water will not flow uphill *continually*, unless it is pumped, yet for a time it will flow uphill with perfect ease. It happens for nearly three hours in a tidal channel, when the momentum of the incoming water carries it up into regions of greater elevation, against opposing forces; which ultimately, however, drive it back again. An air stream, again, may flow from a low-pressure reservoir into a high-pressure reservoir for a short time, if it is started with sufficient impetus or momentum. So also a current of electricity can rush from feebly-charged into a highly-charged body, or from a conductor at negative potential into one of positive potential, by reason of what is called its electromagnetic momentum. It is this capacity for travelling against opposing forces which constitutes the property of *inertia*, and which causes all manner of oscillation. In fact, the simplest of all such cases is the bob of a pendulum, which at every alternate quarter-swing travels up against the force of gravity, until stopped and brought backed by the opposing force. But none of this is possible with heat. Heat cannot flow, even momentarily, from cold to hot. It has nothing corresponding to inertia or momentum. It flows only and solely when urged forward by a higher temperature behind it and a lower temperature in front of it. This is true even for radiation, in a sense, and no burning-glass focus can be hotter than the sun.

It remains to ask *why* heat is only thus transferable; whether it is a definite and unalterable fact, or whether it depends on our present ignorance, that heat can never be got to transfer itself automatically between two bodies at the same temperature. We know that heat is molecular energy, and some forms of molecular energy have no connection with temperature, and can be utilised

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readily enough, although quite cold. As instance, I adduce winds and currents. But in such cases the available motion of the molecules is all in one direction—it has a certain regularity about it—it may be directed and controlled. The molecular motion which constitutes *heat* is not like that—it is perfectly random and irregular—our only way of utilising it is by the bombardment or pressure which the molecules exert upon a surface which they hit by chance in the course of their irregular and uncontrollable motions. Osborne Reynolds puts the matter thus: Here is a chain attached to a weight, and the problem is to raise the weight by means of the chain. Simple enough if we know how to give the chain a vertical pull, but, in the case of air or steam or other working substance beneath a piston, that is just what we cannot do. We cannot make the molecules all move upwards and raise the piston, we can only agitate and knock them about irregularly—a process which we call "heating" the gas. The analogue of the process is shaking the chain. Suppose we can only shake the top of the chain irregularly, waves and disturbances will travel down it, it will get into irregular form, and the weight at the lower end will rise. Our object has been accomplished, but in a wasteful and indirect sort of manner. Precisely so is it when we attempt to utilise the irregular molecular agitation which we call heat. Having raised one weight by shaking the chain, another weight can be raised, and so work can be done perpetually, *provided* that we detach the first weight at its higher level and then let the motion die out of the chain; that is, provided we cool the working substance back to its original condition and so complete the cycle. The only difference between the initial and final conditions lies not in the working substance but in the raised weight, *i.e.*, in the external work done. The substance has been brought back to its old condition but an area has been surrounded on its indicator-diagram.

The necessity for alternately heating and cooling the working substance, simply because it cannot constantly expand for ever, is of somewhat the same nature as the necessity for brushes or sliding contacts in a dynamo, whereby the current which was excited in each segment is periodically stopped and reversed. The area of a circuit cannot increase constantly for ever, without this device.

It will be observed then that the second law of thermodynamics relates to the utilisation of heat energy *as heat*, *i.e.*, as perfectly irregular and uncontrollable molecular motion. If by any means molecular motion could be taken under control it would cease to be heat—the second law of thermodynamics would not apply to it—and a much greater proportion of its energy might be available; availability would, in fact, then not depend upon temperature, which is a term appropriate to the consideration of heat as heat; "temperature" would cease to be a serviceable term if we were dealing with visible and controllable molecular motion. It is, however, conceivably possible some day to regard this motion otherwise than as heat. We have not learnt how thus to deal with it yet, but we already know many ways of dealing with special varieties of molecular energy otherwise than as heat. For instance, the chemical molecular energy employed in the voltaic battery, is much more controllable than if it were first converted into heat. Again, the leaves of trees do not turn solar rays into heat, but they utilise the solar energy direct, in order to elaborate their sap. Animals again do not turn their food energy into heat, but they utilise it direct. They are not heat engines. If they were, they would be miserably inefficient, because of their low temperature; but they are not, they are chemical engines, analogous to the voltaic battery, and are marvellously efficient; so much so that the attempt is sometimes made to turn them into perpetual motion machines, by beating more work out of them than corresponds to the combustion energy of the hay which is put in. There is some heat produced during muscular action, as a waste product, it is true, but it is only a small fraction of the whole energy utilised.* So hereafter it may come to be possible to use even the random energy of heat in a direct manner, simply by directing and controlling the molecules so that their motion is no longer perfectly irregular, so that in fact it ceases to be mere heat and becomes a higher form of energy, transferable on lines other than those controlled by temperature. Already it is suspected that certain bacteria and microscopic forms of life have the power to do this; and, if so, for them the second law of thermodynamics does not exist. It is indeed no ultimate and final law. It will always be true of heat engines working by means of expansion, but it will not be universally true when any portion of heat can be intelligently treated as definite molecular energy.

Practical Outcome.

Since the two laws of thermodynamics assert (1) that when work is done by a working substance in a heat engine a portion of its heat is consumed and utilised, and (2) that the portion thus utilised is immediately dependent on the temperature of the working substance; it follows that a substance suitable for use in a heat engine must have two qualities. (1) It must have a great capacity for heat, so as to store and carry with it a great quantity of energy. (2) It must be able to stand a high temperature.

Air and permanent gases satisfy the second condition admirably, but not the first. There is no limit to the temperature to which they may be raised, but their capacity for heat is small. In order, therefore, to get very much work out of a hot-air engine it must be unwieldy in size, or else it must be worked at a bursting pressure such as is suitable in cannon. You cannot get more energy out of your cylinder than the working substance conveys in, and it takes a great deal of hot air to convey much energy.

Saturated vapour has a far more concentrated capacity. When a liquid passes into the vaporous state, an immense quantity of heat is stowed away, even without considering a rise of temperature; in the case of water boiling as much heat as would raise the water about 900 degrees, as much as would raise an equal weight of air 3,600 degrees, is stowed away in the steam without making it any hotter. This is the most valuable property of steam, that it is able to contain such an immense quantity of energy in a small mass of material. Hence, as Fitzgerald has pointed out, steam engines can be moderate in size and yet powerful.

But the defect of steam is that its boiling point is so low, it will not stand a high temperature without an altogether exorbitant and impracticable pressure. What is wanted is a substance that shall be equally or more expansible, but which can be made much hotter while its pressure is still within moderate bounds. Substances with higher boiling points naturally suggest themselves;* mercury, say, or perhaps other moderately fusible metals. A substance which boils at a red heat is the kind of thing wanted, but then metals mostly have a rather low latent heat of vaporisation, and that is against them; they would not have a very great heat capacity. Still, a substance might be found that could stand a suitable temperature when at high-pressure boiling; and if, when its vapour was condensed at low pressure, its heat were not exhausted, the condensed but still hot substance might be used to boil another liquid, say, water or ether or SO_2 or something with lower boiling point, which ultimately would condense a very low temperature.

The suggestion of a number of engines in series, the hottest a combustion engine, and the coldest a vapour engine, is no new one, it was made by Carnot. Of course, it may happen that the same substance in different states might serve; for instance, steam itself need not be used in a saturated state, it may be superheated without limit, even till it is dissociated, and used so, being only finally employed in its ordinary saturated condition. But then the other objection arises, that in this gaseous state it has so small a heat capacity; most of the heat was passed into it when it boiled and became vapour, and that was at a comparatively low temperature; the amount of energy it can receive during superheating is not very great. The advantage of superheating steam in practice is immense, and the reason of the gain is perfectly known, but it is not much owing to the extra energy thereby imparted; it is due to the fact that condensation during expansive working can thereby be prevented. Saturated steam is an unfortunate substance in this respect, it cannot expand adiabatically without condensing; hence during the expansive part of the stroke the cylinder gets partly full of water. Substances are known which have not this defect: Chloroform vapour is one such substance. It behaves oppositely to steam, it condenses when compressed and dries when allowed to expand,† hence chloroform vapour would in that one respect be better than steam. But the high latent heat of steam is an advantage not to be readily replaced, and it is probably best to use steam, but to counteract the tendency to condensation by excessive and continual superheating. Only I would jacket everything—the cylinder and the connecting pipes and the reservoir—not with steam but with furnace heat—with the waste gases of the furnace—so as to superheat strongly and economically. At every passage from one cylinder to another there should be jacketing—even the low-pressure cylinder should be jacketed too. No condensation is wanted or should be permitted till the actual condenser is reached.

But no minor improvements will overcome the one radical defect of every mere steam engine, that the high temperature of the furnace is ignored and unutilised; the great drop of temperature between furnace and boiler is thrown away. Of course it is used for transmitting the heat quickly through the walls of the firebox, but one reason why this transmission of heat is so difficult is because those walls are so cool. They interfere with combustion, and accordingly flame cannot come into contact with them. The heating of a boiler is done mainly by radiation through a thin stagnant gaseous film intervening between flame and boiler tube. And gases are shocking bad radiators—smoke is better—and this is the reason why bad stoking and smoky chimneys sometimes unfor-

* Since this Paper was read, a great physiologist, Prof. Engelmann, of Utrecht, in his Croonian lecture before the Royal Society (March, 1895), maintains the opposite doctrine; being of opinion that heat in muscles is *not* a waste product but is the efficient cause of their contraction. I adhere distinctly at present, to the view expressed in the text: but I state the opposition, that no student may be misled into considering it as finally accepted truth.

* *See* a letter by Lord Rayleigh in *Nature* 1893 or 1894.

† This was predicted theoretically by Clausius.

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tunately answer better than complete and clean combustion. If the boiler could be heated by direct flame contact this condition of things would be entirely altered. And the only way to permit flame to come into contact with the boiler surfaces is to permit them to be red or white hot—hot enough not to interfere with combustion. At present they interfere with it in the same way as do meshes of a safety lamp. Everything, therefore, points to the advantage of a high-temperature working substance; with such a substance no excessive gradient of temperature would be needed, heat could flow into it from the furnace easily. Either this plan, or some form of internal combustion engine where no conduction of heat is needed, seems to be the direction in which theory points.

The ingenuity of engineers has been successfully applied to the minor economies of the steam engine, so that from boiler to condenser and back again it is a beautiful machine, within the limits imposed by the laws of nature. Thermodynamics, however, points to the possibility of an economy, not of some 5 or 6 per cent., which is almost all the present difference between the best steam engine and the worst, but to a revolutionary change of 50 or 60 per cent., no drop of temperature from furnace to every-day temperature being permitted without delivering up its due equivalent of motive power.

THIRD REPORT OF THE ROYAL COMMISSION ON ELECTRICAL COMMUNICATION WITH LIGHT-HOUSES AND LIGHT-VESSELS.

[Abstract.]

In our first report,* made in December, 1892, we recommended that electrical communication should be established with five light-vessels, one pile lighthouse, 19 shore lighthouses, and four lighthouses on islands or isolated rocks. When, in March, 1894, we issued our second report,† sufficient progress had not, in our opinion, been made to justify us in adding to the list, and we confined our recommendations to the connection of further shore lighthouses, with 19 more of which we urged that electrical communication should be established. Effect has now been given to all the recommendations made in the two reports which we have already issued, except in the case of the "Scarweather" lightship and Caldy and Fastnet lighthouses, and we assume that the connection of these stations will shortly be taken in hand. We therefore submit a further list of stations which we recommend should be connected with the telegraphic system of the United Kingdom as soon as possible.

Before we deal with this list we desire to make a few observations on the subject of the connections which have already been effected, and more especially on the connections with the lightships.

Methods of Electrical Communication with Light-Vessels.

The system which has been adopted in establishing electrical communication with the four light-vessels which are at present connected with the mainland is, with certain modifications, that known as the "Sunk" system, under which communication was maintained with the "Sunk" lightship from November 12, 1886, to January 1, 1889, with only two interruptions. The ship is moored by two or more chain cables attached to mushroom anchors and shackled the lower part of a patent swivel, to the upper end of which are shackled to the vessel's two bridle chains. The electric cable on its way from the shore passes through the centre of the swivel and, entering the bow of the ship between the knightheads, is coiled on a drum fitted to a revolving frame placed between decks, by means of which turns made in the cable when the lightship swings round with the change of tide can be taken out. This system permits of the free use of the telephone, which in our opinion is an important advantage. Since we issued our second report we have considered some further inventions for establishing electrical communication with light-vessels, but we still consider that the "Sunk" is the best system of continuous connection which has yet been brought to our notice. At the same time we think it is desirable that a trial should be given to a system of communication by induction, in order that we may be able to judge, before we issue our final report, whether such a system can be used under conditions (*e.g.*, in deep water and over a rough bottom) which render the establishment of electrical communication with light-vessels by means of the "Sunk" system a matter of very great difficulty.

Working of the Cables.

Electrical communication was established with the "Kentish Knock" light-vessel on March 14, 1894, and between that date and December 31, 1894, communication was interrupted on four occasions. Two, at least, of these interruptions appear to have been caused by want of experience on board in the management of the electric cable, and we anticipate that interruptions arising from this cause will tend to become fewer as time goes on. The "Goodwin" (North Sand Head) light-vessel was connected with the mainland on March 24, 1894, and between that date and December 31, 1894, communication was interrupted on two occasions. We visited this vessel on August 4th last, and it was then apparent to us that the veering (electric) cable would not much longer stand the wear caused by the strong tidal action. The strength of the tide at this place is sufficient to sweep the bottom clean, and consequently the veering (electric) cable is constantly being threshed upon the hard bed of the sea. The anticipations which we formed on the occasion of our visit to the lightship were realised on August 26th, when the veering (electric) cable had to be taken up for renewal. Communication was restored the same day. Communication was interrupted for the second time on September 3rd, and was restored on September 15th. The second interruption was caused by one of the vessel's mooring chains giving way, and cannot, therefore, be attributed to any defect in the system of electrical communication which has been adopted. The "Hasborough" light-vessel was connected on October 2, 1894, and the "Shipwash" light-vessel on November 17, 1894. No interruption in the communication established with these vessels had occurred up to December 31, 1894, although some defects had from time to time become apparent.

The record of the interruptions in the connections with the "Kentish Knock" and "Goodwin" light-vessels does not, it will be observed, compare favourably with that of the interruptions in the communication established with the "Sunk" light-vessel during the period from November, 1886, to January, 1889, to which reference has been made, but we consider that an explanation of this can be found in the fact that by November, 1886, the crew of the "Sunk" had acquired considerable experience in the management of the electric gear, as their ship was first connected in December, 1884. This experience was only obtained after several interruptions had occurred in the working of the electric cable, and we find that the number of occasions upon which communication with the "Sunk" was interrupted during the first nine months is greater than in the cases of the "Kentish Knock" and "Goodwin" lightships during the like period. We anticipate, therefore, as we have previously mentioned, that as the crews of the light-vessels become more experienced in the management of the electric cables, and the other apparatus by which the connections are effected, the interruptions will tend to become fewer.

No difficulty has arisen in regard to the connection with the Gunfleet pile lighthouse, which was effected on October 2, 1893, or to the connection with the Tuskar lighthouse, which was completed on September 10, 1894. As regards the cable to the Lundy lighthouse, the extension to which dates from July 18, 1893, a new shore end had to be inserted in September 1894, the original cable having become chafed at the part where it was landed on the island.

Use Made of the Connections.

We have obtained from the general lighthouse authorities returns showing the occasions upon which use, for the purpose of giving information regarding vessels in distress, has been made of the electrical communication now established on our recommendation with light vessels and lighthouses round the coasts of the United Kingdom.

From these returns (contained in an Appendix to the Report) it is found that, up to the close of the year 1894, use, for the purpose stated, had been made of the electrical communication with the "Kentish Knock" light-vessel (connected March 14, 1894) on six occasions; "Goodwin" (North Sand Head light-vessel, connected March 24, 1894) on nine occasions; "Hasborough" light-vessel (connected October 2, 1894) on two occasions; "Shipwash" light-vessel (connected November 17, 1894) on one occasion; and Gunfleet pile lighthouse (connected October 2, 1893) on 19 occasions. No use for life-saving purposes had been made of the cables to the Lundy lighthouse (connected July 18, 1893) and the Tuskar lighthouse (connected September 10, 1894).

As regards shore lighthouses, use had been made of the electrical communication for such purposes with the Start Point on four occasions, Needles, three; South Stack, two; Nash, two; Bull Point, one; Point of Ayre, one; Douglas Head, one; and Hook Point, one.

For many years past there has been in use on board light-vessels a system of signalling to the shore and to passing ships whenever any vessel has been seen to be standing into danger or to be in want of assistance, and this system is being, and will be, continued by the lighthouse authorities concurrently with the new system of electrical communication.

We are satisfied that the telephonic connections which have been established with lighthouses and light-vessels have added in a very important degree to the effectiveness of the machinery which exists on our coasts for the purpose of rendering aid to vessels in distress and of saving their crews from the perils of the sea, and we consider that a perusal of the extracts from the logs of the "Kentish Knock" and "Goodwin" lightships and the Gunfleet lighthouse, which are given in Appendix A, will show very forcibly the advantage which electrical communication possesses over communication by ordinary signals in affording full details regarding endangered ships. It enables the lighthouse keepers and the crews of the light-vessels to give, in all weathers, precise particulars, not only of the position of ships in distress, but also of the nature and amount of assistance required to save them or their crews, and to prevent a lifeboat being sent out when only a tug or the rocket apparatus can be of any use, while, in the absence of such communication, details of this nature can only be given by means of visual and sound signals, which do not afford such exact information, and which are distinguishable even under favourable circumstances at a very limited distance.

From the records contained in Appendix A it will be seen that the Kentish Knock" and "Hasborough" light-vessels and the Start lighthouse had occasion to summon tugs, while the Nash lighthouses were enabled to send for the rocket apparatus, by means of which three lives were saved.

Recommendations.

I. We recommend that the "Formby" light-vessel be connected with the mainland as soon as possible by the system known as the "Sunk" system, which we have already explained. The "Formby" light-vessel is the middle one of the three lightships in Liverpool Bay which mark the Queen's Channel, the main entrance to the Mersey, and commands a good view over the places where a large number of casualties occur, viz., the

* See *The Electrician*, Vol. XXX., p. 396, February 3, 1893.
† See *The Electrician*, Vol. XXXII., p. 728, April 27, 1894.

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west points of Taylor's Bank and Burbo Bank. The loss of life in the neighbourhood of the "Formby" lightship during the past few years has been heavy. The light-vessel lies in six fathoms of water over a bottom of sand and mud, and it is anticipated that the connection will not be a difficult one to effect and maintain. She is 3½ (nautical) miles distant from the land at Formby Point.

II. We recommend that the Maplin pile lighthouse be connected with the mainland. This lighthouse is situated on the outer edge of the Maplin sand, which runs for several miles along the coast of Essex from Shoeburyness northwards. It is distant from the nearest coast about five miles, &c. It is 15 (nautical) miles south-west of the Gunfleet pile lighthouse, which is already connected, and these two lighthouses command a good view of most of the inner shoals to the north of the entrance to the Thames, upon which a very considerable number of casualties to vessels have occurred during recent years. The bottom between the lighthouse and the shore being of sand and mud is favourable for a cable.

III. We recommend that the Smalls lighthouse be connected with the mainland by means of a continuous cable. The Smalls lighthouse stands on a rock 15 (nautical) miles west of the coast of Wales. It guards the Hats and Barrels Rocks, past which strong tidal currents run, and commands a view over the south-east entrance to St. George's Channel, the south-west entrance to which is commanded by the Tuskar lighthouse, which has already been connected. There is a large passing trade, and casualties to vessels involving loss of life have occurred near the lighthouse of late years.

The desirability of connecting the Eddystone lighthouse with the mainland has been strongly urged on commercial and other grounds, and the recommendation to this effect of the Court of Inquiry into the stranding of the "Dunottar Castle" in August last has been brought to our notice. The Eddystone occupies a very important position as a guiding mark for ships navigating the English Channel, but there are no outlying shoals or rocks beyond a distance of 400 yards from the lighthouse, and only two strandings on these rocks, including that of the "Dunottar Castle," have been reported during the last 12 years, no lives being lost in either case. In the case of the "Dunottar Castle," under different conditions of tide and weather, there might have been heavy loss of life which electrical communication with the shore might have averted, but the chances of casulties occurring on the Eddystone being small the terms of the Royal warrant by which we were appointed appear to preclude our recommending its connection, the cost of which is estimated at about £2,600.

Since the issue of our last report the telegraph cable between Tory Island and the coast of Donegal has been taken over from the Committee of Lloyds by the Government.

IV. We recommend that electrical communication by means of aerial wires be established without delay with the following shore lighthosues, viz., Little Ross, Bidston, and Llanddwyn.

We consider that the value of the warning conveyed to passing vessels by the display of storm signals on the occasion of the approach of heavy gales can scarcely be over-estimated, and we recommend that the lighthouses on the most prominent points of the coasts of the United Kingdom, with which electrical communication exists, should be made storm-warning stations. [Twenty-five lighthouses selected.]

Schedule of Recommendations.

1. Electrical communication to be established with the following light stations :—

(*a.*) **Light-Vessel**—

Name.	To be connected by telephone with	Cost of cable and laying.	Cost of land line.	Total cost.
Formby...	Crosby Lighthouse	£1,675	£55	£1,730

(*b.*) **Pile Lighthouse**—

Name.	To be connected by telephone with	Cost of cable and laying.	Cost of land line.	Total cost.
Maplin ...	Southend P. O.	1,505	470	1,975

(*c.*) **Rock Lighthouse**—

Name.	To be connected by telephone with	Cost of cable and laying.	Cost of land line.	Total cost.
Smalls....	Littlehaven C. G. S. ...	4,380	40	4,420 *
	Littlehaven C. G. S. to Pembroke Dock	—	180	180
			Total	£4,600

(*d.*) **Shore Lighthouses**—

Name.	To be connected by telephone with	Estimated cost (approximate).	Remarks.
Little Ross...	Borgue, P. O............	£200	The connection of this lighthouse has already been effected.
Bidston	New Brighton Ferry Stage	80	
Llanddwyn...	Newborough P. O. ...	—	
Total.......................		£280	

The total approximate cost of giving effect to the above recommendations is therefore £8,585.

The estimated annual cost (approximate) of providing for the display of storm-warning signals at the 25 lighthouses is £25.

Concluding Remarks.—Our tours of inspection during last summer were confined to a visit to the "Goodwin" (North Sand Head) lightship, and to the lighthouses and light-vessels near Liverpool. From Liverpool we proceeded along the north coast of Wales, and inspected the Great Ormes Head, Lynus, and Skerries lighthouses. It has been represented to us that we should visit Denmark, and inspect the system of electrical communication with island lighthouses, and between shore lighthouses, signal stations, and life-saving stations, which exists in that country. We regard it as highly desirable that before we conclude our inquiry we should investigate the system existing in a country where electrical communication with lighthouses has been established for some years, in order that we may be able to take advantage of any arrangements which experience may have suggested, and as Denmark seems to us to be the country in which we are likely to learn most, and the permission of the Danish Government has been granted, we propose to proceed thither during the ensuing summer and inquire into the working of the system in that country. We shall then, we trust, be in a position to prepare the way for our final report. (Signed) Mount-Edgcumbe (Chairman), Henry Lyle Mulholland, Edward Birkbeck, F. L. M'Clintock, G. S. Nares, J. C. Lamb, W. H. Preece, John A. Kempe, R. Munro-Ferguson, Ernest G. Moggridge (Secretary). Dated April 26, 1895.

* This estimate provides for looping in Littlehaven C. G. S. on the Pembroke Dock—St. Ann's Head Admiralty circuit.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, May 17th.

Institution of Electrical Engineers.

8 p.m. Students' Meeting in the Library of the Institution, 28, Victoria-street, S.W. Paper to be read: "Aluminium," by Gerald C. Allingham.

TUESDAY, May 21st.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting in the temporary offices, 9, Great George-street.

WEDNESDAY, May 22nd.

Society of Arts.

8 p.m. Ordinary Meeting. The following Paper will be read: "The Dressing and Metallurgical Treatment of Nickel Ores," by A. G. Charleton.

THURSDAY, May 23rd.

London Chamber of Commerce.

2:30 p.m. Special Meeting in the Hall of the Carpenters' Company, London Wall, when Mr. W. H. Preece, F.R.S., will deliver an Address on "Telegraphy by Induction."

Royal Institution.

3 p.m. Afternoon Lecture. "The Instruments and Methods of Spectroscopic Astronomy," by William Huggins, F.R.S.

Institution of Electrical Engineers.

8 p.m. Meeting at the Society of Arts, John-street, Adelphi. Continuation of Discussion of Mr. Mark S. Robinson's Paper: "On the Recent Development of the Single-Acting High-Speed Engine for Central-Station Work."

FRIDAY, May 24th.

Physical Society.

5 p.m. Meeting at Burlington House. Papers to be read: (1) "On Mixtures of Ethane and Nitrous Oxide," by Dr. Kuenen; (2) "The Measurement of Cyclically Varying Temperatures," by H. F. W. Burstall.

Royal Institution.

9 p.m. Friday Evening Discourse: "The Absolute Measurement of Electrical Resistance," by Prof. J. Viriamu Jones, F.R.S.

Electricity in Hungarian Mines.—An electric railway has been laid down at the Mizserfacsibaj mines in Hungary. It connects the main shaft with the loading place, a distance of about 1¼ miles. The gauge of the line is 2ft., and there are gradients of from 2 to 6·5 per cent. The locomotive, of 6 h.p. capacity and 20 tons weight, is only 3½ft. wide and 4½ft. high. It draws 18 to 20 trucks at a speed of about 10 miles an hour. Double-wire overhead conductors are used, which run in the mines about 6½ft. above the rails, and in the open nearly 10ft. The working pressure is 300 volts, the 40-h.p. generator at the general engine house, at one end of the railway, also supplies current to a winding machine, a pump and a cutter. At the Ludovikaschacht a transmission of power plant has also been installed. A 100-h.p. generator, driven by a turbine, supplies current to a 30-h.p. hoist 775 yards away, and a 14-h.p. rock-drill, which works some 1,200 feet below ground. The spare power is used for lighting at the Unterfermezely mine; a blower and a ventilator are driven electrically. This latter requires a current of 40 amperes at 550 volts, and is about 1·6 miles from the generating station. The Bleiberg Mining Union of Bleiberg proposes to establish a plant for the utilisation of available water power to the extent of about 350 h.p. The plant will be on the multiphase system, and the electrical energy will be transmitted to the Bleiberg mining district, a distance of about 5½ miles, there to be used for miscellaneous power purposes.

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The Electrician.

(The Oldest Electrical Journal, 1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as evidence of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices.*

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SPECIAL NOTICE.

Owing to the growth of the electrical and allied industries the demands for space in "THE ELECTRICIAN" are, for the greater part of the year, so pressing that a permanent increase in the size of the journal has become necessary. To meet the increased cost involved by this step, and by other improvements, such as heavier paper and more numerous illustrations, the price of "THE ELECTRICIAN" has from May 3rd been advanced to 6d. Hitherto this sum has been charged when the number has contained a Supplement, and, as the industries grow, these may be more frequently necessary; but the practice of charging extra for Supplement numbers as issued will be discontinued.

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MUNICIPALITIES AND THEIR ELECTRICAL ENGINEERS.

It is just about a year ago that we had occasion to make a few observations on the subject of the salaries which most municipalities thought it advisable to offer to engineers, upon whose shoulders they proposed to rest the burden of carrying on to a successful issue such important and exceedingly novel enterprises as municipal electric lighting central stations. As we then pointed out, even granting that the iron law of supply and demand could be rigidly applied in fixing such salaries, which we deny, the actual supply of competent men is short of the actual demand; although, of course, if it be assumed that every applicant for a post is capable of filling it, one must admit that the conditions are reversed. Our suggested remedy of a year ago—and nothing has occurred in the interval to cause us to alter our opinion—was that the real relation of supply to demand could be easily ascertained if electric lighting committees and their expert advisers, instead of attempting the invidious if not impossible task of drawing up an exact definition of the term "electrical engineer," would agree to insist on a minimum standard of qualification; say three years in shops and three in a central station or similar position. The law of supply and demand does not. therefore, afford a clue to the low rate of remuneration prevailing, provided

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genuine competency be taken into account. Neither do many other politico-economic considerations, which are usually urged whenever the cry of low wages is raised, throw much light on the matter. To be badgered and bothered by fussy committee men, to have one's qualifications and character, merits and demerits, publicly and not too delicately discussed every time a rise of salary is humbly asked for or a breakdown occurs, does not tend to bring the function of municipal electrical engineer within the category of "agreeable employments." And, again, when one remembers the years which have to be, or should be, spent in going through the examination and laboratory mill at technical colleges, in picking up practical wrinkles in the shops, in working for nothing "to gain experience," it can scarcely be argued that it is cheap and easy to become a well-qualified electrical engineer. Apart from the large apparent supply to which we have alluded, the *fons et origo malorum* is, perhaps, to be found in the fact that electrical engineering has for obvious reasons attracted an unduly large proportion of men of independent means. Now we are assured by the straitest of political economists—and the question we are discussing would seem to be a case in point—that when an occupation is carried on chiefly by persons who derive a portion of their subsistence from other sources, its remuneration may be lower almost to any extent than the wages of other very similar employments. "You mustn't think I am entirely dependent on what I earn," we once heard a rising electrical light remark, little thinking how the very prevalence of that condition in the electrical engineering profession was mainly responsible for the low rate of remuneration so much complained of. If electrical engineers were more frequently entirely dependent upon what they earned they simply could not accept the salaries they now so often take, to the prejudice of their less fortunate fellows. The purely nominal wage so widely met with among the devotees of applied electricity in general, and municipal electrical engineers in particular, may also be partly traced to the absence of any long-established custom. With use and wont to guide them, even the narrowest visioned, most penny-wise-and-pound-foolish "economaniacs" might be trusted not to work much harm. But beside electrical engineering, even such recently-born professions as modern civil or mechanical engineering appear positively senile; whilst the callings of the lawyer and the doctor are covered with a genuine paleozoic crust of custom and etiquette. The narrowest economic considerations thus have their full effect when it comes to fixing the pay of the unfortunate municipal electrical engineer. What wonder that, with such a large apparent supply of competent men and with such readiness to accept ridiculously small salaries, stipends of £150 or £200 a year are deemed sufficient ?

Without, however, entering the debatable region of ethics, it is quite possible to argue, on the ground of bare expediency, that the low salaries which until lately were universal, and still remain the rule, are a mistake. Men tantalised by such doles naturally become mere birds of passage; ready to take flight to fresh fields and pastures new for the smallest increment of pay. No one, we think, would venture to contend that the post of municipal electrical engineer is not a position of trust and responsibility; and it never occurred to any of our leading economists, even in their palmiest days, to settle by the higgling of the market the remuneration of men from whom integrity and fidelity were expected. As a picturesque writer once forcibly put it, we do not on the decease of a bishop offer his diocese to the clergyman who will take the episcopacy on the lowest terms; when ill, we do not drive a bargain with the nearest needy medico. But when an electric lighting committee have to fix their engineer's salary and select their man, they *do* for the most part drive what, by a business misnomer, is called a *good* bargain. They fail to realise that even if it be granted that from the single point of view of engineering knowledge there may exist a plethora of fully-qualified men, the position they are, so to speak, thus putting up to Dutch auction, is one requiring tact, management, method, resource, and above all integrity; it is a position of trust and responsibility, and as such worthy of a generous salary. Indeed, by no other process is a good man likely to be secured. Experience seems, indeed, in one or two instances to have driven the obvious fact home to the municipal mind that two or three hundred a year is not exactly the right thing to throw to an engineer capable not only of economically and smoothly running an important central station, but of designing all extension work, drawing up specifications, settling tenders, and acting as a veritable *deus ex machinâ*. We do not doubt for one moment that plenty of young fellows, certificated up to the crowns of their heads, can be obtained who will be willing to try and accomplish all these things, and as many others as one likes to ask them, for £15 a month. The question is, can they be *trusted* to do them. Is it expedient, we had almost said is it right, to place anyone in a position of responsibility, and omit that important factor in the equation to his salary? A young—and quite incompetent—embryonic electrical engineer was once offered the magnificent salary of 10s. a week, or about 2d. an hour, to take charge of the isolated electric lighting plant of a large place of public resort, the lighting being carried out by a wheezy, semi-portable engine, a miscellaneous collection of antique dynamos, and a drunken stoker. "It is quite true I am a raw hand," replied the budding Faraday, "but the responsibility of the job would make ten times ten shillings a week none too much." And he was right; though he was promptly turned off for his pains.

NOTES ON SUBMARINE CABLE WORK.

BY H. D. WILKINSON.

(*Continued from page 55.*)

36. Polarisation of Fault or Break.—A little examination into the action called "Polarisation" will repay attention. The effect can be watched closely by an arrangement such as shown in Fig. 107.

Into a glass beaker filled with sea water is put a small piece of gutta-percha covered wire, W, the immersed end being bared and exposing some of the copper wire. Opposite to this in the water is a piece of galvanised iron wire, E, twisted to afford a good surface. The two pieces are held steady in a glass by bending their outside ends close to the glass and putting rubber bands round to hold them.

On connecting up five Leclanché cells with the zinc pole to the copper wire, a stream of bubbles of hydrogen is observed to be given off from the end of copper exposed. We may regard the piece of insulated wire as part of a cable, and the exposed bit of copper the fault or break, while the iron takes the place of the sheathing wire of the cable. It is very good practice to use such an artificial fault with a resistance of, say, 1,000 ohms in circuit, and then connect up to a bridge and measure the resistance with reversals of current, noticing the rate and amount of polarisation with each current. If the wires of the battery are reversed and a copper current sent into the insulated wire, the bubbles cease and the resistance goes up. The galvanometer will also show the direction of the current of polarisation, and its rate of fall after the testing current has been taken off.

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A good insight can be obtained into false zero testing with such an artificial fault, especially as there is no interference from electrostatic discharge, as in a cable.

With a zinc current the action is to deposit a sulphate base containing oxygen on the exposed copper at the fault, and thus "seal" it up. In other words, the deposit of salts which almost instantaneously forms on the copper increases the resistance of the fault, because it covers it up from contact with the sea.

In low-resistance faults, or those which have comparatively large exposed area, the action is not so rapid as to prevent a reading being obtained; but, with a fault of small exposure and high resistance, it is risky to touch it with copper current, as it runs up immediately into hundreds and thousands of ohms, and sometimes the zinc current will not break it down again. The fault generally falls in resistance when the zinc current is put on, but not always. Sometimes it

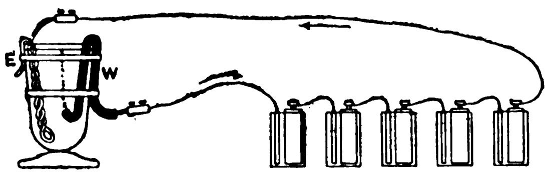

Fig. 107.

polarises up, and this happens only with small exposures at the fault, or exposures of such a character and position that the hydrogen gas evolved cannot easily escape. The gas then collects on the surface of the exposure, and insulates it from the water. When this happens it is best to test with reversals.

37. Improved Blavier.—This is a test from one end of the cable only, and, as is well known, consists in taking bridge measurements when the distant end is freed and earthed successively. The improvement, due to Mr. Kennelly, in the method of using this test consists in arranging the current through the fault to be the same when taking both measurements. With the same battery, of course, the current through the fault is stronger when taking the "free" than the "earth," and a resistance has to be inserted in the battery circuit when taking the "free."

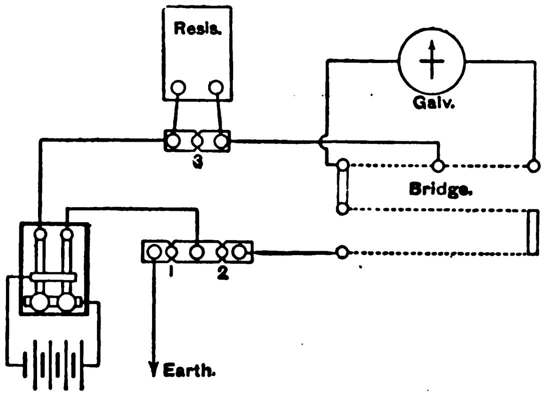

Fig. 108.

To find what this resistance must be we have to make a few trials. First, take the ordinary test without any resistance, from which we obtain the approximate values of x by the well-known formula:—

$$x = \mathrm{E} - \sqrt{(\mathrm{F}-\mathrm{E})\,(\mathrm{L}-\mathrm{E})},$$

where E is the earth reading, F the free reading, and L the copper resistance of the whole cable.

By equating the currents through the fault in the two readings, we obtain a formula for the approximate resistance to add, namely,

$$\frac{\mathrm{F}-x}{\mathrm{L}-x}\times\frac{\mu}{1+\mu}\left(a+x+b\frac{1+\mu}{\mu}\right)\text{ ohms,}$$

where μ is the ratio between the fixed arms of the bridge, a the resistance of the smaller fixed arm, and b the resistance of the battery. If even bridges are used, the ratio μ is unity, and the resistance to add to the battery becomes

$$\frac{\mathrm{F}-x}{2\,(\mathrm{L}-x)}\left(a+x+2b\right).$$

Adding the resistance so obtained a second set of readings is taken, and the resistance again worked out by the above formula.

After one or two pairs there is very little change to make in the resistance, and we may then take it that the resistance so added to the battery circuit is such that the current is the same through the fault in both tests of a pair.

This resistance must be short-circuited when taking an earth, and when a satisfactory pair has been obtained the correct value of x is found by the original formula. Mr. Kennelly recommends using only one direction of current to line and reading to false zero.

The arrangement shown in Fig. 108 is convenient for this and other similar bridge tests. For the earth reading all three plugs are put in, and for the free the plug 3 is removed, thus throwing in circuit the resistance added to the battery. Plugs 1 and 2 are used for loop test, 2 being in for metallic circuit and 1 for the loop.

If the fault varies much, the resistance to add may work out too high, and the result of having too much resistance is to make x too little or to "bring the fault home." And the more the fault is brought home the higher the resistance to add works out, thus making matters worse, which may result in putting the fault on the testing table unless it undergoes some other change. When a fault is behaving like this there is nothing to guide one but experience.

38. Mance Partial Earth Test.—Sir Henry Mance, to whom this test is due, first introduced it to notice in his Paper "On a Method of Eliminating the Effects of Polarisation and Earth Currents from Fault Tests" read before the then Society of Telegraph Engineers and Electricians in May, 1884.

The distant end being free, a pair of observations are made on the bridge in the ordinary manner with different bridge ratios. The battery key is kept down all the time with zinc to line, and the bridge balanced to instrument zero (Fig. 109). The test may be stated thus:—

With equal ratio a/a in bridge, balance obtained is A ohms.
" " " a_1/a_1 " " " " B "
Resistance of battery b ohms.

Reading to instrument zero the galvanometer is in its most sensitive condition, and there is a further advantage in being easier to balance to instrument zero than to false zero. On the other hand, the sensitiveness of the galvanometer is different in two readings of a pair on account of the different bridge ratios.

By changing the ratios of the bridge, the strength of current to line is varied; and for each strength of current two equations are derived by Kirchoff's laws, one containing the E.M.F. of the battery, and the other the sum of the disturbing currents. Combining the four equations, the battery E.M.F. is eliminated, and so also are the disturbing currents, assuming, however, that they remain constant during a pair of bridge readings. So far as the earth current is concerned, it may be assumed that it does not seriously alter if one test of a pair follows the other fairly rapidly. When taking a set of pairs it is a good plan to change the adjustable resistance before changing the ratios. Thus, supposing we have just balanced to B ohms with ratio a_1/a_1; then alter the adjustable resistance to A ohms before changing the ratio back to a/a. A little further adjustment will then bring to balance.

If a/a is 100/100, and a_1/a_1 1,000/1,000 as recommended, B will exceed A, and we have:—

$$\left.\begin{array}{l}\text{Resistance of cable up to fault, } plus\\ \quad\text{resistance of fault}\end{array}\right\} = \frac{\mathrm{A}\,(2\,b+a_1)-\mathrm{B}\,(2\,b+a)}{(a_1-a)+(\mathrm{B}-\mathrm{A})}.$$

If a_1/a_1 is less than a/a, and in consequence B is less than A, the formula becomes:—

$$\frac{\mathrm{B}\,(2\,b+a)-\mathrm{A}\,(2\,b+a_1)}{(a-a_1)+(\mathrm{A}-\mathrm{B})}.$$

Therefore, when testing from one end only, in order to obtain distance of fault we have to judge (by its behaviour under

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test, and a lot of experience) the resistance to allow for the fault, and deduct it from the result obtained by the formula. Actually somewhat less than the resistance of the fault must be deducted on account of the fact that the formula assumes the fault to remain constant during a pair of readings, which (in consequence of the current being changed) it does not. When possible, the test should always be taken from *both* ends, so as to cancel the uncertain quantity of fault resistance.

Sir Henry Mance, in advising tests from both ends, recommends a resistance being added to the end of cable nearest the fault, so as to make the actual resistance in circuit the same when testing from either end. Then, by using testing batteries of approximately the same E.M.F. and resistance, and similar bridge ratios, the current through the fault is the same, and its resistance constant for the time being.

The resistance to add is soon found by working out one or two pairs from both ends, each end freeing in turn. The following is the procedure.

Take a pair of readings with zinc and copper, the other end being free, and work out result by formula. Free while the other end tests. The difference of the two results in ohms is then added to the end of cable nearest fault. Take readings from each end again as above. Call result A that obtained at end nearest to fault (after subtracting resistance added to this end), and result P that obtained at the other end. Then distance of fault in ohms from nearest end of cable is

$$\frac{L + A - P}{2} \text{ ohms},$$

where L is the normal copper resistance of the whole cable. When it is possible to test from both ends in the above manner the results are very reliable if taken fairly rapidly in succession.

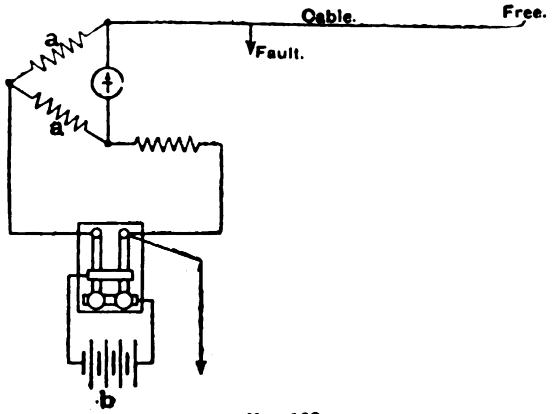


FIG. 109.

A wider range in varying the testing current can be attained by the use of different resistances in the battery circuit instead of different bridge ratios, with the additional advantage that the sensitiveness of the galvanometer remains constant. A pair of readings is taken as follows :—

With equal ratio a/a and total resistance b in battery circuit, balance obtained is A ohms. With same ratio and total resistance b_1 in battery circuit, balance obtained is B ohms. (Resistances b and b_1 both include the resistance of battery and whatever extra resistance is added to vary the current.) If B exceeds A as before (by having b_1 greater than b) we have—

$$\left.\begin{array}{l}\text{Resistance of cable up to fault,}\\ \quad\textit{plus}\text{ resistance of fault}\end{array}\right\} = \frac{A(2b_1 + a) - B(2b + a)}{2(b_1 - b) + (B - A)}.$$

If we use b_1 less than b, and B is consequently less than A, the formula becomes

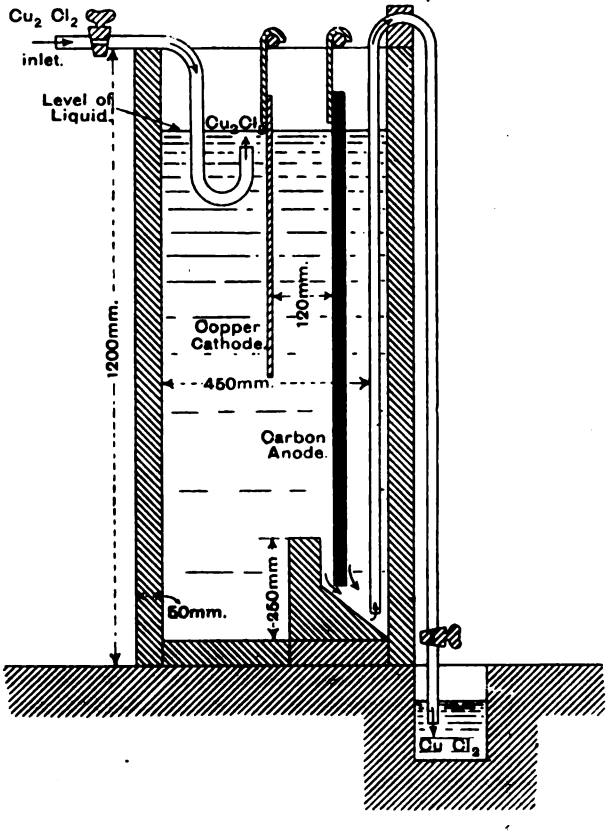
$$\frac{B(2b + a) - A(2b_1 + a)}{2(b - b_1) + (A - B)}.$$

Taken in this manner also the test is subject to the same strictures as mentioned above, and in all cases should be taken from both ends where possible, and the two results combined as explained to eliminate resistance of fault. Incidentally it may be mentioned that on a good cable, when testing for copper resistance, the Mance method is very useful, as it eliminates the effect of earth currents, and these are often very troublesome. Needless to say that the test is then quite accurate from one end only, as there is no fault and no polarisation current. The above formulæ give the copper resistance at once.

(To be continued.)

THE ELECTROLYSIS OF SOLUTIONS OF CUPROUS CHLORIDE.

The following account is an abstract of a Paper by A. Coehn and O. Lenz, appearing in the *Zeitschrift für Elektrochemie* of April 20th. The authors, after referring eulogistically to the Höpfner process, the underlying idea of which is the use of cuprous instead of cupric solutions for the commercial winning of copper, describe a series of experiments designed to determine the conditions under which a solution of cuprous chloride yields smoothly per unit of current twice the amount of copper given by a solution of a cupric salt, *e.g.*, ordinary sulphate of copper.



The chief objection to the well-known Höpfner process—granting the efficiency of the anode liquor to extract copper sulphide ores, and to become by that act reduced to the cuprous condition —arises from the need for a diaphragm. In the absence of some division between the liquor at the anode and the cathode, the copper upon the latter is speedily dissolved by the cupric chloride produced at the former, and a poor yield, falling far short of double the quantity given by a cupric salt, is obtained.

The apparatus shown in the figure indicates the arrangement ultimately found to meet the requirements of the case. The design is obvious from the figure, the only comment necessary being that in the actual apparatus the inlet tube for the solution of cuprous chloride is not on one side on the cathode, but is situated between a pair of cathodes similar to that shown singly in the illustration. During the process of electrolysis, copper is deposited from the cuprous chloride on the cathodes, and the cupric chloride appearing at the anode forms a heavy solution underlying the solution of cuprous chloride, and removable by the syphon shown on the right-hand side of the figure. Stripping of the copper from the cathodes by the action of cupric chloride is avoided by the shortness of the cathodes, which end on a line above the level of the junction

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of the cuprous and cupric liquors. The electrolyte best fitted to give a quantitative yield of copper (approximately double the weight of that precipitated in an ordinary copper voltameter) is one containing cuprous chloride in amount corresponding with 4 – 15 grammes of copper per litre, held in solution by means of sodium chloride (50 cubic centimetres of a 30 : 100 solution for each litre) and a little hydrochloric acid. Any current density up to, but not beyond, 20 amperes per square metre could be used without deteriorating the quality of the coating of copper deposited.

THE REDUCTION OF REFRACTORY METALS.

The increasingly common use of means of decomposing highly stable substances, such as metallic oxides having high heats of formation, on a scale greater than that generally adopted in the laboratory, has within the last few years attracted the attention of the technical public to questions, intellectually interesting, and possibly commercially attractive, which would otherwise have remained untouched save by the eclectic few. No one has done more, in this country, to spread and popularise a knowledge of the properties of those metallic elements, which are more more familiar by name than by appearance even to professional chemists, than Prof. Roberts-Austen. In continuation of previous expositions, he recently gave a *résumé* of modern work in this direction, in the form of a lecture at the Society of Arts, illustrated by well-chosen experiments. Seeing that the title of the discourse was "The Reduction of the Rarer Metals from their Oxides," it is evident that the term "rare" was used in reference to the metals in their isolated state, *i.e.*, palpably as metals, and not in the chemical sense of "rare," viz., very seldom found, whether in the metallic state or as a compound. Chromium—and, until the last few years, aluminium—may be called rare in the former, but not in the latter sense. By accepting the less usual connotation, a good many fairly commonplace elements may be elevated to a temporary position of rarity, and brought within the scope of a Paper with the title already quoted.

At present three distinct methods of reducing refractory metals are in common use. It is proper to remark that by "refractory metals" is meant that class of metals, the heats of combination of whose oxides are too high to allow of their commercial reduction to metal by means of carbon at temperatures up to and including those of the blast furnace; the canon is not absolute for certain metals, notably those of the alkalies, which are sufficiently volatile and may be reduced by means of carbon in spite of their essentially refractory character.

The first of these three methods in point of antiquity, general applicability and inherent interest, is the purely chemical process of performing the reduction in two or more steps, some intermediate compound forming the stepping stone. The most familiar illustration is the reduction of aluminium from alumina *via* aluminium chloride. Carbon will not reduce alumina at ordinary furnace temperatures; sodium is also ineffective; carbon will not reduce aluminium chloride. But carbon in the presence of chlorine will convert alumina into aluminium chloride, and sodium will reduce this latter with ease. The general aim in this method is to convert the refractory substance into a compound less markedly refractory, so that it can be dealt with by some fairly cheap reducing agent—the position is sapped, not stormed. Of all the compounds of aluminium which have seemed likely to serve as half-way houses in the process of reduction, the sulphide has always been one of the most attractive to the devisers of processes. It is not easy to prepare the sulphide, the reaction of carbon disulphide on alumina needing a high temperature for its accomplishment, but the task is light compared with the commercial reduction of the sulphide to aluminium; the metal manganese is the only likely candidate for the contest. Fortunately, the utilisation of aluminium sulphide has been achieved by other means. A variant of this general method is to use some reducing agent, itself frequently obtained by two or more steps, more powerful than carbon under the particular conditions of experiment. The reduction of chromium by the action of aluminium on chromic oxide is a case in point. The aluminium for this purpose may be looked on as carbon that has suffered a sort of chemical step-up transformation (the transformer having, by the way, a somewhat low efficiency), and it is able to accomplish the reduction with corresponding ease. This manner of utilising the energetic essence as distinct from the material accidents of the carbon, is of particular value, when—as often—the metal to be reduced has a tendency to form a carbide. The carbon being represented solely by its astral body, is secure from material union. Both chromium and manganese are much used in steel making, where the fortuitous introduction of carbon is undesirable, and the preparation of these metals and of their alloys with iron, free from carbon, is consequently of industrial moment.

The second method is noteworthy for its extreme neatness and simplicity, and the certainty that the reducing agent will not introduce foreign matter into the reduced product. It is, of course, electrolysis. Unfortunately, as the metals to be reduced are *ex hypothesi* refractory, they cannot be dealt with in aqueous solution until someone has discovered a new kind of water less readily electrolysed than the ordinary variety. The adoption of fused baths presents many difficulties, largely arising from the attack of the vessels in which the electrolysis is carried out; but that these are not insuperable is proved by the flourishing state of the aluminium industry, the bulk, if not the whole, of which now depends on the electrolysis of alumina or its salts. It is here that the utility of aluminium sulphide is shown, for although its chemical reduction is difficult, its electrolysis can be accomplished, and presents certain advantages over that of the oxide dissolved in a fused halogen salt of aluminium, which is the more usual electrolyte.

The third general method is that involving the employment of the electric furnace. On account of the high-fusing point and boiling point of carbon, this element can be trusted to stay at its post by the refractory oxide until a temperature is reached at which reduction of the oxide takes place. When once this is accomplished the carbon escapes as the gaseous oxide CO, and reverse reaction is thus minimised. But the very merit of carbon is the bane of the process when a pure metallic product is required. At the high temperatures requisite for reduction, carbides of great stability are formed and from these the pure metal can only be obtained by repeated fusion with the oxide of the metal under treatment, in order to successively oxidise portions of the carbon by an oxidant from its nature incapable of reacting upon the metal itself. The *rationale* of the action of the electric furnace in reducing refractory metals it totally distinct from that of the electrolysis performed upon a fused salt of the same refractory metal. The latter is, above all, as systematic and selective as the former is chaotic and indiscriminate. Each serves special ends.

In considering experimental work of the nature of that touched upon in the foregoing lines, a certain sobriety of thought and statement is indispensable. There is but little lately accomplished in the production of any of the refractory metals which has not been performed years ago by the chemist engaged in purely scientific research. The only justification for satisfaction concerning these larger scale experiments, and their easy and brilliant execution, is the consequent device of industrial methods and the discovery of some means of utilising the products. Much nonsense is talked about possible new structural metals, the orators forgetting that the abundance of an element on the earth's surface is a weighty factor in its utilisation. Glucinum is no doubt a nice material for many purposes, and its reduction is not beyond our means; but unhappily there is, so to speak, none of it. Even given abundance and fair ease of production, a "new" metal must be shown to be in some respect better than the older group before it can be more than a curiosity. Much more is to be hoped from persistent and enlightened experiment on the influence of small quantities of the more refractory metals on those longer and better known in the metallic state, with the view of obtaining alloys superior to those in common use.

King's College Old Students.—We have been requested to announce that the annual dinner of old students of King's College will be held at the Holborn Restaurant, on Monday, June 24th, with the Bishop of London in the chair.

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ROTARY-CURRENT AND ALTERNATING-CURRENT DYNAMOS OF THE ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT.*

BY M. VON DOLIVO-DOBROWOLSKY.

The relatively large number of poles in alternating-current machines which were necessary to reach a high number of alternations at a small number of revolutions, rendered an economical design of the field-magnets most difficult. A certain saving was, however, effected by using one field-winding to do the whole work,

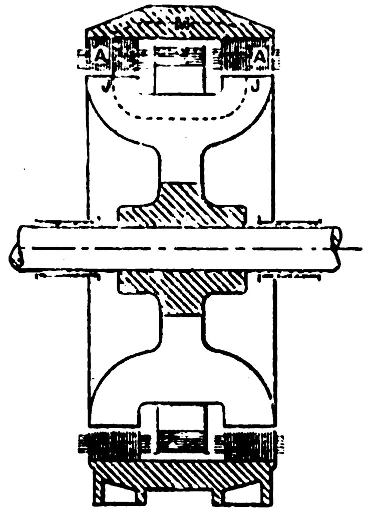

FIG. 1.

nstead of exciting each pole separately. The first alternator of this kind was probably that of Klimenko of Charkow, which was exhibited at the Vienna Exhibition in 1883. The bad proportionality in the design of this machine prevented it from coming into a more general use. The Mordey alternator of the latter end of the eighties, which is really derived from the Klimenko machine, was, in fact, the first practical useful machine with a single-coil magnet. To-day there are many modifications of this type of machine in existence, as, for instance, the one built by the Maschinenfabrik Oerlikon with Brown's inductor, and several others. One might predict that the single-coil magnet arrangement will come so to the front in the construction of alternators in the same way as the ring-

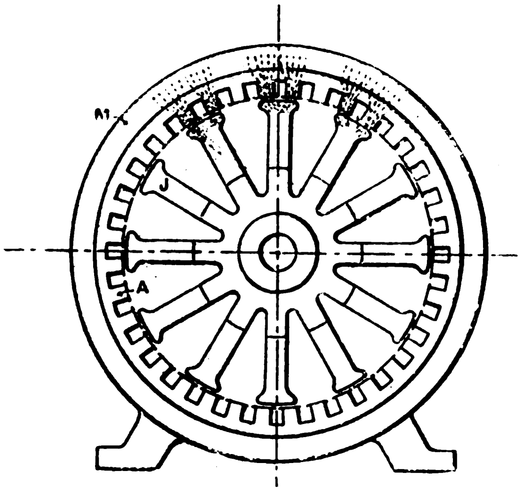

FIG. 2

pole arrangement with radial magnets has, in the case of continuous-current dynamos, displaced all former forms of magnets. Besides its main advantage, economical excitation, the exciting coil of a single-coil magnet in some of its forms may be made stationary so that only the magnet core with its poles revolves. The 1883 machine of Klimenko was without any revolving wires. On the Mordey alternator the magnet coil could also be made stationary, the reason for not doing this in practice lies entirely in the mechanical difficulty of securing the relatively heavy coil to the light disc armature in a workmanlike way. After this introduction, I come to the description of two types of alternators built by the Allgemeine Elektricitäts Gesellschaft of Berlin.

Both types belong to the single-coil magnet class with stationary winding. The first kind, shown in Figs. 1 and 2, is most suitable for high speeds, consequently for belt or rope driving. From both illustrations it will be seen that the magnetic circuit is completed by the outer case M, the two armature rings A, which are built up of laminated iron, and the tooth-wheel or turbine-wheel inductor J, which latter is shown separately in Fig. 3; S is the exciting coil, and is fixed to the frame M. The pole-pieces of the inductor-wheel give rise on the inner face of the armature rings to points of very uneven distribution of field, so that by rotating the inductor the armature coils, which are to be seen in Fig. 2, receive an induction through the number of lines of force which flow in them being changed. On the outer face of the armature A the distribution of field is homogeneous, and therefore nothing prevents the lines of force being led through the frame M. Here I will remark at once that similar machines have lately been built by Stanley in America, and also by Sollman, of Wahl and Co., in Russia. The

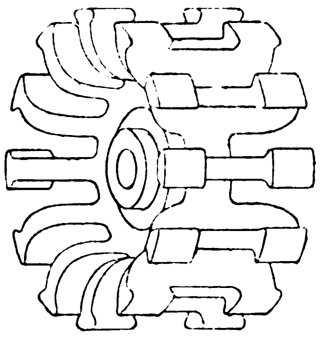

FIG 3.

Sollman alternator was described in the Russian *Elektrotechnische Zeitschrift* a little time ago. A number of alternators of this type have been designed, some also with the modifications as shown in Fig. 4. A 100-H.P. "drehstrom" generator of this type is now at work at the sugar refinery of Messrs. Schwengers Söhne, at Uerdingen, on the Rhine. Of course this kind of machine is suitable for either single-phase, multiphase, or "drehstrom"

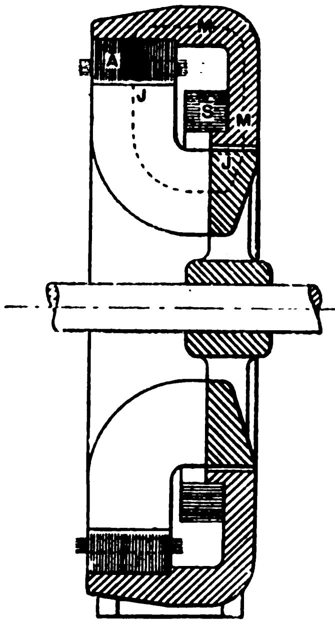

FIG. 4.

current. In Fig. 2 the number of armature coils is three times as large as the number of pole shoes, whereby three currents of 120deg. phase difference are produced. Instead of the "pole-like" (*poligen*) arrangement of the armature winding, the opposite coils can be connected, which is admissible for machines of low voltages, and sometimes even an advantage. In larger size machines the bar winding can be used, as shown in Fig. 5, where each of the coils consists of only one copper bar. Three machines of this type, of 300 H.P. each, are at present under construction at the works.

Besides this type of machine, which is, as stated before, more to be recommended for the high speed, we are also building a slow-

* Paper read before the Elektrotechnischer Verein, and translated from the *Elektrotechnische Zeitschrift.*

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speed machine of a smaller width, but greater diameter, suitable for direct driving. The same is also on the Klimenko principle. Figs. 6 and 7 show clearly that the magnetic lines generated in the large exciter coil S run evenly through the iron ring M and the two armature rings A when the magnetic circuit is closed by pole-pieces P. When these pole-pieces, which are fixed to the flywheel of the engine, rotate, points of high magnetic density evidently travel along the surface of the two armatures, and the armature coils, which are clearly shown in Fig. 6, receive an induction. Things can, of course, be also arranged for multiphase currents by simply using a proper number of coils relatively to poles. "Drehstrom" dynamos of this class are at present being built for the Electric Supply Station at Strassburg, viz., three of 400 H.P., and two of 200 H.P. each.

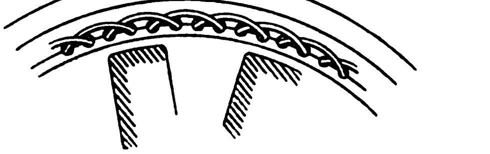

FIG. 5.

Besides the advantage of having no collecting brushes, the little attention which these machines require, the simple and strong construction, is at once evident even from the illustrations. It is impossible to touch the high-pressure coils when the machine is running, as the revolving flywheel in front of it prevents this. When repairing, the whole frame can be moved back, and the armature winding becomes easily accessible. As to the electrical advantages of this type of machine, two must be specially mentioned, first the economic excitation, secondly the very small drop of potential. Some consideration should also be given to the naturally small hysteresis, which, in combination with the little exciting current required, enables an especially high efficiency to be obtained, even at light loads. To demonstrate these advantages by data, I will give you the principal figures of the 400 H.P. machine

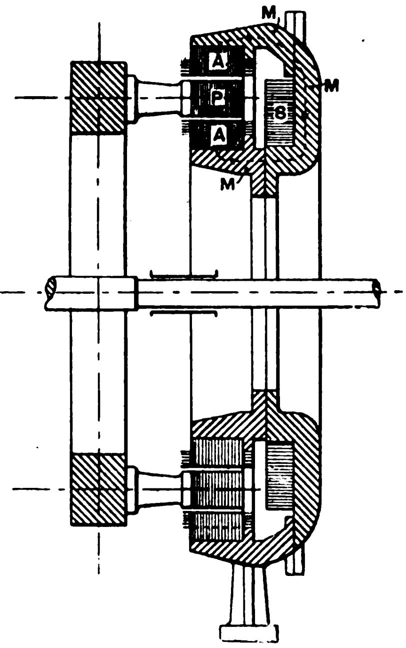

FIG. 6.

for the Strassburg station :—Output, 280 kilowatts at 2,750 volts; revolutions, 150 per minute; number of poles, 40; weight of copper of magnet coil, 730 kilogrammes; weight of copper of both armatures, 200 kilogrammes; excitation required, 4 000 watts—about 1·4 per cent.; total watts consumed in both armatures = 2 per cent.; total hysteresis loss about 1·3 per cent. This machine requires, in spite of the small loss, only a little over 2 kilogrammes of copper per horse-power. The ratio of the effective ampere-turns of one armature coil to the ampere-turns of the exciter coil is about 1·15.

That the weight of iron is not in consequence very high the following figures will show :—

Frame	6,000 kg.
Both armatures	2,000 „
Pole-pieces	750 „
Total weight of iron exclusive of shaft and bearings	8,750 „

Before I conclude, I would like to refer once more to the discussion of last meeting on the most suitable fall of potential in alternating current dynamos. As is known, Hopkinson in the eighties found by calculations that for the synchronous running of two alternators a certain ratio between resistance and self-induction was most suitable, and that the self-induction had the most important *rôle*. From this many concluded that plenty of self-induction must be provided, as it is nearly impossible to calculate the Hopkinson ratio in advance. But often the machines got too much of it, and the consequence was, the thing would get out of parallel. This was explained by saying there was still not enough induction, and we eventually tried to bring the machine to such a point that by means of self-induction it could not give more than 1½ times its normal output. Mordey, at the end of the eighties, maintained just the contrary, *i.e.*, that alternators should have little resistance and little self-induction. The smaller the fall of potential of the machine the easier large currents could be got out of it. However, the most practical and demonstrative proofs of Mordey could not at once shake the general belief in self induction, and the dispute is still unsettled to-day. Of course, after the many experiments with alternators with a small fall of potential, which have been proved to run just as good in parallel as alternators with a large one, certain theorists have moderated their demand, and in fact are already satisfied with a fall of potential of from 15 to 20 per cent. I think one can predict that dynamo constructors will soon come to the general opinion that a little fall of potential more or less is of no consequence to good parallel running, especially as there are no practical proofs that too little resistance or self-induction has ever prevented alternators running in parallel satisfactorily. When, however, neither parallel running nor the conditions of

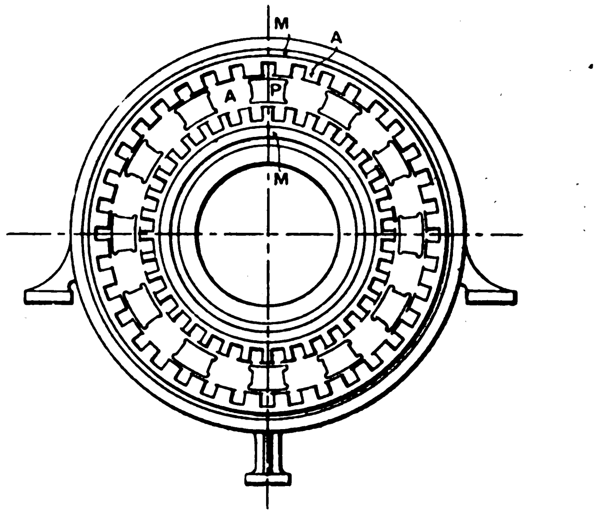

FIG. 7.

synchronism require a large fall of potential, the most important argument for building alternators with self-induction disappears. The fall of potential has many disadvantages which are specially felt in motor driving. The wattless current component operates with its full ampere-turns in the direction of the magneto-motive force of the primary machine, therefore with motor currents one has a bigger reduction of the magnetic field than with lighting currents, and a machine of the latter class with a fall of potential of 15 per cent. is therefore not suitable for satisfactory motor work. If we consider that small motors seldom have cos ϕ more than 0·7, and large ones scarcely above 0·87, and, on the other hand, figure to ourselves that the wattless component amounts of from 0·7 to 0·5 of the whole current, we can easily perceive what a detrimental result the above mentioned subtraction of ampere-turns must have. As, however, at the present time the motor question requires the greatest consideration on the part of electric supply stations, doubtless the question of dynamo design will be answered in one way only, that is, to have the smallest possible fall of potential. No lowest limit can be fixed to this, as even the best of existing machines are far from being perfect in this direction. In my opinion, and according to my experience, it is entirely necessary and quite possible that the fall of potential due to the lighting current should not exceed 4 to 5 per cent., as even then we have still at full load with motor current a fall of from 15 to 20 per cent. The only intelligible reason which was brought forward against such machines is the danger of short-circuiting. Experience with continuous currents has taught us, however, that the dynamos are better protected by good fuses and automatic cut-outs than by a counter-compound winding. Therefore with alternating current —"drehstrom" work—we can very well do without the self-induction, which otherwise only deteriorates the machine.

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In conclusion, I should like to remark that in the last part of my Paper I have treated the self-induction and armature reaction to a certain extent as one, which is not quite correct. However, it was rather an explanation of the self-induction itself I wished to give you to-day than its origin and calculation. Besides, both phenomena are very nearly related and generally appear together, and are of the same order, so that machines with much reaction have likewise large self-induction and *vice versâ*.

ON THE RECENT DEVELOPMENT OF THE SINGLE-ACTING HIGH-SPEED ENGINE FOR CENTRAL STATION WORK.*

BY MARK ROBINSON.

1. The success of the high-speed engine in this country is amongst the notable engineering facts of the time. It relates, in the first place, to mechanical engineering, yet it also concerns this Institution, since it is electrical engineers who are the chief users of high-speed engines; to them, in fact, it is due that such engines hold their present important position.

2. The Presidential Address at the commencement of the present session, in which the high-speed engine was favourably referred to, produced the comment in a leading professional paper, that electricians had little cause to boast about their work in developing high-speed engines, for if they "had stuck to the builders of mill engines and marine engines, instead of trying to strike out a new line of steam engines for themselves, electric lighting would have been very much the gainer." The judgment of electrical engineers has thus been arraigned before the general body of their brethren, and it may be useful to inquire with what justice.

3. According to what purports to be a full list of public lighting stations, published last January in one of the principal electrical journals, the indicated horse-power installed in all the lighting stations in Great Britain was 101,390. Of this, one make of single-acting high-speed engine accounts for 53,340 horse-power, or more than all other patterns put together, and even of these last more than 4,000 I.H.P. are high-speed engines of other kinds. Engines of the mill or marine pattern figure for little in the total, and as the high-speed engine started later than its rivals, its proportion of the more recent work is even greater than the above figures would indicate. Not much apology, therefore, is needed for bringing this subject before electrical engineers.

4. The preponderance of one type of high-speed engine, embodying many views in conflict with those upon which other engine practice is based, virtually obliges this Paper to be both a description and a defence, and may even give to it the appearance of eulogy, of that particular engine. Few but those directly interested in the manufacture of a highly-specialised machine are so conversant with it and its history as to be willing to write upon it; hence such a Paper risks the charge of partisanship, and is certainly open to that of prepossession. A well-remembered charm of the late Mr. P. W. Willans' Papers upon steam-engine economy lay in the fact that his conclusions were as far as possible framed to apply to engines in general; his own engine, though in all cases the one tested, was scarcely described, and certainly unpraised. The present Paper, on the other hand, if it is to have any practical value, must not only describe the Willans engine, but must deal almost exclusively with its difficulties, with its successes, and with its improvements. A description of the engine, with some notes on its history, is given in an appendix.

5. The advantages of single action and of high speed are, however, not limited to any one engine, and they may be described generally. An engine is "single-acting" when the steam acts only upon one side of the piston, the typical case being James Watt's Cornish pumping engine, and this method of using the steam has certain economic advantages in which a double-acting engine cannot share. At equal speeds, however, they are neutralised by the fact that, for a given power, the cylinder capacity has to be twice as great in a single as in a double-acting engine, and it is not until the single-acting engine runs at twice as many revolutions as its rival that it has much advantage. This it is usually able to do, since it can be worked upon the "constant-thrust" plan, which the double-acting engine cannot be; that is to say, the piston-rod can be kept pressing against the connecting-rod, and the latter against the crank-pin, not only throughout the working stroke, but through the return stroke as well; the working parts are thus always in compression, and *never* in tension. The cross-head pin presses always against the same side of the bush or brass in the small end of the connecting-rod; the big-end upper brass maintains constant pressure against the crank-pin, never leaving it even momentarily; the crank-shaft presses always against the lower main bearing brasses, never against the caps.* Of course, a single-acting engine is not necessarily a "constant-thrust" engine, and special means have to be taken to make it so: the point is that these means are possible with a single-acting, and are not possible with a double-acting engine, and though it is a view which is contested, it is the opinion of the author, and certainly it is a widely-held opinion, that really high speed and "constant thrust" should go together, unless in such a case as is referred to in paragraph 8.

6. High speed is at last recognised as a good thing in itself. A fast-running engine is, for a given power, smaller and lighter than a slow one, while a large number of small impulses per unit of time give a more even turning moment than a small number each of greater magnitude. By shorter exposure of the cylinder surfaces to successive changes of temperature, the loss by initial condensation is reduced, so that an unjacketed engine becomes as good as a jacketed one; and for many purposes, as where direct coupling to fast-running machines is required, and especially for dynamo driving, the high-speed engine has advantages which are of necessity admitted. Attempts to revive the belt-driving system in central stations, in the country which is the home of direct driving, and after the rest of the world has almost unanimously come round to its views, will be endured in England only so long as shareholders and ratepayers remain ignorant of the waste of money it entails, while the proposal to make the naturally fast running dynamo into a slow and enormously more costly machine, merely for the sake of allowing it to be driven direct by a slow-running engine, is not likely to meet with success in the long run. The future, however, can take care of itself; it is enough that high speed is already recognised as beneficial by all who are likely to mould future practice.

7. It is evident that a single-acting engine in which there is absolutely no back-lash and no reversal of stresses, and which is otherwise rightly proportioned, will run freer from wear in its brasses than a double-acting engine, at any but very moderate speeds. In the author's opinion an ordinary double-acting engine is in danger of becoming troublesome, if it is run much more than one-third as fast as the speed at which a single-acting engine will run continuously and easily; will need very good design and careful attention if it is to run half as fast; and must be an altogether exceptional engine if it is to run two-thirds as fast, without giving comparatively frequent trouble. There would probably be no difficulty in finding in use many single-acting engines of, say, 80 or 100 I.H.P., running at 450 revolutions per minute, which have had five years' service and upwards without one of the brasses being touched since the engine was first put to work, and it is a safe statement that if these brasses were now removed, in most of them no wear would be detected without careful measurement, while if, through unfavourable conditions of lubrication or otherwise, appreciable wear were found, it would be absolutely without effect upon the good running of the engine. No such statement could be made of any double-acting engine; but for any purpose where the runs are limited to hours, or even to days, an ordinary double-acting engine of the same power would no doubt run at 150 revolutions without giving appreciable trouble. Such an engine, however, would have larger cylinder volume than the 450-revolution single-acting engine, and would suffer more from initial condensation, and it would hardly be trusted by most engineers for purposes (such as electrolytic work) in which an engine must run for many weeks, or even months, without stop. With special design, half-speed, or 225 revolutions (giving equal cylinder volumes, but double exposure of the surfaces in each revolution), is also attainable by a double-acting engine; but few are likely to dispute the opinion that two thirds speed—*i.e.*, 300 revolutions per minute—is not a desirable speed for an 80 horse double-acting engine required to run continuously for weeks or months together under commercial conditions. The author does not overlook the fact that double-acting engines are designed and made to run at even the fullest speeds of single-acting engines, and that by a combination of excellent design and workmanship with a system of forced lubrication (oil is forced into the bearings by pumps) they are able to do so. It would be out of place to refer here in detail to the author's reasons for disbelief in the ultimate acceptance of this ingenious and bold attempt to evade the natural difficulties which the case presents; it is sufficient to say that for the present the single-acting engine holds the field for high-speed work on the large scale, and, according to the most recent experience, with increasing success. Defining high speed as the highest speed which experience shows can be attained without visible disadvantage by a single-acting engine of a given power, it must be said that single action is not essential to high speed, but that it helps enormously to its successful attainment.

8. It may nevertheless be of interest to remark (though, in the author's opinion, the fact has no bearing upon electric lighting practice) that for the attainment of the extremest speeds, with

* Paper read before the Institution of Electrical Engineers

* A single-acting engine can be run with the parts always in tension, and never in compression, with equal ease; but the contrary plan is practically the best

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large powers, a double-acting engine is to be preferred. The maintenance of constant thrust upon the brasses, which may be taken as the real essence of a single-acting engine, involves great difficulties when certain limits are exceeded, and if, through any temporary reason, the constant thrust is lost, and the engine becomes double acting as to its brasses, there will be serious chances of rapid wear, and even of such hammering as to cause fracture. In a double-acting engine, on the contrary, provision is made from the beginning for the change of stress at the end of each stroke; it is a mere question of brute strength in the parts, and since they are always under observation for excessive wear, and periodical adjustments are a part of the system, there is little danger of serious damage. For torpedo boats and other cases where the greatest power must be obtained from the least weight, and where knock and frequent adjustment are comparatively unimportant, double-acting engines are plainly best. But few electrical engineers would care to entrust the continuous running of their stations to engines of this type, or to go through quite the same engine-room experiences as are rightly accepted on board a "catcher."

9. The class of engine called "high speed" in America is usually a double-acting engine, capable of running from one-half to two-thirds the speed of the corresponding single-acting engine of this country. As such, it has already been referred to generally, and though it usually runs well, it has no claim to special consideration, certainly not on the ground of economy.

10. The effect of "single action" in lessening wear upon the brasses must be obvious, and the connection is almost as close between single action and the beautifully simple method of automatic lubrication by the splash of the cranks in an oil chamber; the latter cannot be adopted without risk of much inconvenience, where brasses have to be under constant observation. The very small bearing friction, which results partly from this system of lubrication, and partly from the absence of back-lash, is also unattainable in a double-acting engine, except the special packing rings, and those only by completely duplicating them upon each piston.

11. So far only the general and more obvious advantages of the single-acting engine have been considered. Now it is proposed to describe in some detail three important features in the particular engine which has become, in this country at least, the type of the class; none of them have yet attracted as much attention as, perhaps, they deserve. They are:—

(*a*) The special system of packing rings for pistons, valves, and glands.

(*b*) The special provision for internal drainage.

(*c*) The Cornish cycle, or "transfer plan."

All three are directly related to the single-acting principle. All, except the Cornish transfer, are peculiar to the Willans engine, and none of them could possibly be adopted in a double-acting engine. All are of high value in promoting steam economy.

12. *Packing Rings* (*a*).—One of Mr. Willans' latest improvements in his engine was the system of packing rings shown in Fig. 1, where A is the working end of the cylinder; the pressure in B, below the piston, is materially less upon the down (or working) stroke than that above it, but on the up or exhaust stroke it is practically the same; it is never less, unless in the exceptional case of a looped diagram. There are two rings, *a* and *b*, breaking joint, and turned of the same thickness throughout, which exactly fit the cylinder before they are divided; *c* is a cast-iron spring ring, turned eccentric and slightly too large for the cylinder; great care is taken to have true surfaces at *x*. The follower F is a thin steel plate, very slightly dished, so as to have a slight initial pressure upon the top of the rings. It is perforated, to let steam from A enter the space behind the spring, which it tends to push outward lightly during the up-stroke, comparatively strongly during the down-stroke. The rings are held against the lower flange of the piston body G, not only by the spring follower F, but by the steam pressure on the top of the rings; on the up-stroke, when there is less pressure above the rings, their friction against the cylinder is sufficient to keep them seated on the piston body. It will be noticed in this system, first, that the outward pressure of the rings *is relieved during the ineffective stroke*; and, secondly, that the principle of "constant thrust" is applied to the rings as regards end-play. At all times, whether the piston moves one way or the other, and equally while it reverses its movement on the dead points, the piston rings are held closely down upon the piston flange, and there is none of that wear of the rings endways which tends to arise in all double-acting engines, owing to the friction of the rings causing them to lag behind, so that they are pushed one way by the piston body and the other by the junk ring or follower. Even if wear arose (which under ordinary circumstances it cannot) the spring follower *would follow it up*: there would still be no hammering of the ring between the two sides of the groove. There is thus no increase of ring leakage; the longer the use the tighter the rings. The piston valves are on the same system as regards constant pressure of the rings and other parts against each other, but they are not steam packed (*See* Fig. 3). They are separated by suitable cast distance pieces, with their ends faced to lie against the rings. All are strung together upon a steel tie-rod, with a kind of spring washer under the nut at the end. All parts are free to slide upon each other sideways; all are designed to be held together, without the possibility of hammering upon each other, by the pressure of the steam (in the steam chest) upon the uppermost valve, aided by the spring washer referred to. The gland rings, used instead of stuffing boxes (*see* Fig. 4), are upon exactly the same system as the main piston rings; they are simply piston rings pressing inwards instead of outwards, and guarded against end-play in exactly the same manner. Steam is admitted behind them as in the main pistons.

13. This construction of the various piston and other rings is perhaps the most interesting application of the constant-thrust principle in the engine, but it has not been arrived at without long experiment and some changes. It was originally attempted to dispense with steam pressure behind the piston and gland rings—in fact, to exclude it; and many will remember the collapsing of the rings, especially when the steam was very wet, or when over much oil was used. Under some circumstances a ring could always be set collapsing by increasing the oil supply; it is an old experience that water (or oil) will get behind a ring where steam alone will fail to pass. Once separated from the cylinder wall, the ring was bound to spring inwards, until stopped by the butting of its ends; this butting and the subsequent spring outwards caused much noise and wear, and sometimes breakage of the ring, with, of course, waste of steam. Instead of a spring-plate follower, there was at first a fixed follower—which allowed end-play, and so wear, as in other engines—and afterwards a solid follower pressed down by spring washers, which also was not satisfactory. When "steam packing" was first adopted the holes in the follower were not made large enough to let the full pressure in behind the rings in the short time available, and so the system was imperfect. These defects have been corrected, and the system seems now to be not only perfectly successful, but in a sense beyond rivalry; for it would evidently be impossible to apply it in a double-acting engine—that is, in an engine where the

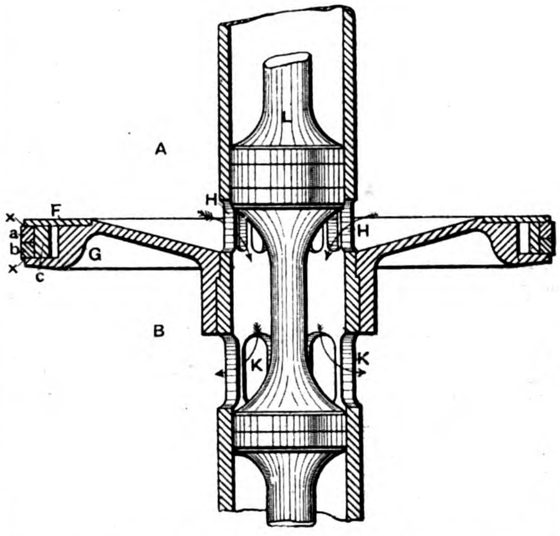


FIG. 1.—Vertical section through piston, showing rings, a and b, which break joint; spring c for *lightly* forcing the rings outwards; spring follower plate F, with holes through it admitting steam to the space behind the spring c.

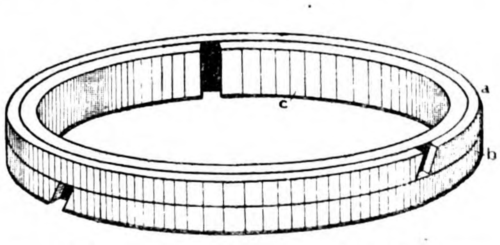
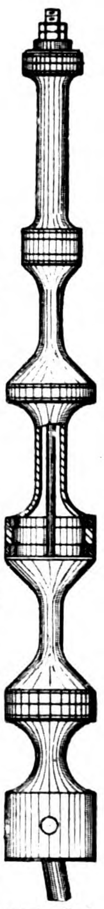


FIG. 2.—Perspective view of set of piston rings complete. Two rings, a and b, breaking joint, and spring c. The steam presses against the inner surface of c. NOTE.—The thickness of the rings is exaggerated relatively to their diameter, for greater clearness.



Eccentric Rod.

FIG. 3.—Piston-valves from compound engine partly in section.

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preponderance of pressure changes from one side of the piston to the other, except by absolutely duplicating the packing arrangements of each piston. It may be added that very careful measurement, based upon some three years' experience, shows that the wear in the cylinders is less than with the earlier rings, whose outward pressure was given entirely by springs. With rings which practically do not wear at all, and which are bound to keep tight whether they wear or not, it is not surprising that the economy of the engine increases with use.

14. *Drainage* (*b*).—The best-drained double-acting engines are probably horizontal engines, with separate Corliss or similar exhaust valves *beneath the cylinder.* The water lying on or draining down towards the cylinder bottom is pushed along by the piston until it reaches the exhaust port, but, unfortunately, only just before the moment of closing; however, it fills the port, and lies in it until the exhaust opens again—ready, it is to be feared, to rob the incoming steam of some of its heat during the next admission, and so to increase initial condensation. In vertical engines, at the bottom end of the cylinder the drainage may act continuously, so far as gravity can effect it, during the whole exhaust stroke, but at the upper end the water will rest on, and be carried up by, the piston until it rises above the port, when, as in the horizontal engine, only a very brief time is available for it to run away; much water probably lies permanently upon the piston, with injurious results from the point of view of initial condensation. If the exhaust port is also the admission port, the water cannot even lie there until the next exhaust; it is thrown back into the cylinder by the incoming steam. In none of these cases is the drainage satisfactory.

15. The drainage arrangements in the Willans central-valve engine offer a striking contrast to the foregoing (*see* Fig. 1). The piston is dished downwards in the centre, not so much with the idea that the water lying on the piston will drain into the centre by itself, but to utilise the inertia of the water to drive it towards the centre during the rapid up-stroke of the piston. There is a ring of ports, H H, in the trunk or hollow piston-rod, flush with the surface of the piston, and of course moving with it, and *during the whole*

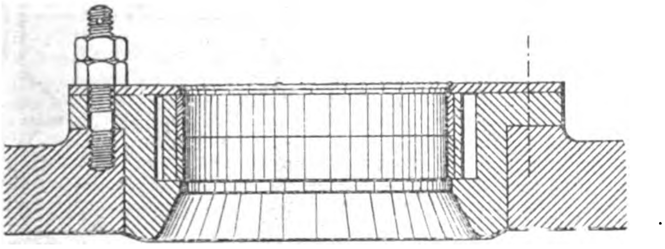

Fig. 4.—Sectional view of a steam gland box.

exhaust stroke there is a rush of steam from the sides towards these ports in the centre, sweeping over the face of the piston and assisting the action last referred to. In fact, the exhaust port is *always* in the best possible place for drainage; it is as though the exhaust port in the horizontal Corliss engine moved along the cylinder bottom so as to be always just ahead of the piston. The water is out of the cylinder before the port closes, nor is there any clearance space in the port—that is, between the cylinder and the valve—where it could lie; there is practically no clearance. It is an ideal exhaust arrangement, and there is no apparent possibility of applying either it, or anything else as good, to a double-acting engine. It is probable that it involves a saving of about 15 per cent. in the steam consumption, in comparison with other vertical engines in which ordinary slide or piston valves are used, common to admission and exhaust. In Fig. 1 the central valve L is shown in its relatively highest position; the exhaust steam (and water) are passing away into the space B, as shown by the arrows, through the ports H H and K K. B is, of course, the receiver; it is in one sense the exhaust chamber of the working cylinder A, in another sense the steam chest of the succeeding cylinder, if there be one. It will be understood that when the valve L is *below* the ports H H, steam passes into the cylinder from the upper part of the hollow piston rod.

16. *The "Cornish Cycle."*—In the Cornish single-acting pumping engine the steam acts only on the top of the piston, the space below being at the time in communication with the condensor. To develop the power of the engine, it would only be necessary to open communication during the up-stroke between the upper end of the cylinder and the condenser, and to maintain communication permanently between the lower end and the condenser; the piston would ascend *in equilibrio*, with vacuum on both sides of it. Viewing the upper end of the cylinder by itself, this is exactly what takes place in every ordinary double-acting engine, and the whole arrangement described, including permanent vacuum below the piston, is the most obvious and natural arrangement for a single-acting engine. In Watt's Cornish engine there is, however, another valve which cuts off the space below the piston from the condenser, at the moment when the steam above the piston commences to exhaust, and the exhaust takes place from above the piston into the space below it, and not direct to the condenser; the piston still ascends *in equilibrio*, but with higher pressure steam on each side of it. By this system Watt raised his pumping engine to a pitch of excellence never attained by his later double-acting engines; in fact, so economical (for a simple engine) is the old Cornish engine that in the controversies attending the introduction of the modern compound engine, the former was quoted to show that a simple engine could work as economically as a compound. The claim was excessive, except at very low pressures, but neither side realised that the Cornish engine is *not* a simple engine—it is half-way to a compound. Fig. 5 is a theoretical diagram from a simple engine in which the working cylinder opens alternately to the boiler and to the condenser. If it is also single-acting, and advantage is taken of that fact to introduce the Cornish cycle, the two diagrams given in Fig. 6 are obtained from the two ends of the cylinder, instead of the single diagram in Fig. 5. There is the same expansion in a single

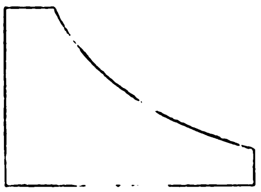

Fig 5.

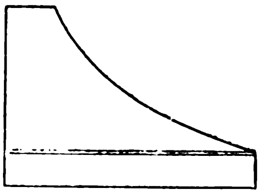

Fig. 6.

cylinder, but the range of temperature in it is only from admission temperature to release temperature, and not to condenser temperature. In other words, though the expansion is in one stage, the fall in temperature is divided over two: hence a great reduction in initial condensation, and marked economy.

17. It is obvious that with modern pressures it would be better to compound the engine—to give it one smaller cylinder and one larger, and add to the diagram the piece shown in dotted lines in Fig. 7, while making the division of temperatures more equal, as is also shown in Fig. 7. But whether the engine be simple, compound, or triple-expansion, if it is single-acting there will always be one cylinder, viz., the last of the series, to which the Cornish cycle may be applied. Mr. Willans applied it in his engine when circumstances were favourable, and he called it the "transfer plan." The steam, when it exhausts through the central valve from the upper to the lower part of the low-pressure cylinder, does not pass away at once to the condenser; it remains in the cylinder (offering no material opposition to the movement of the piston, because the two sides of the piston are in free communication), and passes to the condenser *during the succeeding down-stroke.* It adds to the engine another stage of temperature division, though not of large range, and so lessens the range in each of the others.

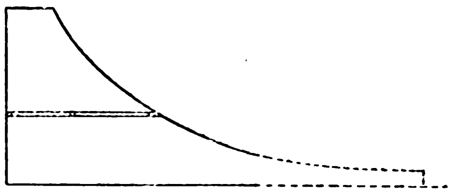

Fig. 7.

18. Simple as it sounds, the "transfer" adds several parts to the engine. The cylinders are lifted a good deal, as a "transfer chamber" is required below the low-pressure cylinder; the trunks or hollow piston rods are lengthened, and an extra valve and an extra gland are required in each line, and of course involve extra friction. Thus it is only under particular conditions of pressure, &c., that it is worth while to use the "transfer"; it is often better to add another complete stage of expansion rather than the transfer. It is, nevertheless, useful in cases where, for some extraneous reason, such as very great fluctuation of load, it is convenient to cut down the number of stages of expansion, as in an engine for electrical railway work. In such an engine the average load is usually but a small proportion of the extreme load, and the total cylinder volume should be so chosen as to give the best ratio of expansion, and therefore the most economical consumption, at the average load. It might then be impossible, without much complication, to obtain the extreme load at all, if the first cylinder were relatively so small as that of a triple-expansion engine must be, and if the cut-off in it, for normal load, were as late as in a triple-expansion engine it ought to be; it is better, therefore, to use a compound engine, gaining the needful expansion by cutting off

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early for average loads, and of course cutting off late (economically, too late) for extreme loads. Economy suffers from this, but it can be partly restored by adding another temperature-division stage in the shape of the "transfer." Where the steam pressure exceeds 160lb. it is also worth while to add the "transfer" to a triple-expansion engine; it takes it half way towards quadruple expansion, the latter not being, in a Willans engine, worth the complication it introduces, until the pressure is well over 200lb.

19. It will be noticed that the last statement is qualified by the words "in a Willans engine," and by this is meant that the Willans engine, even if the "transfer" is not used, has always one definite source of superiority over other engines working with the same number of expansion-stages (*i.e.*, compound or triple), namely, in respect of the smallness of its temperature-range in each cylinder. The explanation is that, in all the expansion stages except the last one, *i.e.*, in the high-pressure and intermediate stages, the Willans engine works necessarily upon the Cornish cycle; the "transfer" is applied in those stages as a matter of course. In double-acting engines, the exhaust steam passes direct from one cylinder to the next, placing the two in communication through the receiver, and therefore exposing the first of the two to the same temperature as the second; in the Willans engine, each cylinder exhausts successively in the Cornish manner, and the power developed in each is represented, as in the Cornish engine, by two diagrams, that from the cylinder proper and that from the "receiver." The effect is that the temperatures of the high-pressure and intermediate cylinder, for instance, do not overlap, as in other engines they do, and the range in each is consequently smaller. It is perhaps the most distinctive feature in the Willans engine; it is highly advantageous to it; and it is of interest as a meeting point between the very oldest and the very newest, and as bringing together in significant association the names of James Watt and Peter Willans—an association which to the author has always appeared natural, and which he believes will at no distant time be so recognised by all.

(To be continued.)

PARLIAMENTARY INTELLIGENCE.

SELECT COMMITTEE ON THE TELEPHONE SERVICE.

The Committee met again on Tuesday, Mr. Arnold Morley, Postmaster-General, in the chair.

Major-Gen. WEBBER, R.E., C.B., called and examined by Dr. Cameron, stated that he was formerly divisional engineer of the military postal telegraphs, and was in charge of the telegraph wires during the Egyptian War. Since his retirement from active service he had been Managing Director of the Bell-Edison Telephone Company, and consulting engineer to other companies. He was well acquainted with the history of the telephone industry in the United Kingdom and on the Continent. Asked if he was in favour of a Government monopoly of telephones if there was to be a monopoly,

WITNESS replied: Not altogether. I think that the Post Office are unquestionably right in regarding the telephone service of this country as the handmaid of the telegraph service for which they are responsible, and for which the public has paid so large an amount, but my view of the possible extension of the use of telephones in this country makes me think that it will get beyond the reach of even so great a department as the Post Office. I think the latter are right in retaining the great arteries of the system, and in believing that they can manage better than anyone else that part of the system which is centrally used for commercial purposes, but the subsidiary requirements of the country will eventually require an extension of wires and stations beyond conception; and with regard to that great system of capillaries, which I firmly believe will come into existence in this country in future, I do think that it would be beyond the powers of even so great a department as the Post Office to deal with it. Therefore it would be wise for them to leave that entirely in the hands of private enterprise, securing the department against loss by means of a system of royalties.

Replying to further questions, WITNESS said he considered that since 1880 there had been two forces operating to prevent the development of telephony in this country. One was the natural precautions taken by the Post Office; the other retarding force had been the existence of a monopoly.

Dr. CAMERON: What is your idea as to the existing arrangements for telephone service in London?

WITNESS: In 1880 I was so impressed with the injury that would arise to the telephony of the future if London were not mapped out for the purpose that I was led to draw up a plan of my own. I can only say that ever since then the telephones of London have been extended in what may be called a haphazard manner. In my view each exchange should be kept for the service of the area for which it was established, instead of having its wires irregularly extended for from a quarter of a mile in one direction to three miles in another direction beyond the limits of the original area, with the view of reaching new customers. Such a system must lead to confusion, because you have a huge number of subscribers brought together at the same points, most of whom have no desire to communicate with each other, and consequently there are difficulties and delays in dealing with them. Instead of selecting a clear *clientèle* for each exchange, the effort has been to bring everyone within the 637 square miles the National Telephone Company claim to cover into intercommunication.

Asked as to what principle he would himself proceed on, WITNESS said he would first take the case of the City of London. He told the late Duke of Marlborough that to place wires underground in the City was probably one of the most difficult operations in the world, owing to the limited space available. He also told him that one great central exchange for the City was impracticable because of the impossibility of laying down, radiating from one centre, a sufficient number of cables to carry the service that would be required. He, therefore, proposed to the Duke to establish eight telephone exchanges situated at points in the periphery of the City. When the Duke suggested that eight points were not so good as one he explained to him, that there was no practical difference between having eight exchanges at eight points in the City and having eight exchanges in eight rooms in a single house. The Duke saw the force of the argument, and induced the City of London Electric Lighting Company, in laying down their system for the distribution of electric light, to insert in all their trenches extra or spare tubes in sufficient quantity to meet the possible future demand for telephone purposes. The Duke also entered into agreements with other electric lighting companies in the City to do the same. He denied that there was anything surreptitious or underhanded in the laying down of those spare tubes; it was open to anyone to see what was being done. Of course, the City of London Electric Lighting Company could not positively say that the spare tubes were destined to be used for telephones, but there was no doubt that the Duke of Marlborough, in getting the electric lighting companies to lay them down, had a very strong view that they might be used for the purposes of the New Telephone Company, of which, as well as of the City of London Electric Lighting Company, he was a Director.

By Mr. Benn: By means of these tubes his system of eight exchanges could have been carried out without the abomination of overhead wires. There was no reason to-day why that should not be done if those tubes were available. The length of 2½in. tubing was 147 miles, and they were capable of holding 12,500 miles of twin conductors. The City of London Company expended £69,000 on the tubes, and the cost of the twin wires necessary for his scheme would be £80,850 when drawn into the tubes, making a total of £149,850, or £1,020 per mile.

WITNESS went at some length into figures, with a view of showing the financial practicability and advantages of his plan.

In answer to Dr. Cameron, WITNESS said he claimed that his system of limited exchanges supplemented by a system of tolls chargeable to persons using exchanges to which they were not subscribers would enable them not only to satisfy the large cities and towns, but also to meet the wants of small traders, farmers, and other persons in rural districts. He had been a member of the Board of Trade Committee on Light Railways, but it struck him that if the object was to benefit agriculture the establishment of a rural telephone system should have consideration before the construction of light railways.

By the Chairman: Under his scheme for London a subscriber would practically pay £8 a year to be in communication with one-eighth of the City. If he wanted to go beyond that he would have to come under a separate classification or toll which would have to be a matter of calculation and arrangement.

By Mr. Grant Lawson: Witness had never been consulted by the National Telephone Company, He could not admit that under his system the officials at the call offices would be put to the trouble of ascertaining the number of the subscribers to be communicated with at a distant exchange. A person in London wishing to call some one in Manchester would have to supply the latter's number just as he had now to supply his address if he wanted to write or wire him. The public would soon adapt themselves to such a requirement. In regard to his rural scheme, if it was undertaken by the County Councils and if the revenue did not come up to witness's estimate no doubt the deficiency would have to come out of the rates.

In answer to Sir J. Fergusson, WITNESS admitted that if private companies or municipal authorities succeeded in obtaining licences from the Post Office they would, in view of the fact that all such licences would lapse to the Postmaster-General in 1911, have to face the necessity of providing a sinking fund for 16 years.

By the Chairman: He was in favour of the State taking over the whole telephone system of the country, except in the rural districts. In regard to his proposals respecting the City, he knew of no town in any country which had adopted such a system, but then it must be remembered that there was no town like London.

The CHAIRMAN: You not only differ from the National Telephone Company in the plan they have adopted, but also from every country in the world in the plans they have adopted?

WITNESS. I don't know whether the Americans have laid out their plans with a view to the future of New York, or the French with a view to the future of Paris.

In answer to further questions, WITNESS said in his rural scheme he proposed to have no subscribers; everything would be done by a payment of 2d. per call, for a conversation of five minutes. He had allowed 3s. 6d. per week for expenses of each call office. He had made no provision for a silent box. The chance of being overheard was an inherent defect of all telephonic communication.

General Webber's evidence having occupied the Committee for nearly four hours, the examination of Sir F. Bramwell and Mr. J. S. Forbes, who had been in attendance throughout the sitting, was postponed until to-day (Friday).

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CORRESPONDENCE.

FIRE RULES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: As certain statements have been made with regard to electrical installations placed up in consumers' premises that may give rise to erroneous impressions and cause needless alarm, I beg you will be courteous enough to spare me a portion of the valuable space in your columns to enable me to say a few words upon the subject.

So far from electrical installations being now placed up in buildings in a worse manner than formerly, my experience is that every year shows an improvement in the way the work is done; and that taking electrical installations as a whole the work is better put up now than it has ever been. So far as I can learn there is no country in the world where the installations inside buildings are to be compared to those installed in England.

With regard to fire danger I have to say that the Phœnix Fire Office has not yet had to pay a shilling of loss with regard to any electrical installation of any kind, when the work has been placed up in accordance with its rules, notwithstanding the enormous number of buildings containing electrical installations that have come before that Office, comprising not only private houses, but all kinds of public buildings, mills, factories, workshops, warehouses, shops, &c., &c. And this immunity from loss has not merely been for a year or two, but extends back to the commencement of electric lighting in the beginning of 1882—over thirteen years ago. A more satisfactory condition of things, from a fire point of view, it would be impossible to conceive.

It is with great surprise I learn that the Institution of Electrical Engineers is about to issue new rules for electrical installations inside buildings. I have to state that the Phœnix Fire Office will not for one moment recognise any such rules if they be issued; and it is well that all electrical contractors, not only in London, but throughout the country, should be fully aware of this. The Phœnix Fire Office will not depart from the course that long experience has proved to be so safe, and will require as before that in any building insured with it the electrical work shall comply with its rules. It has the responsibility of paying for fire losses, and therefore it is absurd to think that it would agree to anything that might practically place the disposal of its funds at the mercy of the views of an outside body.—Yours, &c., MUSGRAVE HEAPHY.

London, May 16, 1895.

SERIES GLOW LAMP LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In the article on the "Parfitt Series System" in your issue of the 10th inst., it is stated that "we think it to be a fact that as yet no other device has been used for this purpose with even a fair degree of success." In this connection, I would beg to say that several stations in the States and elsewhere, chiefly small towns, are using, and have been for several years, the Thomson-Houston series alternating system for street lighting with every success. The cut-out used is very simple, reliable, and inexpensive. In one station I was personally acquainted with, four circuits of 40 25-c.p. lamps each have been running for more than two years without any trouble.—Yours, &c., ARTHUR H. SHAW.

Holly Bank, Cornbrook, Manchester, May 14, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your last week's issue, when describing the Parfitt system of electric lighting, you say "It is well-known that incandescent lighting by series lamps has not been successful, at any rate in any place in Great Britain," and then you go on to say, "The difficulties have been twofold: first, the candle-power provided has generally been too small, and secondly, the failure of a lamp filament has been apt to open the circuit, in spite of automatic devices, and to put out all the lamps in the series. In the experiment made at Barnet a few years ago, both of these causes operated to condemn the series system."

We beg to say your criticism of the Barnet lighting is quite erroneous; neither of the causes you mention applied to Barnet. We used 32-c.p., 50-c.p. and 100-c.p. incandescent lamps and 1,000-c.p. arc lamps at Barnet, so that it cannot be said that the candle-power was too small, and in no single instance did the automatic device fail to act. We had trouble at Barnet: our posts were knocked down by carts, as we understand was the case at Kingswood, but the whole of the failures at Barnet from first to last, including single lamps not quickly replaced during our three years of contract lighting, did not amount to more than ½ per cent. We say that such a result was a very great success.

The reason why the Barnet lighting was not continued, and why we obtained £500 damages from the Local Board for breach of contract, are quite outside the question as to the success and value of the system of incandescent series lamps for street lighting we introduced for the first time in this country at Barnet.—Yours, &c.,

May 15, 1895. HENRY F. JOEL & Co.

[We are quite ready to accept Messrs. Joel's statement that none of the Barnet failures were due to their automatic bridge, and we regret therefore that we cast any reflection on its efficacy. But the fact remains that the public lighting of Barnet was by no means a good advertisement for electric lighting; that the lamps were frequently extinguished; that whatever the photometer candle-power might have been the light was distinctly disappointing, and from first to last there was constant strife been the Local Authority and the contractors; all of which, we hold, can be traced to the adoption of glow lamps for street lighting, and was aggravated by the fact, that being in series, the vagaries of a single erratic coster's cart was sufficient to cause a big interruption.—ED. *E.*]

"EARTHING."

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With reference to the report and leader you publish in your issue of April 26th, referred to by Mr. Sharpe, probably the reason for the lack of publication you refer to is due to the limited experience that has been gained *re* earthing street mains in this country, and also to the definite regulations set out by the Board of Trade, which have given an appearance of settlement to the question.

The report you publish and the authoritative names attached to it should, and it is to be hoped will, induce those responsible for such regulations to reconsider the restrictions to earthing, and provide rules to admit of and regulate earthed systems.

The Board of Trade regulations as they stand limit the choice of the consumer to practically one system in the houses, the two-wire, and prevent the selection of the earthed concentric system, which has conspicuous benefits in price, safety, and neatness. Is not such a restriction opposed to the principles of the Board of Trade? If so, it is an additional reason why a modification of the regulations should be expected.

The report you publish relates solely to the three-wire system; but the advantages recited are even greater when the two-wire system is earthed, whether continuous or alternating currents be used.

If the influence on telegraphs and telephones is entirely due to wandering currents, or in any case it will be less if one of the conductors be earthed under correct conditions, for the reason, as stated in the report, that the distance traversed by wandering currents is reduced, in fact, it is practically reduced to the distance between the two parallel wires; and if an earthed concentric conductor constitutes the mains, there will be no current at all passing through earth from one conductor to the other.

The following are the main conditions under which street mains may be earthed:—The feeders to the network should be insulated at the dynamo end, and throughout their length to the feeding point. The earthed conductor of the network should be uninterrupted by fuses or switches throughout. With continuous currents the negative would be the earthed conductor, and it should be insulated to a light degree to provide

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against electrolysis, but be earthed at each feeding point and house connection. If alternating currents are used, the insulation on the earthed conductor is not a necessity. If concentric cables are used, the earth connections may be omitted. To reduce as far as possible the pressure between different points of the earthed conductor, the extreme ends of branches should be connected together and where possible back on to the mains. A further saving in fall of pressure may be effected by putting the extra metal that would be added to both conductors above the normal capacity all into the earthed conductor; this would specially refer to continuous currents and a two-wire or concentric system.

An earthed concentric system for street mains has special advantages as an earthed system, whether for double or three wires, and the service joints are exceedingly cheap to make. Notwithstanding an earthed street system, it will be understood that both wires in the houses should be well insulated, except with concentric, and the switches and fuses would be inserted in the non-earthed conductor only.

The writer has had sufficient experience both with earthed street mains and earthed interior wiring, concentric and two-wire, to be able to assert that telephones and telegraphs interference is at least no greater with a properly arranged earthed system, whether for continuous or alternating currents, and the same may be said with regard to electrolysis.—Yours, &c.,

J. D. F. ANDREWS.

45, Fulham Park-gardens, S.W., May 14, 1895.

CURIOUS VACUUM TUBE PHENOMENA.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With regard to the behaviour of a vacuum tube, as cited by your correspondent, Mr. W. Lomas, in May 10th issue, I have often noticed the after-glowing in question, but cannot say I have ever regarded the explanation as very obscure. The same explanation of course holds for the shocks obtainable from a tube. Both are due to the discharge of accumulated electrostatic strain in the glass.

The following experiment, in which a clean, dry glass plate without conducting coatings is charged in a similar manner, may make clear the actions taking place which give the effects spoken of. The knobs of a Wimshurst machine, preferably minus the jars, are placed so that on turning a continuous discharge is kept up from knob to knob. In the path of the discharge insert the glass plate. The discharge still continues vigorously for a time on either side until the plate is fully charged. Proof of this charged state can then be had by laying the glass flat on a smaller piece of insulated tinfoil, and placing a similar piece of foil on the upper surface, in which case the glass and foil simply constitute a charged Franklin's pane, from which shocks or the usual Leyden jar discharge can be obtained.

In the vacuum tube the electrostatic capacity producing the effects is not at all inconsiderable on account of the amount of surface and thinness of the glass. On presenting the tube to the machine to obtain a glow, the fingers or hand (and the effect is increased if the tube be completely grasped by its centre in the hand) represent a conducting coating already on one side of the glass, and it is not even necessary that the tube should be exhausted in order to charge the glass from the inside. The exhaustion is necessary, however, to obtain a shock from the tube, as the inner surface is, of course, more readily discharged through rarefied gas. The after-glowing is due to the gradual discharging of the tube as the outside charge creeps over the surface to the electrodes.—Yours, &c,

Postal Telegraphs Instrument Factory, J. E. TAYLOR.
Holloway, N., May 13, 1895.

ACCIDENT AT CHELMSFORD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: An accident occurred to one of our men in connection with the electric lighting of this town, and as we notice that an erroneous description of the causes which led to the accident has found its way into the papers, we beg to give you what we believe to be the true facts of the case, so far as we have been able to ascertain them.

Our man went up a ladder placed against a pole in order to fix some new insulators for a new circuit. He hooked a linesman's vice on to the steel suspending wire of the street lighting circuit, which was then switched off. This steel wire was probably charged by induction from the neighbouring private lighting circuit, so that when our man placed his hand upon it, and touched the lightning conductor or transformer case, which was connected to the earth, he received what is called a static shock, harmless in itself, but which probably caused him to lose his balance. He fell 20ft., and has received serious injuries, which are, we believe, entirely due to his fall, and not in any way connected with the static shock, but we hope he will make satisfactory recovery.—Yours, &c, A. H. POTT.

Arc Works, Chelmsford, May 14, 1895.

PROF. FORBES'S ROYAL INSTITUTION LECTURES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In attributing to me the particular modification of Lord Armstrong's cotton thread experiment shown by Prof. Forbes at the Royal Institution last Tuesday, I fear you are giving me credit to which I am altogether unentitled.

The experiment was shown at the Royal Institution in precisely the same form as that in which Lord Armstrong himself exhibited it to the Literary and Philosophical Society, Newcastle-on-Tyne, in February, 1893.—Yours, &c.,

May 10, 1895. A. A. C. SWINTON.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *May 3, 1895.*

General Electric Company's Annual Report.—The third annual report of the General Electric Company was made public on Wednesday, and while it shows that a profitable business was done during 1894, but little improvement in the position of the Company is indicated. The sales for the year 1894 aggregated $12,540,395, and receipts from other sources brought the total up to $13,263,611. The gross profits were $1,811,747, against which are the following charges: Interest on debentures, $464,583; various old losses between 1894 and earlier years, $443,023; cost of patents and franchises acquired during the year, $162,293; depreciation of inventions, $288,401; sundry losses, $38,798; leaving a net profit of $414,642. Notwithstanding the fact of the expiration of three of the most important patents of the Company during the last year —the incandescent lamp, feeder-and-main and Thomson arc regulator patent—that asset is yet carried at $8,159,264, which is the same as appears on the first annual report of the Company made three years ago. Among the losses noted are $945,000 through the failure of the North-West General Electric Company, and an asset added consists of a claim of $1,137,555 against the Fort Wayne Company, now in the hands of a receiver; in connection with the latter item it may be stated that in last year's report the stock and bonds of this Company, held by the General Electric, were scaled by the latter to $1.00 from over a million. This year's statement shows that the debt of the Company, other than outstanding debentures and real estate liens, has been reduced from $2,022,454 to $90,021, but, on the other hand, the profit and loss balance, or shrinkage of assets, is raised from $12,454,967 to $14,794,716.

Niagara Power for Buffalo.—The Committee of the Buffalo Council charged with specifying the terms of a franchise permitting the Niagara Company to sell electric power in Buffalo, after unusually lengthy deliberation, handed in its report on Saturday of last week. In brief, it is proposed to grant a franchise for 25 years, at the expiration of which time the City may purchase the plant at appraisal, on one year's notice of its intention to purchase, and if such notice is not given, the grant is to be renewed for another 25 years or longer term, subject to such conditions as the Council may impose. A bond for $250,000 is called for. The grant is not to be transferable or

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assignable without the Council's consent, and there is a provision against consolidating or merging with any other company to prevent competition or reduction in price. The grant provides that accommodations shall be afforded on poles or in conduits for at least two other companies requiring the same facilities as the Niagara Company, which extra space may be used by the City for public purposes without charge. Free accommodation is to be provided for fire alarm and police wires, and the Company will be required to supply the city with power to run the waterworks or for other public purposes at not exceeding $20 per horse-power per annum for use 24 hours in the day, and to light the streets at a cost not to exceed $50 a year for each electric light of 2,000 c.p. It is also provided that any contractor may have electricity at the city line for street lighting at the same figure. When applications aggregating 1,000 H.P. come from within a radius of a mile from any part of the city where the company has not constructed a line of transmission, and the applicants tender contracts for at least one year, accompanied by a satisfactory bond, the Company may be ordered by the Common Council to extend its line of transmission within six months so as to comply with these demands. The Company must be prepared to supply 10,000 H.P. to consumers before December 31, 1895, and 10,000 additional every year thereafter for four years in accordance with the demand. The general plan is to be under the direction of the Council, the details under the superintendence of the Board of Public Works. No price is specified for the cost of supply to private consumers, but one consumer cannot be charged more for the same or less quantity of electricity than another, or more than the Company will charge other persons further from its Niagara generating station.

LEGAL INTELLIGENCE.

Muirhead and Others v. the Commercial Cable Company.

The defendants' appeal in the case of Muirhead and Others v. the Commercial Cable Company was in the list on Tuesday last for hearing in the House of Lords. It will be remembered that the action, which has reference to a patent for the duplex working of submarine cables, was tried in March, 1894, before Mr. Justice Kennedy, who gave judgment for the plaintiffs, a decision which was reversed on appeal in December last.

Counsel for the plaintiffs: Mr. Finlay, Q.C., Mr. Bousfield, Q.C., M.P., and Mr. E. H. Pollard; for the defendants: Sir Richard Webster, Q.C., M.P., Mr. Moulton, Q.C., M.P., and Mr. Walter. On the case being called, Mr. Finlay, Q.C., for the plaintiffs, stated that their lordships would not be asked to adjudicate in the matter, which had been settled by the parties on terms which did not transpire; but we understand that the plaintiffs have succeeded in their claim, and that a considerable sum has been paid to Messrs. Muirhead for royalty.

Crossley Brothers (Limited) v. Peel and Others.

On Monday last, in the House of Lords, an appeal of considerable importance to engine and machinery builders was decided. It was an action in which Messrs. Crossley Brothers (Limited), the well-known gas engine makers, resisted the contention of the official assignees of the Court of Bankruptcy in Ireland as to the legal construction to be placed upon an ordinary hire-purchase agreement. The bankrupt, T. F. Peel, had obtained from Messrs. Crossley Brothers a gas engine which he agreed to pay for by instalments, the agreement expressly stipulating that until the payment of the £240 by instalments had been completed the engine was to remain the property of Messrs. Crossley Brothers, who were empowered on the failure to pay any of the instalments either to sue for the unpaid balance, or to demand the return of the engine. Only £60 was so paid, and after the bankruptcy of the hirer, Messrs. Crossley Brothers demanded the engine to be returned, but the official assignees in bankruptcy disputed the firm's right, and they succeeded in obtaining a verdict to this effect in the Irish Bankruptcy Court. The Irish Court of Appeal, however, set aside this verdict, and the assignees then appealed to the House of Lords, with the result that the judgment of the Irish Court of Appeal was upheld with costs, the Lord Chancellor stating that it was a very plain case of an agreement between the parties which must be construed precisely as though no bankruptcy proceedings had taken place and apart from any statutory provisions. The parties to it had in terms expressed their intention that the property in the engine should not pass until the instalments were paid. He knew no reason why such an agreement should be regarded as an illegal one.

H. Binko and Co. v. Leslie.

This case was heard in the City of London Court, on the 13th inst., by Mr. Commissioner Kerr. It was a claim by the plaintiffs, of Leadenhall-street, for £2. 10s. for goods supplied to the defendant, as the receiver of Woodhouse and Rawson United (Limited). The defendant's solicitor said the goods were supplied neither to Woodhouse and Rawson nor to the defendant, but to one Long, who gave the order on his own behalf. Long would have paid for them but for a dispute. The plaintiffs' case was that the goods were received by Woodhouse and Rawson, one of whose boys signed for them. It was said that the boy had no authority to sign for them on behalf of the firm, but the learned Commissioner found for the plaintiffs, with costs.

Carter, Saunders and Co. v. Rummens.

Mrs. Elizabeth Rummens, of 48, Leadenhall-street, E.C., was sued in the City of London Court by the plaintiffs, of Great Turnstile, High Holborn, London, W.C., for £4. 19s., the price of telephones supplied, as alleged, to her. It seemed that the telephones were supplied by the plaintiffs on sale or return, and that after a time they stipulated a date on which the goods were to be returned, or else to be considered as sold. The defence was that the telephones were supplied to the defendant's son, and not to the defendant's order at all. Mr. Commissioner Kerr found for the defendant, but disallowed her costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Although about 100 pages are added to the book, no addition is made to the price, which is 7s. 6d., post free 8s. 3d., abroad 9s.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices:—*

LABORATORY NOTES AND FORMS.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. A full prospectus can be obtained post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s. —each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains some 230 illustrations, a large proportion of which have been specially made for the book. The price is 10s. 6d. post free (abroad 11s.).

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"ELECTRO-CHEMISTRY."—This useful work, by Dr. G. Gore, is still on sale, the price being 2s., post free.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. net., is now ready.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson, price 6s. 6d., post free.

"THE ELECTRICIAN."—A special notice concerning certain changes in the price, &c., of this journal will be found on page 86.

TENDERS INVITED.—The Corporation of Birkenhead invite tenders for the supply and erection of apparatus and plant for their electric supply works. Tenders must be in by 12 noon of the 23rd inst.

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TENDERS INVITED.—The Electric Lighting Committee of the Huddersfield Town Council invite tenders for cables, transformers, switches, fuses, and covers for their electric lighting works during the ensuing 12 months. Specifications and particulars can be obtained of Mr. A. B. Mountain, borough electrical engineer, St. Andrew's-road, Huddersfield, and tenders have to be sent in to Mr. Mountain not later than Saturday, June 1st. Some particulars are given in our advertisement columns.

——— The Corporation of Hanley invite tenders for the supply, delivery, and erection complete of boilers and fittings, water tank and girders, arc lamps, of cables, street boxes, &c., transformers, switches, &c., under contracts Nos. 12, 13, 14, 15, and 16. Forms of tender, specification, &c., can be obtained at the Town Hall, Hanley, Staffs , and tenders have to be sent in to Mr. Joseph Lobley, borough engineer and surveyor, before Monday, the 27th inst. Some further particulars are given in our advertisement columns.

——— The Corporation of Brighton invite tenders for—(a) Preparation, supply and delivery at Brighton of cast-iron lamp pillars and copper canopies ; (b) Preparation, supply and delivery of cast-iron and drawn steel bracket posts, for which tenders must be sent in before 10 a.m. on Monday, May 27th. Drawings, &c., may be had from the offices of the borough engineer and surveyor, at the Town Hall, Brighton. Some further details will be found in our advertisement columns.

——— The Electric Light Committee of the Oldham Corporation invite tenders for two 200-H.P. steam engines and dynamos and steam pipes. Specifications, &c., can be obtained from Mr. A. Andrew, at the Gas and Water Offices, Oldham, and tenders must be sent in to Mr. Andrew not later than Tuesday, May 28th. Some particulars are given in our advertisement pages.

——— Tenders are being invited until June 29th by the Municipal Authorities of Brailă, Roumania, for the concession for the lighting of the public streets either by electricity or gas.

——— Tenders are invited for the construction of foundations for new engineering works at Rugby for Messrs. Willans and Robinson (Limited). Plans, &c., can be obtained of Mr. T. W. Willard, architect, St. Andrew's Chambers, Rugby, and tenders, addressed to the secretary of the Company, Mr. C. S. Essex, Picton House, Thames Ditton, Surrey, must be in by the 30th inst.

——— Tenders are required for the installation of an electric lighting plant at Elswick Lead Works, Newcastle-on-Tyne, for Messrs. Walkers, Parker and Co. (Limited). Tenders to be in by May 16th.

TENDERS ACCEPTED.—The tender of Messrs. Rogers and Co. has been accepted by the Hampstead Vestry for the construction of transformers and draw-boxes, for the sum of £57 for each large transformer chamber, £49 for each small chamber, and £3 for each draw-box.

——— The Huddersfield Borough Council have accepted the tender of Messrs. S. Z. de Ferranti (Limited) for plant required at the electricity supply station, for the sum of £3,558.

——— The Londonderry Town Council have accepted the tender of Messrs. Siemens Brothers and Co. for the supply of arc light carbons.

——— The Bolton Corporation have accepted the tender of Messrs. Hick, Hargreaves and Co. for an additional engine for their electricity works.

SALE BY AUCTION.—Messrs. Wheatley Kirk, Price and Goulty will sell by auction at the works of the Leeds Machinery Stores Company, Kirkstall-road, Leeds, *on Tuesday and Wednesday next*, the entire stock of new and second-hand machinery detailed in our advertisement columns. Particular attention is called by the auctioneers to the large number of valuable machines to be disposed of. Further particulars and catalogues can be obtained at the stores, Kirkstall-road, Leeds, or of the auctioneers, 49, Queen Victoria-street, London, E.C., and Albert-chambers, Albert-square, Manchester.

APPOINTMENTS VACANT.—The Governors of the Woolwich Polytechnic invite applications for the following appointments :—(1) Principal of the Polytechnic, (2) Head of Social and Recreative Department, (3) Clerk to the Governors. Some particulars are given in our advertisement columns, and all further information can be obtained with forms of application from the office of Mr. W. Garnett, the hon. secretary, 13, Spring-gardens, S.W. Applications have to be in by 10 a.m. of May 25th.

——— The Tunbridge Wells Town Council require a resident engineer for their electricity works. Salary, £250 per annum. Applications have to be in by the 25th inst.

APPOINTMENT.—The Hampstead Vestry, having considered the qualifications of the six gentlemen mentioned in our last issue at its meeting last week, finally selected Mr. G. H. Cottam, of Hanley, who obtained 34 votes, against 26 received by Mr. E. Sayer, of Hampstead. Mr. Cottam, who is 44 years of age and a member of the Institution, has for some time past been chief electrical engineer to the Hanley Corporation Electric Lighting Works, and has had a very varied experience in engineering and electrical work. The commencing salary at Hampstead is £300 per annum. Mr. Sayer has been appointed to take charge of the station until Mr. Cottam finally takes up his duties.

DISSOLUTION OF PARTNERSHIP.—Messrs. J. S. Morris and C. C. Gold, carrying on business as electrical engineers under the style of Morris and Gold at Wardrobe-chambers, Queen Victoria-street, London, E.C , have dissolved partnership.

MESSRS. POPE, BODDY AND CO.—In order that there may be no misunderstanding as to the effect of the retirement of one of the partners (Mr. Barker), we are desired to state that there is no alteration whatever in the business of this firm, but that everything will continue as hitherto. Messrs. Pope, Boddy and Co. report that the sale of their incandescent lamps has rapidly increased, and that they have a good demand throughout the country. Mr. Pope, who was one of the first to engage in the incandescent lamp business in this country, has been for some time past engaged in making some improvements, which are now completed, and the patents taken out. Under these improvements plaster has been superseded, with the result that the life of the lamp has, it is stated, sensibly increased. In addition it is claimed that the material of the old lamps can be used up again, including the bulb and the old cap. A metal ring is used attached to the glass on which the cap is fastened, enabling the parts to be easily disconnected. Other claims are—1. Perfect insulation, enabling the lamps to be burnt in any atmosphere without danger of loss of current through saturation ; 2. No interruption of circuit through current passing from one pole to the other; 3. Absence of heating other than that caused by the energy expended in the lamp; 4. Owing to the absence of plaster there is less liability of the glass cracking at the leading-in wires through expansion or contraction. In *The Electrician* for November 25, 1892, a report appeared, in which, from the result of experiments made, favourable mention was made of these lamps ; and the firm claim that since that period many improvements have been adopted.

BANKRUPTCY.—The first meeting of creditors in the bankruptcy of P. C. Pope, electrical engineer, of Hapton, near Burnley, will be held at the Exchange Hotel, Burnley, on May 23rd, at 3:30 p.m. The public examination takes place at the County Court, Burnley, on the same day, at 11 a.m.

DIVIDEND.—Notice is given that a second and final dividend of 11d. in the £ is now payable in the liquidation of Newington, Priddle and Co. (Limited), at the Official Receiver's, 33, Carey-street, London, W.C., any day except Saturday.

REMOVAL.—The "Empire" Telephone Company, who are also makers of the electro-magnetic "Victory" telephone, have removed to 1, Lombard-court, 32, Gracechurch-street, London, E.C.

PERSONAL.—Mr. Richard J. Middleton, manager of the *Mining Journal*, has opened a mining agency at Broad-street House, London, E.C.

AMSTERDAM.—At an exhibition opened in this city on Saturday last, which was originally to be one of hotel equipment and travel, but which has considerably developed. In addition to a large number of exhibits showing plant in connection with the construction and equipment of railways and shipping, there are many of the latest electrical novelties, including "an electrical restaurant," where guests are served by means of electric contrivances.

ARGENTINA.—The Government at Buenos Ayres has contracted with Messrs. Bonison and Mautalen for the construction of a building for the electric light station for the illumination of the port works, at a cost of $49,450.

ASHBY-DE-LA-ZOUCH.—The Gas Committee of the Urban District Council, in recommending that the arrangements for lighting the district by gas should be renewed up to March, 1896, further recommend that the Council should take into consideration the advisability of lighting the town by electricity. The Committee's report was approved.

ASYLUM LIGHTING.—The Hartwood Lunatic Asylum, recently erected for the Lanark District Lunacy Board, and which was formally opened on Tuesday last, is lighted throughout by electricity. 1,260 lamps, from 8 c.p. to 100 c.p., are used. Besides the generating plant, storage batteries equal to the entire capacity of the lamps have been installed. The various sections of the building are being connected by telephone.

BELFAST.—In this city, as in the metropolis, the question of the telephone service is one upon which the leading business men feel keenly. In December last a severe storm interfered seriously with the working of the service, and the storm of January 13th completed the havoc. Since this time the telephone service of Belfast has left much to be desired. At the quarterly meeting of the Chamber of Commerce, last week, Mr. J. H. Greenhill brought the

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matter forward, and said the telephone in a city like Belfast had become a matter of necessity, and the whole subject called for the immediate attention of the Chamber. There could be no doubt that if the telephone were properly worked it was an immense advantage to business men, but, if badly worked, was a nuisance and a hindrance to business. The Company who provided them with the telephone had received the sympathy of their subscribers owing to the heavy gale which prevailed in December last, but at the same time it was thought by many of them that after four or five months had elapsed it was time that the wires were put in working order again, as it was not difficult to see that the time would shortly come round when another storm would put them *hors de combat*, and leave the subscribers in even a worse position than before. No blame, he thought, attached to the local managers of Belfast; but he thought there was a want of vigour in the governing body. The agreement they had signed with the Telephone Company was a very stringent one, and seemed to him to show a clear want of mutuality of conditions that it was questionable if it could be sustained in a court of law. When, in addition to this, it was remembered that telephone subscribers paid in advance the onesidedness of the arrangement was apparent. He thought it a proper question for the Chamber to consider whether the Company, having received payment in advance, and having failed to render in return the services agreed upon, were entitled to the payment made. If a subscriber could call upon the Company to refund a portion of the money paid in advance for services not rendered, it would be an incentive to the Company to give more prompt attention to the requirements of their subscribers. Perhaps there was an analogous instance in the case of one of the English railway companies, where a number of passengers booked through to a certain destination, and after getting a certain distance they were impeded by a snow storm and were unable to proceed further. The railway company, after looking into the matter, found that it was necessary for them to return the fares for that part of the journey which was not completed. He was not quite sure whether the same rule would not apply to the Belfast Telephone Company.—Mr. G. McConnell supported Mr. Greenhill, and said that with regard to the agreement they must sign it or their telephone would be taken away; they must pay in advance or their telephone would be cut off; and they had to pay whether the services were rendered or not. If the Company knew that they would not be paid for any time the services were not rendered, he believed repairs would be made more quickly, and better attention would be paid to the wants of the subscribers.—Mr. Greenhill subsequently proposed "That the alleged imperfections in the working of the Belfast Telephone Company's service, as well as the stringency of the conditions imposed upon subscribers, be referred to the law committee of the Chamber to consider and report to the Council."—Mr. C. C. Connor, M.P., Chairman of the local directors of the Telephone Company, thought it was not at all unnatural that attention should be drawn to the delay in repairing the telephone system after the great storm of December last; but if they were conscious of the enormous amount of damage that had been done, and the number of wires that had been destroyed, he thought they would have more consideration for those in charge of the system. In addition, the still more serious storm on January 13th did more harm to the telephonic and telegraphic system than even the great storm of December. After the storm in January they had 480 exchange wires missing from the exchange in Belfast alone. The Company had put up 300 miles of new telephonic wires since the December storm, and were still continuing the repairs. As to who was to bear the loss of the interrupted service, it must be remembered that this was beyond all human control, involving great expense to the Telephone Company, and he thought that it was not unreasonable for the Company to ask that the subscribers should themselves bear the loss—(laughter)—that was to say, should put up with the deprivation of service. Mr. Greenhill's proposal was carried.

Belgium.—A Foreign Office despatch from Her Majesty's Minister at Brussels, dated March 27th last, contains two maps—one of the Belgium railway system and another showing postal, telegraphic, and telephonic facilities throughout the kingdom.

Bowness.—The proposed agreement between the Urban District Council and Messrs. R. H. Fell and Son for lighting this village by electricity has been approved upon the recommendation of the Lighting Committee.

Bury St. Edmunds.—The leading local firm, Messrs. Oliver and Richardson, have recently put down plant for the lighting of their business premises in Abbeygate-street by electricity, and have obtained the permission of the Local Authorities to supply current to tradesmen on the opposite side of the street, necessitating the opening of the roads. The gas interest on the Town Council were opposed to permission being given, but finally the recommendation of the Highways and Waterworks Committee granting the request was approved, subject to the conditions of the Electric Lighting Act.

Cheltenham.—At the last meeting of the Town Council, Mr. Alderman Norman presented the Electric Lighting Committee's report, which stated that the supply station had been running from April 9th, and from the start there had been no hitch or anxiety. They had begun the supply with a total equivalent of about 2,000 8 c.p. lamps wired, and he had little doubt that the Committee's anticipations would be justified and the electric light prove no burden upon the ratepayers.

Church Lighting.—The church at Buckland, near Dover, has for some time past been lighted electrically, and a letter from the vicar and churchwardens states that "after a month's trial of the electric light we consider it only right to say that the result is indeed gratifying, exceeding by far our most sanguine expectations. For the three months ended March 31st the cost of gas was £3. 18s. 3d., while with electricity, based upon the consumption during the last month, it would have been £3. 5s. 1d. For the purpose of this test the church has been lighted during April for the same number of hours as in January, and thus shows an absolute gain of 13s. 2d. per quarter. Our other substantial gains are improved ventilation, intensity of light, and cleanliness. We can strongly recommend its adoption to other churchwardens."

Colwyn Bay.—At the last meeting of the District Council it was decided to appoint a committee to take the necessary steps for obtaining a Provisional Order to enable the Council to supply the district with the electric current.

Cowes (I. W.)—Mr. Nelson F. Dennis, the town surveyor, has presented a lengthy report, including a scheme for lighting a portion of the town by electricity. Under this scheme it is proposed to first of all provide plant equivalent to 2,200 8-c.p. incandescents, with an ultimate main capacity of 3,000 lamps. Willans' engines and Cornish boilers with Meldrum's furnaces, are recommended, together with an accumulator set capable of taking the entire day load. The scheme is estimated to involve an outlay of £6,000. The annual maintenance is estimated at £1,100, and the revenue at £1,275, plus £133. 10s. per annum for public lighting. At its meeting on Tuesday evening the District Council discussed the advisability of employing an expert, but ultimately it was decided to refer the whole matter to the Water and Lighting Committee to bring up the names of several experts, and to prepare and provide other information on the subject for an early meeting of the Council.

Code Telegrams to China.—The Eastern Telegraph Company notify that they have received advice that the Chinese Government will now accept code telegrams for inland stations in China without restriction.

Crewe.—At the last meeting of the Town Council a letter from Mr. W. Wade, builder, asking the Council if they were favourable to a tramway being laid down from the corner of the gasworks to the Queen's Park, which could be worked by horses or by electricity generated from the waterfall in the Park, was referred to a committee for consideration and report.

Customs Tariffs.—Under the British Honduras tariff ordinance of 1895, included in the articles which are exempt from duty are: Plant and materials for railways, telegraphs, telephones, tramways, and electric lighting. The Legislative Council of St. Vincent, on the 14th of March last, passed an ordinance exempting machinery driven by steam, water, electricity, gas or compressed air; telegraphic wire, telegraphic, telephonic and electrical appliances of all kinds for communication or illumination, including all material required for use by the West India and Panama Telegraph Company.

Dublin Tramways.—We have received from Mr. Robert Hammond a copy of his "Report on Electric Traction in Dublin," addressed to the Directors of the Dublin United Tramways Company. This report sums up strongly in favour of the side trolley.

Exhibition.—There is to be a great national exhibition at Kioto (Japan), which is to continue open till August, 1895 (?1896). An association called the Taihina-Kyokwai has been formed with the special object of affording information and generally helping intending visitors to the exhibition, one of the chief objects of which is to introduce to Japanese specialists those who desire investigation in science, arts, and manufactures. The association is also to be a medium for business transactions between foreigners and the Japanese.

Expansion of Telegrams.—*The Times* of the 15th inst. contains a moderately worded but effective protest against what appears to be, if the facts are as stated, a most reprehensible practice on the part of the Central News Agency. In *The Times* and other London dailies of February 8th, telegrams appeared purporting to be dated from the seat of war between China and Japan (Wei-hai-wei, *via* Talienwan, February 5th). The telegram, as it finally appeared in *The Times*, contained rather more than 500 words out of the 655 words originally sent out by the News Agency in question. According to one of the leading Japanese journals, the *Kobe Chronicle*, the original message, "the origin of which was Tokio or

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Yokohama," contained only 216 words, so that two-thirds of the message as sent to the London Press was manufactured in London. This is a serious charge, and it is to be hoped that the Central News Agency will be able to satisfactorily meet it, as it is most important that the public should not gain the impression that lengthy items of foreign intelligence appearing in the Press are manufactured in Fleet-street, where not only the offices of the London but also those of the provincial dailies are centred. It is recognised that the great London dailies observe the utmost care in the preparation for publication of their telegraphic news, and especially is this the case with *The Times*, which has a grand reputation for special telegraphic information.

Factories and Workshops Bill.—The House of Commons Grand Committee on Trade met for the first time last week, and discussed Clause 1 of this Bill. On the question of the provision enabling the Home Secretary to increase the cubic space "for any period during which artificial light is employed," Mr. W. Allan moved to add after "artificial light" "other than the electric light." This was supported by Mr. Mundella and accepted, placing the electric light in a distinctly favourable position so far as regards the carrying out of the provisions of this Act. In factories and workshops where space is limited this amendment of Clause 1 will enable the full staff of hands to be employed for overtime hours as for ordinary hours, whereas where gas and other illuminants are employed the extra cubic space required necessitates a considerable reduction in the number of employés who can be kept for overtime work.

Falmouth.—Notwithstanding that the question of lighting this town by electricity is under the consideration of the Local Authorities, a committee was appointed by the Town Council at its meeting on Monday last to consider the question of purchasing the local gas works.

Fareham.—Some alarm is being felt by many prominent residents of this town as to the possible cost of the litigation between the District Council and the Fareham Electric Light Company. A deputation was appointed at a meeting of ratepayers held last week to approach the Directors to see what steps could be taken to stop the litigation.

Hospital Lighting.—The Brook Hospital Committee, at the meeting of the Board last week, reported having given careful consideration to the question of the appointment of an electrical engineer for the installation of the electric light at the Hospital, and recommended that the Committee be authorised to employ Prof. A. B. W. Kennedy to design the installation for the electric lighting, to draw the necessary reports, plans, and specifications, and supervise the execution of the works, at a commission of 5 per cent. on the cost thereof, out-of-pocket expenses and the wages of the clerk of the works being extra. After some discussion the report was approved.

Hove (Sussex).—At the meeting of the Urban District Council last week, on the report of the Works and Improvements Committee, attention was called to the cost of lighting the public streets by electricity. Mr. C. T. Cheesman, Chairman of the Committee, stated that the Surveyor was preparing a report relative to the comparative cost of gas and electric light, but, so far as the Committee were at present advised, he stated that the price of electric current was so much higher than that they were now paying for gas that he did not think the Council were likely to substitute electricity.

Huddersfield.—At its meeting this week the Borough Council instructed the Town Clerk to take the necessary steps to obtain borrowing powers for a further £50,000 for electric lighting purposes.

Institute Lighting.—The premises of the Central Art Department of the London Technical Education Board, situate in Bolt-court, Fleet-street, E.C., have been wired throughout for the electric light by Messrs. Wenham and Waters, current being taken from the City of London Company's mains. Two 200-c.p., seven 150-c.p. and two 100-c.p. Sunbeam incandescents are used. Provision has also been made for two 2,000 c.p. arcs being provided for photographic work. A large number of smaller candle-power incandescents are used in the class-rooms.

Islington (London, N.).—In a report issued on Wednesday the Finance Committee of the Vestry submit a correspondence which has passed between the Vestry Clerk and the Comptroller of the London County Council with reference to a loan of £51,000, which the Vestry require for electric lighting purposes. The Finance Committee of the Council, having obtained the consent of the Treasury, are prepared, as an alternative to their proposal, to sanction the loan for land, buildings, and bare copper mains (estimated to cost £18,000) for 50 years, and for all other machinery (estimated to cost £33,000) for 20 years, to recommend the Council to sanction a mean period of 42 years for the repayment of the whole amount "on condition that if any portion of the machinery requires to be renewed during this mean period it shall not be made the subject of a new loan." The Vestry's committee point out that acceptance of this condition would render it necessary, besides providing for the annual repayment of capital and interest, to further burden the undertaking (or possibly the ratepayers) during its earlier years by the creation of a renewal fund to provide not only for the wearing-out of machinery, but for the possibility, owing to the advance constantly taking place in electrical science, of portions of such machinery becoming obsolete during the currency of the loan. Further, it is considered doubtful whether the Council, in sanctioning a loan, has power to limit the period for repayment provided by Section 8 of the Electric Lighting Act of 1882 and Section 190 of the Metropolis Management Act, 1855. The Vestry's Committee, therefore, advise that counsel's opinion be taken on this point, and meanwhile the Vestry Clerk is asked to make a formal demand for the County Council's sanction to the loan.

Leyton (Essex).—The Hall Building Committee of the District Council have presented an interesting report on the subject of lighting the Town Hall and Municipal Buildings by electricity. The estimated cost of this lighting is £1,250, with a further expenditure of about £400 if the whole of the buildings are lighted. The Committee are of opinion that the buildings, including the present offices, should be lighted by electricity rather than gas, although the former is more costly than the latter, and the Committee recommend that they should be authorised to arrange for specifications, &c., and that tenders be invited for the necessary work. After a brief discussion the Committee's report has been adopted.

Litigation.—We learn that the Edison and Swan Company have commenced legal proceedings against an electrical firm and one of the licensees under the Company's holders patents, for breach of the licence in giving to customers a larger discount than the allowed maximum. For some time past there have been rumours that some of the licensees were selling holders at a lower price than that fixed by the Company under the terms of the licence, and recently a committee of the licensees was, we understand, formed in order to establish "an honourable understanding" among the licensees that this underselling should be discontinued. The terms of the licence are very stringent, as will be seen from the following:—

"The licensee shall not make or allow any discount commission rebate return gift or allowance to customers greater than the discount from time to time allowed by the Company."

The Edison and Swan Company gave notice on December 31st last that, should any future breach of this condition be proved, they would take legal proceedings for an injunction and for damages, and it is hoped that the legal proceedings now being instituted will put an end to any unfair advantage being taken.

London County Council and Sardinia-street Station Extensions.—At the weekly meeting of the London County Council, on Tuesday, it was agreed, on the recommendation of the Building Act Committee, "That, subject to the provisions of Section 76 of the London Building Act, 1894, the consent of the Council be given to the erection and construction of a dynamo room (over and in connection with the boiler house) at the Metropolitan Electric Supply Company's premises in Sardinia-place, Lincoln's Inn-fields, to exceed in extent 250,000 but not 450,000 cubic ft., and to be used only for the purposes of generating electricity, as shown by the plans and particulars submitted on behalf of the Company, on condition that the whole of the work be executed to the satisfaction of the district surveyor; and that if the said plans, particulars or application be hereafter found to be inaccurate in any respect the said consent shall be null and void."

Mansion Lighting.—The Duke of Montrose has entrusted to Messrs. Drake and Gorham, of 66, Victoria-street, Westminster, S.W., the lighting of his town house, 27, Pont-street, S.W. The entire building is to be lighted electrically.

Melrose.—It is reported that a firm of electrical engineers have offered to undertake the lighting of Melrose. The price suggested to be charged for current is 7d. per unit, upon a guarantee of 1,000 lamps of 16 c.p.

Mildenhall.—An extensive range of buildings is being erected at Mildenhall as a workhouse and infirmary for the Mildenhall Union. The contractors are Messrs. Kerridge and Shaw, Cambridge. The question of lighting has not yet been settled, but in all probability the electric light will be adopted, on the score of economy for no other reason, as gas is very expensive in the district.

Mill Lighting.—A complete installation of 1,200 lights is being fitted in the Valley Mills of Messrs. James Nelson and Co., of Nelson, Lancs., the work being carried out by Messrs. Coates Bros. The dynamos are being built by the Coventry Electrical Engineering Company, and will consist of two 600-light machines running at 500 revolutions, rope-driven from main shafting, and one 250-light pilot dynamo driven by separate engine. The mill

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will be lighted entirely by electricity, gas being excluded.——It is stated that the extensive mills owned by the Harrington Mill Company at Long Eaton, Derbyshire, are shortly to be lighted by electricity, and that it is intended to form a company for the purpose, in order that current may be supplied to several factories in the neighbourhood.

NEWCASTLE.—Prof. A. B. W. Kennedy's report upon the proposal of the Corporation to purchase the undertakings of the two local electric lighting companies has been issued. Prof. Kennedy points out that the charge for current by both companies is exceptionally low, and it is therefore necessary to consider how far it is financially advisable for the city to take over the businesses. There is nothing in the Acts of Parliament nor in the usage of the Board of Trade which will compel the companies to sell; this therefore involves the condition that the companies are willing to sell at a price at which the Corporation is ready to purchase. As the Newcastle Corporation is able to borrow money at a low rate of interest, a total of 5½ per cent. per annum would pay both interest and sinking fund charges. To find the amount of earnings of each of the companies which would be available for payment of interest and sinking fund, Prof. Kennedy has subtracted from the gross profits earned in each year an amount of 1 per cent. on the capital as representing such depreciation allowance as the Corporation would probably have to make if the works were purchased. Taking the two companies together, the total capital actually expended has been £103,911, while the net profit (after allowing 1 per cent. depreciation) has been sufficient to pay 5½ per cent. on £100,200 capital. It would not be advisable for the Corporation to attempt to buy one company and not the other, and it is doubtful whether such a course would be sanctioned by the Board of Trade. Although the companies have not yet formulated their views on the matter of the values of their undertakings, it is reasonable to suppose that they would not sell at anything like the figures above quoted, and therefore it remains to be considered whether such economies could be effected in the cost of working as to warrant the Corporation's purchasing; and further, whether the town would materially gain by the electric lighting works becoming the property of the municipality. One way by which the Corporation could economise would be by connecting the two stations, so that one only need run continuously, the second supplying current during the time of heavy load. This is electrically possible, although there are some practical difficulties, and considerable expense would be involved. As at present officered, the cost of management of the companies is very low, and it is questionable whether any economies could be effected in this direction outside the directors' fees, which amount to no more than £341 per annum for the two companies. As this small sum is paid to gentlemen who render very able and effective services to the companies, it is probable that the Corporation would have to pay a much larger sum for equivalent services. Although the works of the two companies are in such a state that they may be run by the companies themselves with very little additional expense, it is doubtful whether the Corporation would be content to carry out the work under existing conditions. Taking the actual figures for the working during 1894 it might be possible for the Corporation to have done the same work as the companies for a sum of £1,200 less, but it is doubtful for many reasons, whether the Corporation would have actually effected the whole of this saving. Prof. Kennedy regrets to say that he is driven to the conclusion that it could not pay the Corporation to purchase the undertakings and goodwill of the two companies at any price covering the premium approximate to that which has been suggested by one of the companies. Finally Prof. Kennedy considers that the whole question resolves itself into the price charged per unit, and as this is exceptionally low at Newcastle, the financial success of the Corporation's proposed purchase is dependent upon their ability to increase the price to 6d. per unit, as they would be entitled to do by Act of Parliament. Prof. Kennedy could not suggest to the Corporation that they should raise the price, as he presumes this is practically out of the question, but it is undoubtedly the key to the whole situation. The price per unit charged by the Newcastle companies is 4½d. for light, and 3d. for power or day supply.

NORTHAMPTON.—At the last meeting of the Town Council a proposal by the Highways and Lighting Committee to light the market square by means of four 1,000-c.p. arcs at an annual cost of £70 was referred back for reconsideration.

OSSETT (YORKS.).—The Town Council have under consideration the question of the lighting of the town by electricity.

OXFORD.—Owing to a steady increase in the Oxford Electric Company's business, it has been found necessary to add a 100-kilowatt plant in order to accommodate the coming winter's demand. The Company have placed orders with the Electric Construction Company for a dynamo and exciter, and with Messrs. J. and H. McLaren, Leeds, for an engine. A considerable extension of the Company's mains has recently been made and further extensions are now in progress.

PERTH.—As mentioned in a recent issue, it was decided some few weeks back to light the water works electrically. It being pointed out by the Water Works Commissioners that the work would be much facilitated by this change. Tenders were issued, and the contract was placed with Messrs. Lowdon Bros., Electrical Engineers, North Tay-street, Dundee. The firm have used an 8-H.P. engine which was originally put down for pumping feed-water to the boilers; and the installation includes a 30-ampere "E.C.C." dynamo. The light was switched on on Monday last by Lord Provost Dewar, who said it was the first installation of the electric light in a public department in Perth, and he believed there would soon be a further extension. From the present installation there would be power enough to light the municipal buildings as soon as they were completed. There was considerable water-power running to waste at the city mill, and this could be profitably utilised for driving electrical machinery. Mr. Davidson, the manager of the water works, was complimented upon the success of the installation, which has been carried out by Messrs. Lowdon Bros. to his plans.

REDDITCH.—The *Indicator* in a recent issue calls attention to the advantages which would accrue to this town if the electric light were adapted. It would appear that Redditch as a town is immensely attractive from many points of view, but one of these is certainly not its lighting arrangements. It is true that the Gas Works are returning good dividends, but all the same the public lighting leaves much to be desired. Complaints have been made of the quality of the gas, and it is probable that an agitation for the adoption of the electric light will shortly be started.

RHYL.—At the last meeting of the Urban District Council an application was received from a Birmingham firm asking for permission to construct an electric railway between Rhyl and Prestatyn, and the clerk was instructed to obtain further particulars.

ROTHESAY.—At the last meeting of the Harbour Trust and Town Council it was resolved, on the recommendation of the Harbour Committee, to postpone the proposal for the electric lighting of the harbour for this year, as it had been found that the light would not be available before the end of August.

ST. PANCRAS (LONDON, N.W.).—The Electricity Committee, at the meeting of the Vestry on Wednesday, reported that with regard to the Board of Trade's recommendations in relation to the recent explosions in Euston-road and Gee-street the Vestry were now carrying out the following works:—(1) Ventilating the culverts and manholes with the view of getting rid of any accumulation of escaped gas through leakage from defective gaspipes; (2) reducing the cubic capacity of the manholes, as far as practicable, by filling them with bricks; (3) removing the present bearers and insulators in the manholes and substituting a new form of bearer and insulator with a larger insulating surface; and also, as far as it is practicable, taking steps to detect any incrustation on the insulators in the culverts. Mr. A. Sweet, in moving the adoption of the Committee's report, said that it did not follow that because the Board of Trade recommended the Vestry to do certain things the latter were bound to do them. In one instance a precaution, adopted at the instance of the Board of Trade, had proved an utter failure, and had to be abandoned. The motion was adopted. Mr. Clements objected to the Vestry borrowing from the County Council at the rate of 3¼ per cent. when, upon their own bonds, they could get money in the City at 3 per cent., or even less. He gave notice of his intention to move that the Vestry thus raise the £65,000 still needed for electric purposes. Dr. Bell remarked that the loan would be taken up locally at less than 3¼ per cent.

SHOREDITCH (LONDON, E.C.).—The Vestry have received a report from the Electric Lighting Committee that the draft specification for the construction of destructors, furnaces, boilers, flues and accessories, for which tenders are to be received by May 20th, has been settled. The Committee have decided to defer advertising for the electrical contracts until this section of the work has been definitely settled. A further consideration of the matter will take place at the next meeting of the Vestry, when tenders will be before the members. The designs for baths and wash-houses, for which an outlay of £30,000 is to be incurred, are to include provision for heating and lighting by electricity.

SOUTHAMPTON.—The Works Committee of the Corporation in their report recommended that professional advice be obtained to assist them in valuing the works of the local electric light company in reference to the proposed purchase by the Corporation. It was pointed out by several members that the company having been established so short a time no difficulty should be experienced in ascertaining the value of its electricity works. The Committee's proposal was, however, finally adopted.

SOUTH SHIELDS.—Mr. G. W. Willcocks, C.E., last week held a Local Government Board inquiry, at the Town Hall, into an application of the Corporation to borrow the sum of £28,300 for electric lighting purposes. The Town Clerk having explained the nature and scope of the scheme, the electrical engineer (Mr. J. A. Jeckell) explained the system proposed to be adopted, and the streets

through which the mains would be laid. They were in a ring, and so arranged that any section could be cut out for inspection and testing. The plant intended to be put down at first would be capable of supplying current for 2,500 lamps. The capital cost of the works, based as far as possible on the accepted tenders, was estimated as follows :—Boilers and pipes, £1,809 ; pumping plant, £905. 14s. 3d. ; engine room plant, £8,003 ; spare gear, £205 ; cables, £3,340 ; pipes, &c., £1,506. 2s. 9d. ; arc lamps, £793. 11s. ; meters, £475 ; new flagging stones, £325 ; extra transformers, £450 ; jointing on consumers, £200 ; land purchase-money, £4,400, and interest and legal expenses, £250 ; buildings, £3,500 ; deputation and office expenses, £100 ; contingencies, £500 ; engineering supervision, £600 ; printing specifications, £100 ; travelling expenses and testing plant, £100 ; Provisional Orders, £360 ; experts' report, £26. 5s. In addition to these items a further expenditure of £300 will be necessary for low-potential cables to be constructed in Ocean-road. Alderman Reynoldson (Chairman of the Electric Lighting Committee) said the entire machinery would be of a permanent kind, and of the very best and most modern type.

SURBITON (SURREY).—The Urban District Council propose at an early date to consider the question of lighting the district electrically.

TECHNICAL EDUCATION.—The annual report of the Technical Education Board of the London County Council was submitted at its last meeting. The report states that "working, as it does, in harmonious co-operation with existing institutions, the Board is glad to recognise, at the close of its second year's existence, a marked increase alike in the number of classes for every branch of technical and manual instruction, and in the attendance at such classes."

TELEGRAPH WIRE EXPORT TRADE.—April was anything but a satisfactory month as regards the export trade of this country in telegraph wire and apparatus connected therewith. The value of the exports only reached a total of £35,544, as compared with £186,739 in April of last year. The returns for the first four months of the year indicate the depression which at present hangs over this branch of trade, the total value of the exports being £99,746, against £452,018 in the corresponding period of 1894.

THEFT.—Harold Delane Radcliffe, aged 20, described as an electrician, lately in the employ of the Great Northern Railway Company, was charged at North London with stealing a number of tools and electric switches. The tools were the property of a fellow-workman, and the switches belonged to the Company. The prisoner had been in custody a week, and, as there seemed to be no object in the theft, and no reason whatever for the foolish act, he was discharged, bail being accepted for £20 to come up for judgment if called upon.

TRAIN LIGHTING.—Most of the carriages on the London, Tilbury, and Southend Railway are now lighted electrically, in substitution for the lightless and dirty oil formerly used.

YARMOUTH.—At this week's meeting of the Great Yarmouth Town Council, the surveyor reported that the monthly loss on the electric lighting undertaking was gradually diminishing. 3,900 lamps have been connected up or applied for by 75 customers. Mr. W. H. Preece presented a lengthy report on the proposed extension. Mr. Preece recommends that the lights in the streets should be doubled, but to this proposal the Council's surveyor takes exception. Mr. Preece anticipates that in two or three years the Corporation will be supplying 14,000 lamps, and that the existing plant is inadequate, and that extensions are necessary. He recommends the Council to at once provide plant equal to supplying current for 9,000 additional lamps, and his detailed estimate for this work amounts to £15,500 ; and the Electric Committee recommend the Council to apply for powers to borrow £15,500 accordingly. The Committee's report was unanimously adopted. It was also decided to place 20 25-c.p. incandescents on the band-stand in the Beach Gardens.

COMPANIES' MEETINGS AND REPORTS.

Brazilian Submarine Telegraph Company (Limited).

The forty-third ordinary general meeting of the shareholders of the Brazilian Submarine Telegraph Company (Limited) was held at Winchester House, Old Broad-street, on Wednesday, under the presidency of Sir John Pender, G.C.M.G., M.P.

The SECRETARY (Mr. Richard Collett) having read the notice convening the meeting and the minutes of the last meeting, which were approved by the present meeting,

The CHAIRMAN said : Gentlemen, I presume that you will take the report and accounts as read, but before moving the resolution I will, as usual, go over in some detail the proceedings of the last six months. The receipts for the half-year ended December 31, 1894, were £104,926, while for the previous half-year they were £94,679, showing an increase of £10,247. The receipts from messages show an increase of £10,192, and those from miscellaneous receipts from interest, rents, and transfer fees an increase of £55, resulting in a net increase, as before stated, of £10,247. The number of messages for the half-year ended December, 1894, was 96,917 ; and for the half-year ended June, 1894, 85,414, being an increase of 11,503 in the December half. The average exchange value of the Brazilian currency was, in the December half-year, $10\frac{3}{16}$d., and in the June half-year $9\frac{1}{2}$d., being an increase of $1\frac{1}{16}$d. Leaving the credit side of the revenue account, and taking the expenditure, we find that the total charges falling upon the half-year amount to £36,772, compared with those of the previous half-year, £20,269, showing an increase of £16,503. This large increase is due to the fact that heavy expenditure for repairs of cable and renewal of both shore ends at Pernambuco, the landing-place in Brazil, falls upon the half-year under review, while there were no expenses of a similar character in the previous six months. The total cost of the operations referred to, including charter of repairing steamer and new cable used, was £21,273 ; but allowing for the cable recovered, which can be used elsewhere, the total cost is reduced to a net sum of £16,402, which practically accounts for the increase of £16,503 I have given as the increase in working expenses for the half-year. My reference to the cost of this repair and renewal will serve to remind you of the heavy expenses that must from time to time occur in repairing the cables and in maintaining the efficiency and regularity of the service which has become indispensable to the Governments and commercial communities of the world. I may take this opportunity of stating that, in consequence of our having provided a second cable for the public use, there has not been an interruption of service on our route since March, 1884, a period of 11 years. The item of debenture interest and sinking funds shows a more satisfactory result, for there the expenditure is £4,841 against £12,880 in the half-year ended June last, being a reduction of £8,039, due to the termination of the interest and sinking fund in respect of the first issue of debentures on July 31st last, when the balance of that issue was paid off. Deducting the saving last referred to, £8,039, from the increase in expenses of working and repairs and renewals, £16,503, there is a net increase in charges of £8,464. But taking both receipts and expenses into account, there is, after providing for income tax, a net profit for the December half-year of £61,822, which, compared with that for the half-year to June, 1894, £59,793, shows an increase of £2,029, which, under the circumstances cannot, in my opinion, be looked upon as other than satisfactory. I have before me the heads of each increase and decrease, but I do not propose going through them in detail unless desired to do so. I may say, briefly, that the expenses in London show a small increase of £31. Those at the stations are greater by £931, which is chiefly caused by additional expenses connected with agencies established abroad for the protection of the interests of your Company. The expenses under the other heads show in the aggregate a decrease of £861. As usual in the first half of the financial year, two quarterly interim dividends at the rate of 6 per cent. per annum have been paid, leaving £24,324 to be dealt with. Of this your Directors have transferred £20,000 to the reserve fund, and the balance, £4,324, is carried forward to the current half-year. The reserve fund now amounts to £722,000, a satisfactory result after some 21 years' working. A strong reserve is absolutely necessary for such a Company as ours. We have to maintain and repair cables of great length lying in very deep water. One cable has been submerged 21 years, a period at one time thought to be beyond the "life" of a cable. With age and wear-and-tear we must expect more frequent breaks, and be prepared for much heavier expenditure in repairs and renewals of cables. With reference to the probability of the purchase of the cables of our ally, the Western and Brazilian Telegraph Company, by the Brazilian Government, I can afford no information. The Government has been authorised to acquire the cables at a certain price ; but upon investigating the matter, and fully considering all the surrounding circumstances, they may decide not to use the power given or postpone the exercise of it to some future and more convenient period. In the meantime, your Board are endeavouring to make satisfactory arrangements with the Government, whether they acquire the coast cables or not, for the working of the traffic in a way beneficial to both the Government and the people of Brazil, and to telegraph companies also. As traffic grows, reductions in rates are made. Your Directors are of opinion that an efficient and high-class service can be best maintained in combination with lower rates, as and when justified, by mutually beneficial arrangements being agreed upon between the Government, your Company, and the other cable enterprises in Brazilian waters. The lines of the Pacific and European Telegraph Company (Limited), in which we are largely interested, have now been opened for a year, and have worked with satisfactory results. The traffic grows from month to month, and it forms a very valuable feeder to the allied cable companies dealing with the traffic to and from the West Coast of South America. £55,660 appears in the balance-sheet as paid for 5,566 shares of £10 each in the Azores Company, in which we are interested, and which may eventually connect the present system with the North American Continent. I have now given you some particulars in detail, and when you look at the successful working of the half-year, and at the large reserve fund which we have now at our credit, I think you will agree with me that we occupy a very strong position at the present time. We, however, also require to maintain a thoroughly efficient system, and we can better maintain that system if all the parties interested in it join with us heartily in carrying out the views which we hold to be essential for the well-being of any submarine telegraph company. I have told you something of our prosperity. I have now to announce the death of our Managing Director, Mr. Fuller, who was associated with the Company from its inception. You cannot in any way point to the great prosperity of this Company without associating the late Managing Director's name with it. He had retired from the service, and we had agreed to pension him, as I

think it was our duty to do. He only lived a few days after he knew that he had been awarded this pension, and I can only express, on behalf of my colleagues and myself, our deep regret at losing an old colleague so closely associated with us, not only in the commercial work of the Company, but also on our Boards, where we met every alternate week. I believe you will join with me in an expression of sympathy to those he has left behind him the widow and family—and authorise me to convey to them the condolence which I will communicate to them on the part of the Board, and which I shall also be glad to express on behalf of the body of the shareholders. I have referred to the non-completion of the purchase of the Western and Brazilian Company by the Brazilian Government. Until that question is dealt with we shall probably be at a standstill. I should be glad to see that matter settled, but we cannot hasten it. It is in the hands of the Brazilian Government, and I have no doubt that the energy which the Western and Brazilian Company has shown in obtaining the approval of the purchase by the Government will also be exhibited in the direction of pushing the Government on to an early settlement of it. When that question is disposed of we may have to deal, not with a Brazilian Company, but with the Brazilian Government, and I may remind you that for 21 years of our existence we have worked in the most friendly relations with that Government. I remember well in the early days of this Company going with Captain Sherard Osborn, who was the brother-in-law of our Managing Director, to wait upon the Emperor of Brazil at Claridge's Hotel. Those are by-gone days, but the remark which his Majesty made to me at the time was one that I shall always remember with interest. He said, "We cannot give you money, but I think we have got such a trade as will give you a good return on any money you may invest, and you shall have every encouragement that we can possibly give you." I believe that those words were honestly and earnestly expressed, and I have the belief still, and I hope before long I shall be able to tell you that the relations between this Company and the Brazilian Government are as good and sound as the relations of the submarine companies generally are with the Governments of other nations. Submarine telegraphy is a broad question. No nation can do without it, and the position we hold now among the nations of the world is a very proud one. I therefore appeal to any Government that if they want to maintain a thoroughly efficient system of submarine telegraphy they must act in touch with the companies who conduct it, and who are dependent to a great extent on a fair and open field, with no favour excepting the favour of being protected against any innovations which might be destructive to the interests of the Company. We have approached the Brazilian Government in a spirit which I hope will bear fruit. I have always said, and I repeat that in connection with these telegraphs there may be different companies, but the different companies ought to act always as one, and until that system is observed the shareholders will suffer. I believe that where boards get to pulling against one another it is always the shareholders who suffer. Therefore I ask you to give your Board a full and hearty support in endeavouring to maintain such a system as will give fair dividends and satisfy the telegraphing community of the world. With these remarks I beg to move

"That the report of the Directors and the accounts to December 31, 1894, now submitted, be approved and adopted."

The Hon. W. St. JOHN BRODRICK, M.P.: I have much pleasure in seconding the motion.

Mr. W. GRIFFITH remarked that the Chairman's speech was so full of information that it was difficult to find an opportunity of asking a question, everything being anticipated beforehand. Their Company had been most successful, and he thought that the Directors had done right in investing in allied companies, but he considered that when a new company was brought out whose business was likely to assist them, the shares and debentures of such new company ought to be offered to the shareholders of the old company. The latter would then be able to support the Directors by taking up the shares, while the shareholders would be able to benefit themselves in getting a good return.

The CHAIRMAN: The policy you recommend to the Board is the policy which the Board have always practised. I think you are referring to the shares which I have alluded to—the £50,000. They are now in the hands of the Brazilian and Eastern Companies, and so that we have never gone to the public with those shares, which form part, practically, of the capital of the companies in which you are shareholders. You may depend upon it, that if we are bringing out any new company or any important enterprise, our own shareholders will have the first offer of the capital. I am reminded that in the case of the Pacific and European Telegraph Company the debentures were offered to the public, but they were first offered to shareholders. He then put the motion and declared it carried unanimously.

On the motion of Mr. JOHN NEWTON, seconded by Mr. GRIFFITH, a resolution was passed expressing the deep regret of the shareholders at the death of Mr. Fuller, and requesting the Chairman to convey to the widow and family of the deceased gentleman their sympathy and condolence.

Mr. ROBERT TAYLOR afterwards proposed a vote of thanks to the Chairman and Directors for their admirable management of the Company's affairs.

Mr. NEWTON seconded the motion, which was carried unanimously.

The CHAIRMAN stated that he had received a letter from a shareholder complaining that he was not invited to the banquet on the occasion of the 25th anniversary and "silver wedding" of the submarine telegraph companies. Taking in all the companies concerned, there would have been about 20,000 persons to invite if all had been invited, and this was simply impossible. There was something higher in connection with the celebration in question than simply £. s. d. It was a celebration of what one of the greatest living statesmen described to him as "the greatest achievement in the world's history." He believed that the shareholder who had addressed them had done so through misunderstanding the position. On behalf of his colleagues and himself he warmly thanked the shareholders for the renewed confidence they had shown in them by again according them a vote of thanks.

China and Japan Telephone Company (Limited).

The twelfth ordinary general meeting of the shareholders of this Company was held at the office, 14, Austin Friars, London, E.C., on Tuesday, under the presidency of Mr. H. Grewing.

The SECRETARY (Mr. Alexander B. Chalmers) having read the notice calling the meeting,

The CHAIRMAN remarked that there was very little for him to state, as all the information which the shareholders might find desirable in connection with the past year's operations would be found in the report. The amount of the subscriptions had been better than it was in the previous year, and so far the Company was making steady though slow progress; but, owing to various circumstances, partly through the war between China and Japan, and partly on account of epidemics which had existed, especially in Hong Kong, the sales fell off to some extent, as did also the profits, which were also markedly affected by the fall in exchange. However, in consequence of the recent rise in silver, and the conclusion of the war, it was to be hoped that these matters would rectify themselves, and that in the present year they would not only improve the total of their sales and make a corresponding profit, but also add considerably to their subscriptions. China had, so far, not taken any more kindly to telephones than it did in former years, but now that the war had changed the condition of things, the Chinese might alter their views on the subject, and might come under the Company's exchanges. He concluded by moving the adoption of the report and accounts.

Mr. THOMAS LLOYD seconded the motion, which was carried unanimously.

Resolutions were afterwards passed re-electing Mr. Lloyd to his seat at the Board, reappointing the auditors (Messrs. Price, Waterhouse and Co.), voting the Directors 200 guineas as remuneration for their services in the past year, and according a vote of thanks to the Chairman and Directors.

The Directors' report states that revenue account, after charging debenture interest, shows a sum of £387. 6s. 8d. to credit, which has been transferred to profit and loss account. Including £710. 18s. 10d. brought forward from 1893, this account shows an amount of £1.098. 5s. 6d. to credit. From this sum it is proposed to write off £526. 17s. 1d. in reduction of goodwill and expenditure on exchanges, carrying forward the balance, £571. 8s. 5d. The profit for the year shows a falling off as compared with that of the preceding year, and although the actual amount received for subscriptions has exceeded that of the previous year, the loss on remittances has been heavier. The business at the Hong Kong branch was much interfered with owing to the outbreak of the plague, which extended from April to July, and was then followed by two typhoons in close succession, necessitating considerable reconstruction of lines owing to the damage done.

The Bournemouth and District Electric Supply Company (Limited).

The annual ordinary general meeting of shareholders in this Company took place at the offices of the Company, Bournemouth, on Friday last, Mr. A. H. Sanderson presiding.

The CHAIRMAN moved the adoption of the Directors' report, which stated that the number of lamps connected to the Company's mains on December 31st was equivalent to about 19,000 8 c.p., an increase of 4,500 for the year. The accounts show a profit of £1,642. 1s. 9d., and after paying interest on debentures, interest, and commission on loans for capital purposes, &c., a balance of net profit remains of £395. 6s. During the year considerable additions and extensions were made at the generating station and in connection with the mains and system of distribution, all of which were rendered necessary by the steadily increasing demand for current, and the funds required for these purposes were obtained from the Brush Provincial Company, on loan, pending a rearrangement of the Company's capital account, and a further issue of shares or debentures. The demand for electric current in Bournemouth was steadily increasing, and the regularity of the supply from the Company's mains gave general satisfaction.

The CHAIRMAN continued: The applicants for supply of electric current consisted of a large number of shop proprietors, and of small rather than large consumers, which in his opinion testified to the general popularity of the light, and augured well for the future of the Company's business. The Company's business had expanded by about 29 to 30 per cent. during the year, which was certainly a gratifying result. The maximum current ever demanded from the Company's machinery at any one time was made on Christmas Eve last, and amounted to 164 amperes, as compared with 132 amperes on Christmas Eve 1893, or an increase of 26½ per cent. upon the maximum previously demanded. A large sum had been spent upon extensions to buildings and plant, as well as upon improvements and modernisation of the Company's system of mains, the single-cable high-tension mains having been replaced by concentric cables throughout the system; a large number of transformer pits had been constructed, and a network of new low-tension cables had been laid. These outlays were incurred with a view both to increased economy in distribution and increased regularity and reliability of supply, and they had already borne good fruit in these directions though the full benefits to be derived would doubtless be still more apparent in future years. The Company had also duplicated the trunk

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main from the works to the centre of the town. It had also been necessary to put down new plant at the lighting station, and to lay mains in new districts, in order to cope with the largely increased and increasing demand for current throughout the Company's area of supply. The engine room had been considerably enlarged during the year, and further extensions to buildings and plant were contemplated in the immediate future. The necessary funds for the carrying out of these works had been, as stated in the report, borrowed from the Brush Provincial Company, pending a re-arrangement of the Company's capital at an early date, and this loan appeared in the general balance sheet under the head of bills payable. He was pleased to be able to inform the shareholders that the first three months' working of 1895 showed satisfactory results, and he considered that the Board were justified in adopting the course on which they had lately decided, in reducing the charge for current from 8d. to 7d. and 5d. per Board of Trade unit to the consumers, between whom and the Company, he was glad to say, very cordial relations existed. Experience both at Bournemouth and elsewhere had demonstrated the impossibility of a very small lighting station, with its comparatively high maintenance costs, being made to pay, as an instance of which the Bournemouth station, with its present output, and with its lamp connection of upwards of 19,000, was only now, after seven years' hard struggle, entering upon a profitable stage. The Electric Lighting Company (Limited) had become very large shareholders in the Bournemouth undertaking, and the Bournemouth Company had been fortunate enough to secure the services of Mr. B. Percy Sellon as a Director. The shareholders were to be congratulated upon having secured the services, as managing engineer, of Mr. Henry M. Sayers, who had had a long experience in electric lighting matters, dating back from the very commencement of electricity supply in this country. Mr. Sayers had already rendered good services to the Company, and had been ably seconded in his efforts by Mr. Ingram (the station superintendent) and the staff at the works, as well as by Mr. Charles Offer, their secretary.

The report was adopted, the retiring Director (Mr. Sanderson) re-elected, and after a vote of thanks to the Chairman the proceedings terminated.

Dover Electricity Supply Company (Limited).

The first annual meeting of this Company was held at Dover on Friday week, under the presidency of Sir William Crundall, the Chairman of the Company.

The report of the Directors stated that the contracts for the generating station buildings, offices, and street work had been completed, and part of the generating plant had been delivered and erected, so that the Company had been enabled to commence the supply of current under the contract already entered into with the Corporation for the public lighting of the streets. A contract with the War Office for the lighting of the gun turret on the Admiralty Pier and several contracts with private consumers had also been entered into, and current for private lighting is being supplied. The Directors confidently look forward to having the equivalent of at least 5,000 8-c.p. lamps connected to the mains by the end of the year. Inquiries have been received for the supply of power for working cranes and hoists, from which considerable revenue is anticipated.

The CHAIRMAN, in moving the adoption of the report and accounts, said that although the works were in a fair way towards completion and were indeed practically complete, they had not yet commenced to supply private consumers; therefore their revenue account had not fairly commenced. Out of the Ordinary share capital of the Company £25,000 had been taken up, of which only £4,000 was applied for locally, so that the balance has been provided by outside friends. With regard to plant, they had eight engines in all, which combined 640 H.P.; two boilers, each of 200 H.P., were already installed, and two more ordered. At the end of the year 1894 they had expended £27,000, and estimated the expenditure up to the present at about £46,000. They had laid down pipes in the streets to the length of 14 miles, and had cabled six miles with an extra mile of cable in the most important thoroughfares. In the course of a few days they would be able to connect up the private consumers who had already wired their houses. The charge for current was at present 8d. per unit, but as they got more customers they would be able to reduce the charge. They were already supplying arc lights equal to about 2,200 8-c.p. lights, and hoped soon to have lights equal to 3,000 or 4,000 more, equal in all to 5,000 or 6,000 8-c.p. lights. As regards their future prospects, they were negotiating with several consumers, and intended to make the Company a great success. They had put down plant capable of supplying the whole town, and, if necessary, could, with extra machinery, supply adjacent towns. They would not expect him to declare a dividend at that meeting, but he hoped that the time was not far off when they would declare a substantial one, and that the shareholders who had shown an interest in the undertaking would not have shown it in vain.

Mr. VAN TROMP said everything necessary for carrying on a large business had been provided for. He would suggest to the owners of house property in Dover that they should adopt a course which he suggested in the City of Bath. It was extremely difficult to induce occupiers to wire houses which they might only occupy for a comparatively short period, but if landlords could see their way to do the wiring, and charge a moderate sum extra in the rents, the occupiers would be very glad to have the light. That plan had been adopted at Bath with beneficial results.

Mr. W. G. LEWIS said that at Buckland, an adjacent district, they had the light in their church, and were very well pleased with it. They had 64 lamps, and on the first Sunday night that they used it the meter showed the cost during the evening service to be 3s. 8d.; the next week it was 3s., and on the last Sunday it was 2s. 8d.

The CHAIRMAN said he was afraid they would not get much dividend out of that, but he was glad to hear that the churchwardens of Buckland were perfectly satisfied. With regard to the wiring of houses, he had agreed with some of his tenants that, if they liked to do the wiring, he should be prepared, within certain limits, to take the fittings over on their removal. He felt sure that houses wired for electricity would be more quickly let than where there was only gas.

Sir William H. Crundall and Mr. B. H. Van Tromp were re-elected as Directors, and Mr. R. H. Marsh as auditor.

Western and Brazilian Telegraph Company (Limited).

The following report of the Directors of this Company for the half-year to December 31st last will be presented at the twenty-ninth ordinary general meeting, to be held at Winchester House, Old Broad-street, London, E.C., on Thursday, the 23rd inst., at 12 o'clock:—

The total earnings for the period amount to £82,815. 11s. 11d., as against £80,338. 18s. 3d., an increase of £2,476. 13s. 8d. over the half-year to December 31, 1893. The working expenses amount to £36,403. 17s. 3d., against £35,592. 8s. 10d., an increase of £811. 8s. 5d. Including the amount brought forward from June 30, 1894 (£5,630. 6s. 7d.) and the dividend received upon the shares held in the "Platino" Company, the balance to the credit of the revenue account is £56,660. 3s. 9d., from which has been deducted £11,601. for debenture interest, and £5,000 for the debenture redemption fund, leaving £40,059. 3s. 9d., of which £8,000 has been placed to the reserve fund. The Directors now recommend the payment of 6s. per share, free of income tax, for the half-year on the Ordinary shares, making, with the dividend paid in November last, £3 per cent. for the year, leaving a balance of £2,846. 1s. 9d. to be carried forward. In the case of shares which have been divided into "Preferred" and "Deferred," the 6s. per share now recommended will be payable, viz., 4s. 6d. to the "Preferred" shareholders (making up the full dividend of £5 per cent. on these shares for the year 1894) and 1s. 6d. per share to the "Deferred" shareholders.

The accounts include £5,000, an estimated income derived from the traffic over the Pacific and European Company's line between Buenos Ayres and Valparaiso, from the date of the opening of the line up to December 31st last. Debentures amounting to £15,000 have been drawn and paid off at par. Dividend warrants will be posted on the 24th inst.

This Company's action against the Brazilian Submarine Company, referred to in previous reports, was heard on March 8th last before Mr. Justice Romer, and decided on all points in the Company's favour. The £6,000 per annum is now being paid by the Brazilian Submarine Company.

The Brazilian Government have passed a law through the Chambers and the Senate authorising the Government to acquire this Company's undertaking, and, in this connection, the Company's representative in Rio de Janeiro has been at home for consultation with the Board. He is now on his way back with full instructions for the arbitration which is required in Brazil under the Concession. The Board has every reason to believe that the Company will receive fair treatment at the hands of the Government.

Mr. W. S. Andrews and Mr. D. H. Goodsall seek re-election as Directors, as do the auditors, Messrs. Turquand, Youngs, Bishop and Clarke, and Messrs. Deloitte, Dever, Griffiths and Co.

West India and Panama Telegraph Company (Limited).

The report of the Directors of this Company for the half-year ended December 31st last, to be submitted to the thirty sixth ordinary general meeting, to be held at Winchester House, Old Broad-street, London, E.C., on Wednesday, May 22nd, at 12 o'clock, is as follows:—

The amount to credit of revenue is £33,243. 4s. 4d., against £34,265. 6s. 4d. for the corresponding half-year of 1893, and the expenses have been £23,613. 14s. 8d. against £22,602. 8s. 3d. for the same period in 1893, leaving a balance of £9,629. 9s. 8d., which, with £2,850. 3s. 11d. brought from last account, makes a total of £12,479. 13s. 7d., with which it is proposed to deal as follows:—

First Preference shares—			
Dividend, 6 months to December 31st, 6s. per share	£10,368	18	0
Second Preference shares—			
Dividend, 6 months to December 31st, 6s. per share	1,400	14	0
Balance to current half-year's account	710	1	7
	£12,479	13	7

The traffic receipts for the six months show a decrease of £1,948. 17s. 5d., as compared with the corresponding period, and those for the current half-year show no improvement. The cost of repairs to cables during the half-year amounted to £10,501. 2s. 10d., being £951. 16s. more than that for the corresponding period. This increased expenditure is due to the number of interruptions and to the length of new cable required to repair them. Owing, however, to the Company's duplicated system these interruptions have caused no loss of traffic, every station having been maintained in constant communication.

The contract with the French colony of Guadeloupe expired on December 31st last, and that colony's subsidy of £2,000 per annum was from that day transferred from this Company to the Compagnie Française des Cables Télégraphiques. It will be remembered that a similar course was adopted under orders of the Home Government by the French island of Martinique in March, 1890. This Company has thus been deprived of a revenue of £4,000 per annum, after performing the telegraphic service of those colonies for upwards of

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20 years, and their subsidies have been transferred to a competitor possessing only a single line of cable connecting them with Cuba. This loss of revenue, combined with the declining traffic and the reductions made in subsidies by two British colonies in 1893, has rendered the payment of any dividend on the Ordinary shares impracticable this half-year. The duty of maintaining an efficient service, and of fulfilling the unprecedented obligation of providing news to the colonies, is one that, in existing conditions, it is impossible to perform with due regard to the equitable claims of the capital employed in the enterprise.

The Company's second repairing steamer "Duchess of Marlborough" is still lying up in London, the "Grappler" having satisfactorily dealt with all repairing operations in the West Indies.

Mr. Henry Holmes seeks re-election as Director, as do the auditors, Messrs. Deloitte, Dever, Griffiths and Co.

NEW COMPANIES, STATUTORY RETURNS, &c.

ACETYLENE ILLUMINATING COMPANY (LIMITED).—This Company was registered on May 9th with a capital of £21,900, in £1 shares, to enter into an agreement with Samson Fox for the acquisition of certain licences and privileges, and to carry on the business of constructors and users of electric smelting and other furnaces, machine builders, engineers, purchasers of and dealers in chemical and mineral substances and products of all kinds, and manufacturers of all kinds of apparatus necessary for carrying on the manufacture and disposal of materials and substances produced or formed by means of heat generated electrically.

CAMBRIDGE SCIENTIFIC INSTRUMENT COMPANY (LIMITED).—This Company was registered on May 11th, with a capital of £10,000, in £5 shares, to purchase and take over the business now carried on at Cambridge by Horace Darwin, under the style or firm of the Cambridge Scientific Instrument Company, to carry out an agreement with the said Horace Darwin, and to carry on the business of mechanical and electrical engineers and manufacturers of and dealers in scientific and electrical instruments.

DE MARE INCANDESCENT GAS LIGHT SYSTEM (LIMITED).—This Company was registered on May 8th with a capital of £100,000, in £1 shares. Included in its objects are the carrying on of the businesses of an electric lighting and power company, mechanical engineers, &c.

D.P. BATTERY COMPANY (LIMITED).—This Company was registered on May 11th, with a capital of £10,000, in £1 shares, to carry into effect an agreement between Walter C. Johnson, of "The Dignaries," Westcombe Park, Blackheath, Kent, and Bernard Drake and John M. Gorham, electrical engineers, of 66, Victoria-street, Westminster, London, S.W., to carry on the business of making, buying, selling, repairing, maintaining, and otherwise dealing with accumulators, or storage batteries, and accessories for electrical purposes, and of making, buying, selling, and dealing in machinery, materials, stores, appliances and apparatus of every description applicable for, or in connection with, the supply or use of accumulators or secondary batteries, or used for the accumulation or distribution of electrical force. The subscribers, with one share each, are: Walter C. Johnson, Mrs. W. C. Johnson, Bernard Drake, John M. Gorham, Alfred C. Read, Edwin G. Giller, Mrs. Bernard Drake, and G. A. Hughes. The first Directors are: Bernard Drake, John Gorham and Walter C. Johnson.

ALTRINCHAM ELECTRIC SUPPLY (LIMITED).—The first annual return, to April 11th, has been filed. Of a nominal capital of £50,000, in £1 shares, 25,000 have been taken up, and a call of 10s. per share has been made and paid. The statutory return of the Company ro August 2nd was filed on May 3rd.

ANGLO-PORTUGUESE TELEPHONE COMPANY (LIMITED).—The annual return, to April 11th, has been filed. The nominal capital is £75,000, in £1 shares, of which 50,000 have been taken up and issued as fully paid. The total amount of shares for which share warrants, comprising 10 shares each, are outstanding is £4,020.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY (LIMITED).—The annual return, to April 5th, has been filed. The nominal capital is £100,000, divided into 7,000 Ordinary and 3,000 Preference shares of £10 each. All of these have been taken up, and the full amount called. £99,940 has been received.

ROGERS' ARC LAMP COMPANY (LIMITED).—The statutory return to April 19th has been filed. Out of a nominal capital of £20,000 in £5 shares, 3,007 have been taken up, and of these 3,000 have been issued as fully paid.

ROSE AND BIRD (LIMITED).—The statutory return to April 22nd has been filed. Of the nominal capital of £3,000 in £1 shares, 2,184 have been taken up, and 1,000 shares have been issued as fully paid. The full amount has been paid on the remainder.

ROWLAND BARNETT AND CO. (LIMITED).—The statutory return to August 2, 1894 has been filed. Out of a capital of £20,000, in £1 shares, 5,009 have been taken up, and 5,000 of these have been issued as fully paid to Rowland H. Barnett, of Brighton Grove, Newcastle-upon-Tyne. The full amount has been paid on the remainder. The first annual return to April 24th has also been filed. 5,000 shares have been allotted as fully paid to Rowland H. Barnett as the purchase money of the business, which, according to a remark on the return, practically belongs to him, and is now being carried on by him with his private moneys.

SALT LAKE AND OGDEN GAS AND ELECTRIC LIGHT COMPANY (LIMITED).—The annual return of this Company to February 9th has been filed. Out of the capital of £300,000, in £1 shares, 260,000 have been taken up and issued as fully paid.

SCARBOROUGH ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company to April 2nd has been filed. Out of a capital of £50,000, in £10 shares, 2,681 shares have been taken up, and on each of these £9 have been called.

SCOTTISH HOUSE-TO-HOUSE ELECTRICITY COMPANY (LIMITED).—The annual return of this Company, to December 31st, was filed on May 3rd. No meeting was held in that year, as business has not yet been started. The nominal capital of £100,000 is divided into 19,900 Ordinary and 100 Founders' shares of £5 each. All the latter have been issued as fully paid, and the full amount has been called on the Ordinary resulting in the receipt of £3,758.

SOUTHAMPTON ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return of this Company to April 22nd has been filed. The nominal capital is £30,000, divided into 4,000 Preference and 2,000 Ordinary shares of £5 each; 50 Preference and 708 Ordinary shares have been subscribed for and allotted, and the full amount called.

SOUTH-WESTERN DISTRICT AND THAMES VALLEY ELECTRICITY SUPPLY COMPANY (LIMITED).—In answer to a request for the filing of the statutory returns of this Company, the solicitors state that the Company has never carried on business, and that its name should be struck off the Register.

ST. MARTIN'S ELECTRICAL MANUFACTURING COMPANY (LIMITED).—The annual return of this Company, to March 12th, has been filed. The capital consists of 100 shares of £5 each, and 45 of these have been taken up. The full amount has been called and paid.

SYNDICATE OF ELECTRICAL ENGINEERS (LIMITED).—The annual return of this Company to March 11th has been filed. The nominal capital is £10,000, divided into 1,900 Ordinary and 100 Founders' shares of £5 each, and 1,007 of the former and all the latter have been taken up. The Founders' have been issued as fully paid, and £4 per share has been called on the Ordinary.

UNIVERSAL ELECTRICAL FITTINGS COMPANY (LIMITED).—The statutory return to April 3rd has been filed. The whole nominal capital of £6,000 has been taken up, and a call of 2s. 6d. per share has been made.

UNIVERSAL ELECTRIC LIGHTING COMPANY (LIMITED).—The statutory return to January 31st has been filed. The nominal capital of £5,000 is divided into shares of 10s. each. Only seven shares were subscribed for and allotted. The first annual return, to May 1st, is also filed. 8,527 shares were taken up, of which 6,000 were issued as fully paid, and the full amount has been called on the remainder.

WARD ELECTRICAL CAR COMPANY (LIMITED).—The annual return, to December 16, 1894, was filed on April 25th. No meeting was held in 1894. The whole nominal capital of £300,000, in £10 shares, has been taken up, and 29,993 of these have been issued as fully paid. The full amount has been paid on the remainder.

WATERHOUSE ELECTRICAL MANUFACTURING COMPANY (LIMITED).—The annual return to December 31st was filed on the 6th inst. The nominal capital is £20,000, divided into 1,000 Vendors', 800 Ordinary, and 200 Preference shares, of £10 each. All the Vendors' shares have been taken up and issued as fully paid; 285 Ordinary and 53 Preference shares have been allotted and the full amount called.

WATERHOUSE ELECTROMETRIC SYNDICATE (LIMITED).—The annual return to January 14th has been filed. The nominal capital is £20,000, divided into 1,000 Vendors' and 1,000 Ordinary shares of £10 each. All the former have been taken up and issued as fully paid; 308 Ordinary shares have been allotted and the full amount called and paid.

WEST INDIAN DEVELOPMENT COMPANY (LIMITED)—(Supplying electricity to the City of Bridgtown, in the Island of Barbados).—The annual return to January 1st has been filed. Of a capital of £5,000, in £1 shares, 4,070 have been taken up, and of these 4,000 have been issued as fully paid.

WOODFIELD SYNDICATE (LIMITED).—The annual return to April 10th has been filed. The whole nominal capital of £12,000, in £1 shares, has been subscribed for and allotted, the full amount called and paid.

CITY NOTES.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended May 12th were £832, as against £905 in the corresponding period of 1894, being a decrease of £73. The total receipts for the half-year amount to £17,815, against £17,305 for the corresponding period of 1894, an increase of £509.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—The Directors of this Company have resolved, subject to audit, to recommend to the shareholders at the approaching general meeting a dividend at the rate of £1. 10s. per cent. per annum, less income tax, for the year ended March 31, 1895.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 12th inst. amounted to £1,159. The amount for the corresponding week last year was £824.

REUTER'S TELEGRAM COMPANY (LIMITED).—The thirty-first ordinary general meeting of the shareholders of this Company will be held on Wednesday, the 29th inst., at noon, at the offices, 24, Old Jewry, E.C., for the reception of the Directors' report and balance sheet.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended May 10th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,793.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, May 8.		Price Wednesday, May 15.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending May 15. Highest	Lowest
			TELEGRAPHS.								
£1,012,880	Stock	10/0	Anglo-American	45	47	47	49	4 1 8	Jan., Apr., July, Oct.	46¼	..
£2,993,560	Stock	20/0	Do. Preferred	84	85	85	86	4 13 0	" "	86¼	85
£2,993,560	Stock	5/0	Do. Deferred	8½	9	8½	9	..		9 1/16	8¾
£134,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	101	104	102	105	3 17 1	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	12½	13	12½	13	5 0 0	Mar., June, Oct., Dec.	12 11/16	12⅝
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	110	114	111	115	4 7 6	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	148	152	150	154	4 10 11	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	3½	4½	3½	4½	4 8 11	April and October —	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10¼	9¼	10¼	4 7 7	" "	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	105%	108%	4 3 4	..	..	..
60,710	20	2/0	Direct United States Cable, 1877	9¼	9¾	9¼	9¾	4 0 5	Jan., Apr., July, Oct.	9½	9½
400,000	10	2/6	Eastern	16¼	16½	16¼	16½	3 18 9	" "	16½	16¼
70,000	10	6%	Do. 6 per Cent. Preference	17¼	17¾	17¼	17¾	3 7 7	" "	17¾	17¼
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	124	127	123	126	3 3 6	May and November	125	—
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105	108	106	109	4 11 11	February & August	..	..
250,000	10	6/6	Eastern Extension	17½	17⅝	16⅞	17⅛	4 7 7	Jan., Apr., July, Oct.	17 5/16	16 15/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	123	126	124	127	3 3 0	February & August	126	124⅞
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	107	105	108	4 13 11	January and July ..	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	107	105	108	4 13 11	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106	109	107	110	3 13 7	February & August	..	—
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	110%	113%	110%	114%	3 10 2	May and November	111½	..
180,227	10	2/3	Globe Telegraph and Trust	9¾	10¼	10	10¼	3 12 0	Jan., Apr., July, Oct.	10 3/16	10
180,042	10	6%	Do. 6 per Cent. Preference	16⅜	16⅝	16⅞	17⅛	3 10 0	" "	17	16¾
150,000	10	7/2	Great Northern	21¼	22¼	21¾	22¼	3 15 7	Jan., April, and July	22¼	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	108	..
17,000	25	37/6	Indo-European	50	52	47	49	5 2 0	May and November	—	..
37,548	10	2/6	London Platino-Brazilian	5	7	5	7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	105	109	106	110	5 10 1	March & September	..	—
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	108	106	109	3 14 7	—	..	—
11,839	8	4/0	Reuter's	3½	4½	3½	4½	..	April and October —	..	—
3,331	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	123	128	123	128	4 13 9	" "	..	..
15,609	10	5/0	West African Telegraph	4	5	4	5	..	January and July ..	..	—
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	102	105	102	105	4 16 2	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July ..	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	103	99	104	7 13 10	June and December	102¾	102½
88,321	10	6d.	West India and Panama	⅞	1⅛	⅞	1⅛	..	..	1	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	11	11½	11	11½	5 4 4	May and November	11	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	109	112	110	113	4 10 1	June and December	..	..
64,242	15	3/0	Western and Brazilian	9¾	10¼	10	10½	3 6 8	May and November	10 3/16	10⅛
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6¼	7	6½	7	..	—	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	3¾	4¼	4	4½	..	—	..	..
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	102	106	102	106	5 14 10	February & August	..	—
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	102	106	102	106	5 14 10	" "	..	—
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	5 18 8	May and November	..	—
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	101	103	101	103	5 17 8	March & September	..	—
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	—	May and November	3¾	..
224,850	10/0	2⅔d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	—	Yearly	..	—
171,504	£1	8·215d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	June and December	..	..
484,597	5	2/6	National	5½	5¾	5¼	5½	4 10 11		5½	5¼
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15½	16½	15½	16¼	3 12 9	" "	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	14½	15½	3 17 5	" "	..	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¾	6	5⅝	6⅛	4 1 8	—	6	5¾
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	104	106	3 6 0	January and July —	105½	..
58,000	5	1/0	United River Plate	1	2	1	2	..	" "	..	—
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	85	90	85	90	5 9 11	" "	—	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	13	14	14½	15¼	[illegible]	—	14¾	14
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15¼	15¾	15¼	15¾	3 16 2	—	15⅝	15½
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	136	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	—
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	—	..	—
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		—		..	—	..	—
8,322	£5	..	House-to-House Electric	—		—		..	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	—		—		..	—	—	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July —	..	—
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7⅜	7⅝	7½	7¾	..	—	..	..
111,000	5	..	London Electric Supply	..		..		..	—	..	..
49,900	£10	6/0	Metropolitan Electric Supply (fully paid) xd	10	10½	10¼	10¾	2 15 10	..	10⅝	10½
£150,000	Stock	4½%	* Do. 4½% Debs.	118	120	118	120	3 16 3	June and December	..	..
6,452	£10	2/0	Notting Hill Electric	7½	8	7½	8	..	—	..	..
19,980	£5	4/6	St. James and Pall Mall	7¼	8¼	8¼	8¾	..	—	8¼	..
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9¼	8¾	9¼	3 15 8	—	9¾	9¼
59,900	5	5%	Westminster Electric Supply (fully paid)	7¾	8	7¾	8¼	3 2 6	—	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅜	2⅝	2⅜	2⅝	5 14 3	—	2½	2 1/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2¾	2¼	2½	4 16 0	—	—	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	113	116	113	116	3 18 3	March & September	113½	—
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2½	3	2½	3	—	January and July —	..	—
12,139	5	—	Edison and Swan United	1⅝	1⅞	1⅝	1⅞	—	..	—	—
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		—		..	..	—	—
120,000	2	..	Electric Construction	⅝	⅞	½	¾	—	..	1⅛	—
12,845	2	2/9⅔	Do. 7 per Cent. Cumulative Pref.	1¼	1¾	1½	2	—	..	..	1
91,195	2	10/0	Elmore's Patent Copper Depositing	1	1¼	⅞	1⅛	—	..	—	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	February & August	22⅛	..
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	101	103	101	103	4 8 0	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..	—	..	..
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	⅛	—	⅛	..	..	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	39	41	40	42	5 14 3	March and July	41½	41
£150,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4 11 9	January and July	..	..
37,514	£5	..	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,870	10	12/0	W. T. Henley's Telegraph Works Ordinary	9½	10½	9½	10½	5 14 3	..	10⅜	10
£30,000	10	..	Do. Preference	..		..		..	..	..	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1¼%	City and South London Railway	45	47	45	47	2 13 2	May and November	45½	..
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	..	—
£67,130	Stock	4%	Do. 4% Perpetual Debenture xd	131	133	131	133	3 0 2	May and November	..	..
37,500	£10	2%	Liverpool Overhead Railway	8⅞	9	9	9¼	2 5 1	—	..	..
6,295	10	5%	Do. 5% Preference	14	14½	14	14½	3 11 5	..	..	..
155,000	Stock	4%	Do. 4% Debenture	110	112	110	112	3 10 2	January and July	..	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 888. [No. 4. Vol. XXXV.] FRIDAY, MAY 24, 1895. PRICE SIXPENCE.

NOTES.

We would call the attention of our readers to the evidence given on Tuesday last by Mr. James Staats Forbes before the Select Committee on the Telephone Service. It is undoubtedly the best contribution to the matter under inquiry that the Committee has so far elicited. The statement of the President of the National Telephone Company was, of course, a piece of special pleading, and a remarkably fine specimen of the art; but it was instructive, interesting, lucid, and to the point, and should serve as a wholesome corrective to the many *ex parte* assertions which have preceded it. There has been far too much comparison of the charges and service of the National Company with those in happy lands where Post Office and patent royalties are non-existent, and way-leaves give no trouble, where wages are low and material cheap; the charges made and the service rendered in countries more or less comparable with our own, such as America, Germany, and France being conveniently ignored.

We cannot but commend the wisdom of the Postmaster-General in granting the Committee asked for by Mr. Kearley to inquire into the alleged grievances of the postal- and telegraph servants, and especially his choice of men outside the service to institute the inquiry. It is not particularly flattering to telegraphists to be lumped in with letter carriers for a purpose of this kind; but it may be useful, if only to make clear by comparison the relative pay and privileges of these two very different classes of civil servants. The public will probably find out that the postmen have little or nothing to complain of; while Mr. Morley will discover that the telegraphists have greater grievances than he has been led to suppose. It is hoped the last-named body of men will not spoil their case by asking unreasonable and impossible concessions which are granted to no other branches of the Civil Service. Of the several substantial hardships of which the telegraphist complains, not the least is the one denying him redress because of the "shrinking revenue" of the service to which he is attached. He knows perfectly well that the alleged shrinkage is a fiction, and, rightly or wrongly, regards it consequently as a mere excuse for rejecting his claims in order that the insatiable demands of his more powerful comrades of the postal service may be satisfied.

The clause inserted this year by the Board of Trade in the Strand and other metropolitan Orders to which attention was called in the House of Commons on Monday, although undoubtedly excellent in intention, seems to us to go perilously near to being *ultra vires*. The clause in question provides that the Local Authority shall have the option of purchasing the undertaking, not at the end of 42 years from the passing of the Confirmation Act, as is usually the case, but after "a period of forty-two years from the twenty-sixth day of August one thousand eight hundred and eighty-nine." The reason for this provision, Mr. Bryce informed the House on Monday, was that "the Board of Trade have held that it is in the interest of London that the power of purchase by the Local Authority shall as far as possible operate at the same date over the whole of the metropolis." In view of the pertinacious opposition offered by the North Metropolitan Tramways Company to the acquisition of its undertaking by the London County Council, under the terms of the Tramways Act of 1870, and its absurd contention in connection with the taking over of its lines piecemeal, this step of the Board of Trade shows shrewd foresight.

Considering the efforts that were expended in securing the deferment of the day of purchase from 21 to 42 years, it has always seemed to us to savour of weakness and to tend to reckless finance to whittle away the advantage so secured in order to gain the favour of Local Authorities. But in many instances it is doubtless a case of Hobson's choice for the promoters of Electric Lighting Orders, as Section 2 of the Act of 1888 undoubtedly gives Local Authorities full power to drive a hard bargain. But for a Government department, be its intentions of the highest order of excellency, entirely on its own authority, as implied by Mr. Bryce, to curtail a certain period deliberately laid down in an Act of Parliament is, to our mind, a very high-handed proceeding. If such curtailment be to the public interest, well and good; but those who suffer for the public weal should be reasonably compensated. An alteration in the terms of purchase by mere fiat of the Board of Trade would not, of course, be tolerated by the Local Authorities. But electric light companies, on the other hand, are expected to indulge in "sombre acquiescence" when a Government department legislates against them *pro bono publico*.

The Bureau de Contrôle des Installations Électriques, the main objects of which are set forth in another column, is a very characteristic French institution. To English minds a corporate body which openly admits that it owes its existence

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to the numerous accidents caused by defective wiring, and announces it chief *raison d'être* to be the testing of house wiring and the affording of information concerning the safe working of electric lighting plants, would seem to be tolerably well calculated to frighten intending consumers. However, across the Channel they not unnaturally prefer any cure to none at all, and we might do well to consider what sort of English equivalent would meet the exigencies of the case at home. Since the interests of the electric supply companies and the fire offices are identical, it is to be regretted that instead of each supply company and each fire office drawing up its own set of rules, differing only in unimportant details, they do not devise a common set of thoroughly practical regulations, and secure their enforcement. This might not have been possible in the early days of electric supply, when it was not politic nor even, perhaps, possible for struggling companies to refuse to connect up a large customer merely because he had been short-sighted or unfortunate enough to get his wiring done on the cheap. In this year of grace, however, the supply companies can afford to be a little more independent. To suggest to electric light consumers that they should join a sort of society for mutual protection and safety would no doubt sound to some of them rather alarming; but since periodic inspection of wiring is even more necessary in the interests of safety and convenience than perfunctory visits by overworked fire-office officials before houses are connected up, the meter inspectors of the supply companies might very well be made to do a double duty, and, armed with an ohmmeter and a dose of common-sense, might make a rough, but nevertheless reliable, test of the wiring. In any case, however, the householder would have to put up with the fuss of having all the lamp bulbs removed from their sockets and all the switches turned on. To avoid giving unnecessary alarm and trouble these tests might invariably be carried on during the out-of-town quarter.

Even in France the operations of the Bureau de Contrôle do not appear to have proved very extensive, though perhaps under the new management this state of things may be altered. Either the standard set by the Bureau must be extremely high or jerry wiring must be even more rampant in France than in this country; and, what is worse, on the increase. In the first year of the existence of the Bureau it will be observed that some 60 per cent. of the installations inspected were reported as being defective from one cause or another, whilst in the second year the figure was nearly 90 per cent. This would give cause for decided uneasiness were it not that in matters of this kind the personal equation of the inspector is all important, especially if anything and everything has to be done to his satisfaction, and he is not bound down within the four corners of explicit regulations.

Mr. Campbell Swinton has been "amang" the electrical supply companies of London, with a hot-wire recording voltmeter, "takin' notes." He has been the round of the mains, and day by day has tapped them to find out what sort of continuity there is in the maintenance of their electrical pressure. The story told by the hot-wire instrument, and we doubt not it is a true story, so far as it goes, is embodied in an instructive set of diagrams, which we publish this week, together with some explanatory remarks by Mr. Swinton.

Comparisons, it has been said, are odious; but we hope that none of the supply concerns, whose lapses from the ideal are embodied in these researches, will experience any odium from the seeming irregularity of the electrical pressure supplied by them. It is rarely that comparisons such as these bring out the actual relative merits of the competitors in their true light; and we apprehend that no one will recognise this fact better than Mr. Swinton himself. It is to be regretted that he has given us such scant information as to the exact position on each network of mains of his tell-tale voltmeter. So much depends on this position. If the voltmeter happen to be quite close to a feeding point in one case, and at a distance from a feeding point in another case, this alone would produce a difference in the record, although, of course, if the distributors were up to Board of Trade requirements the difference should not be very marked.

In our footnote to Prof. Unwin's lecture, on page 80 of our last issue, we made a comment which was based upon a misapprehension of Prof. Unwin's remarks on the expansion of steam. The isothermal for superheated steam is $pv =$ constant, and for saturated steam it is $p =$ constant; so that when Prof. Unwin says that "the actual expansion curve of an engine is much more nearly an isothermal than an adiabatic, because the steam receives heat from the cylinder wall," he refers to a case where the influx of jacket heat is so great as to cause the expansion line to rise considerably above the corresponding isentrope for adiabatic expansion. As a matter of fact, however, the effect of the jacket is rarely, if ever, so pronounced as to cause the steam to expand nearly isothermally; and, as Prof. Unwin observes in a communication made to us, it is more correct to speak of the expansion as "nearly a hyperbola" in the case of most, if not all, jacketed engines.

There have been a great many primary batteries invented lately, and as one of the chief *raisons d'être* of a primary battery is to exhibit remarkable properties, the electrical world has been treated to a surfeit of "wonders." Recently M. Renault, of Paris, has devised a neat little primary battery, which we should judge would be serviceable in experimental work. There did not appear to be anything wonderful about this battery until a contemporary discovered that gelatinous silica, one of the constituents of the cell, possesses "the remarkable property of absorbing 60 times its volume of water." But the wonder of the thing vanishes when we remember that gelatinous silica will not do this without, like Sam Weller's maternal parent, "swelling wisibly"; or, when we state the matter in another way and say that water has the power of dissolving one-sixtieth of its volume of this gelatinous compound.

Electrical Bills in Parliament.—The London, Walthamstow and Epping Forest Railway Bill was read a second time in the House of Commons on Monday.

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Society of Arts Conversazione.—This *conversazione* will be held at South Kensington on Wednesday evening, June 19th.

Cable Interruptions:

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	Nov. 27, 1894.	May 22, 1895.
Gibraltar—Tangier	April 24, 1895.	May 16, 1895.

Electric Railway to Vesuvius.—Messrs. Thomas Cook and Son, the owners of the railway up Vesuvius, propose to put down an electric railway between Naples and the funicular railway terminus.

Royal Institution.—The Friday evening discourse on June 7th will be by Prof. Alfred Cornu, F.R.S. This discourse will be delivered in French, and the title is "Phénomènes Physiques des Hautes Régions de l'Atmosphere."

North Sea-Baltic Canal.—At the opening of this canal the harbour of Kiel, right down to the mouth of the canal at Holtenau, will be lit by electric light, as also the extraordinary marquee which is being made to the designs of the Emperor.

Northern Society of Electrical Engineers.—Mr. John Darney has been compelled to resign his position as hon. secretary of this Society, owing to his removal from Manchester, and the position has been taken by Mr. J. Vincent Swindells.

Meeting of the Verband Deutscher Elektrotechniker.—It is announced that the third annual meeting of this Association will be held on July 4th to 7th, at Munich, and not, as formerly stated, at the end of June. During the meeting of the Association the Ohm memorial will be unveiled.

Street Lighting by Arc and Glow Lamps.—A rather interesting example of street lighting came into operation last week at Wilda, near Posen. The system is a combination of arc and glow lighting, and was laid down by the Helios Company. Forty arc lamps provide the necessary illumination up to 11 p.m., after which hour glow lamps are used, taking their current from a battery.

Alternators.—In connection with the Paper recently read before the Elektrotechnischer Verein by Herr von Dolivo-Dobrowolsky, and published in our last issue, we may say that we have been shown by a well-known English electrician the drawings of a new type of alternator somewhat on the lines of those described by Herr Dobrowolsky, of which more may be expected to be heard as soon as the experimental machine now in course of construction has been completed and tested.

The Fluid Theory of Electricity.—The fluid theory of electricity, notwithstanding its lack of solid basis, apparently still holds its own in America. A New York contemporary, of recent date, contains the following announcement:—"Manchester, N.H.—The contract for furnishing electricity for the new electric road stipulates that *the fluid* shall be ready to be turned on on July 1st." The winters of New Hampshire are, we believe, somewhat severe, and it is to be hoped that the fluid will not freeze.

Liverpool.—Another step has been taken by the Lighting Committee of the Liverpool Corporation towards the acquisition of the plant and rights of the Liverpool Electric Supply Company, this being the approval of the draft of the agreement for the purchase of these at the price of £400,000. The agreement having been approved by both parties, the next step will be to apply to Parliament for powers to carry out the arrangements agreed upon, and it is expected this authority will be secured during the present session.

A Secondary Battery Patent.—Mr. J. Wilson Swan's patent, No. 2,272 of May 24, 1881, intituled "Improvements in Secondary Batteries or Apparatus for Storing or Conserving Electricity," legally expires to-day. In *The Electrician* of January 18th last, on page 339, we published abstracts of all the secondary battery patents expiring this year. The Swan claim was as follows:—Constructing the plates of secondary batteries or apparatus for storing or conserving electricity with cells, corrugations, grooves, or interstices substantially as and for the purpose hereinbefore described.

The Illumination of Streets by Electricity.—In an article on this subject in the May number of the *Engineering Magazine*, Mr. Franklin Leonard Pope states that the first attempt to illuminate a town by electricity was made at Wabash, Ind., in March, 1880. Arc lamps were used, two being placed upon the tower of the court house and two more on a mast erected for the purpose. The trial run was witnessed by hundreds of visitors from all parts of the country. The plant, consisting of four lamps and the dynamo, is said to have originally cost £3,600. It was operated continuously for six years, after which it was taken down and ultimately sold for £6 as a historical curiosity.

Steam Engines (Persons in Charge) Bill.—This Bill came to an untimely end on Wednesday, in the Select Committee to which it was referred. In accordance with an understanding arrived at when the Bill was read a second time, Mr. John Wilson (Durham) proposed the exclusion of locomotive engines, the engines of steamboats, and agricultural engines from the scope of the Bill. On the division of the Committee, seven voted for the provision and seven against, and the Chairman gave his casting vote in its favour. Mr. Brunner then moved that the Committee should not proceed any further with the Bill, and this motion was carried, after a sharp discussion, by nine to four. The Bill will consequently not be reported to the House.

Electricity in Australian Mines.—At Hillgrove, in New South Wales, an electric transmission of power plant has been put down for the working of several of the mines of the district. The water of the Gyra river is employed to the extent of about 850 H.P. A canal 1½ miles in length leads the water to a large reservoir. From thence it is carried in pipes, and in a distance of 900ft., 500ft. fall is obtained. The power-house contains three Pelton water wheels of 250 H.P. for driving the power generators, and two ditto of 50 H.P. each for lighting purposes. It has been ascertained that while steam-power at Hillgrove cost £49 per horse-power per annum, owing to the difficulty of obtaining fuel, the electric power only costs £30 per horse-power per annum, or a saving of nearly 40 per cent.

Hydro-Electric Supply.—The Compagnie Hydro-Électrique d'Anvers, which was started some time ago with a considerable flourish and a capital of £110,000 to work an electric supply station on the Van Rysselberghe hydraulic system, has just issued its first annual report. By this it will be seen that the system of hydraulically driving dynamos, situated in various sub-stations up and down the town, has not been so successful as anticipated. The entire capital has been expended, and though there are 248 consumers, the balance-sheet shows a deficit of £1,713. The management frankly admits that the hydro-electric system is very much handicapped, and cannot compete with other electrical systems. Notwithstanding this, the Directors propose to continue the experiments on an extensive scale, and intend to take up a new loan of £72,000.

Electric Mail Cars in America.—The post office officials in Washington, says the *Street Railway Gazette*, are greatly interested in utilising street railway systems for the rapid distribution of letters, and they are now extending the service. Electric mail cars have just made their appearance in Boston, where the system has been organised on a much more liberal scale than has yet been attempted elsewhere. Eight mail cars have been equipped. The preliminary trials that were made by the post office authorities to determine the possibilities of the new system indicated that the saving in time would be very considerable. Within a comparatively short time mail cars will be operated on the street railway tracks in Chicago and Philadelphia, and plans for the extension of the system to New York are under consideration.

The "Holland" Submarine Electric Boat.—The United States Navy Department, says the *Electrical Engineer* of New York, has contracted with the John P. Holland Torpedo Boat Company, of New York, for a submarine torpedo boat, to cost $150,000. The dimensions of the boat are: Length, 80ft.; diameter, 11ft.; displacement, 138·5 tons. The boat is to be completed in every respect by March 26, 1896. She is to have a speed of not less than 15 knots when in a light condition, 14 knots when awash, with a minimum endurance of 12 hours at these speeds, using only steam power, and 8 knots an hour when the vessel is completely submerged, using electric power, with a minimum endurance of 6 hours at this speed. Below

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13½ knots for the light condition, or 12½ knots for the wash condition, or 6½ knots when submerged, the Secretary of the Navy may reject the vessel, or accept her at a reduced price.

Overhead Wires.—In answer to a question by Mr. Weir in the House of Commons, the President of the Board of Trade stated that private electric lighting companies having statutory powers were under obligations similar to those imposed on Local Authorities, and were also prohibited from using overhead wires without the consent of the Board of Trade and the Local Authority. Private electric lighting companies not having statutory powers were subject to regulations for the protection of the public safety prescribed under the provisions of the Electric Lighting Acts, 1882 and 1888. Although the use of overhead conductors were not prohibited by those Acts, urban authorities under the Public Health Act of 1890 were empowered to make regulations for the prevention of danger or obstruction to the public from wires stretched over, along, or across any street.——It is as well that this fact should be widely known, and the powers granted to urban authorities under the Public Health Act of 1890 made vigorous use of to prevent the disfigurement of rich residential districts by ugly cables flung across roads at all possible angles to the vertical and horizontal, and occasionally secured to huge transatlantic-looking poles.

The Size of Transformer Chambers.—At the weekly meeting of the London County Council, held on Tuesday, the Highways Committee reported that on February 12th last the Council directed that it should be suggested to the Board of Trade that in the Orders for which applications had been made that year by the County of London and Brush Provincial Electric Lighting Company in respect of (*a*) Battersea, (*b*) Newington, and (*c*) St. Olaves districts the following words should be inserted :—"Provided always that nothing in this Order shall be held to authorise the undertakers to construct in or under the surface of any public street or place chambers or receptacles for transforming apparatus of greater span than 3ft. and more than 2ft. 6in. in depth." With regard to the applications, the first two had been withdrawn, and with regard to the last, the Board of Trade had intimated that they thought it undesirable to limit in the Order (which can only be amended by a further Order) the precise size of transforming chambers, and was therefore unable to insert the clause suggested by the Council. Having regard to the opinion of the Board of Trade, the Committee did not see that anything further could be done with reference to that Order.

Electrolytic Zinc Works.—In the large pyrites mines of Sicilia and Sigena, at Grevenbrück, Westphalia, the pyrites obtained contains a large proportion of zinc. The pyrites is first sent to a chemical works in Mannheim, on the Upper Rhine, where it is used in the manufacture of sulphuric acid by the usual process. The residue is then shipped to the new electrolytic zinc works which Messrs. Sicilia and Sigena have built on the Rhine at Duisburg-Hochfeld, in the neighbourhood of some of the largest blast furnaces in Germany. Here it is unloaded by electric cranes. The material is then lixiviated, and the residue roasted with salt to obtain the purple iron ore. The new residue is again lixiviated, and the zinc is then electrically deposited from the lye. The zinc thus obtained is said to be much purer than the best zinc hitherto obtainable, and it commands a high price. The purple ore is sold to the neighbouring blast furnaces. The works have only been in operation a few months. At present they deal with an average of 30 tons of the residue from the sulphuric acid works per day; this contains 10 per cent. of zinc, all of which is recovered. The works when completed will be capable of dealing with four times this quantity—*i.e.*, of producing 12 tons of zinc per day. The cost of sending the ore from one factory to the other is very small, as both the chemical works at Mannheim and the electro-chemical works at Duisburg-Hochfeld lie close to the water's edge.

Electric Traction Disturbance of Telephone Lines at Hobart.—In an appendix to the second report of the Committee appointed at the Postal and Telegraph Conference held at Hobart in 1892, for the purpose of drafting a set of electric light and power regulations, Mr. R. Henry, Superintendent of the Tasmanian Telegraphs, describes the disturbances caused on the Hobart telephone system by the running of the electric tramway in that city. According to Mr. Henry, there is a steady humming sound in the telephones, which, however, is not sufficient to destroy conversation, and is distinctly traceable to induction pure and simple. Occasionally there is a musical sound, difficult to describe, but resembling a steam siren at a great distance. This sound always commences at a comparatively low pitch and gradually ascends until it finally disappears as if the vibrations were too rapid to be rendered audible. Its duration extends over a few seconds only. Yet another disturbance is noted by Mr. Henry—namely, a rasping sound very much like broken contacts with a battery through a telephone receiver. This would appear to be caused by leakage currents and irregular contacts with dirty rails. The most annoying trouble is, says Mr. Henry, the dropping of the shutters at the exchange, long lines suffering more than short wires. The greater the number of cars in use the greater the number of shutters affected. Occasionally when there is short-circuit on the line 250 out of 400 shutters go down. Mr, Henry finally reports that the resistance of the earth return seems to be more than it should be (0·4 ohm—0·23 ohm).

Electrical Trade Section.—The following paragraph relating to the Electrical Trade Section appears in the thirteenth annual report of the London Chamber of Commerce presented at the annual general meeting on Tuesday :—

"Twelve meetings of this Section and its committees were held during the year. The Section had under its consideration the advisability of the industry as a whole lending its support to the Antwerp Exhibition, and a circular was issued with the object of ascertaining what support was likely to be forthcoming, to which, however, there was no practical response. Early in the year the Traction Committee had an interview with the officials of the Board of Trade with reference to the draft of the Protective Powers Regulations, and a set of rules was ultimately issued which were believed to be satisfactory to the various interests concerned. Subsequently the Traction Committee made representations to the Postmaster-General with reference to what is known as 'the Postmaster-General's clause,' and satisfactory assurances as to the due protection of the traction interests were obtained. Special attention was given by the section to the rating of electrical works, a small Committee being appointed to deal with the matter, and a large amount of evidence as to the anomalies of the present system was obtained. The Section took joint action with the Engineering and Allied Trades Section in regard to the question of Light Railways as raised by the Board of Trade. Steps were also taken by the Section to bring their views before the Board of Trade Inquiry as to the placing of transformer chambers in the public streets, and a resolution was passed expressing the opinion that such chambers would not be dangerous to the public, and could be constructed so as to form no serious obstacles to the future use of the streets for other necessary purposes. The decision ultimately arrived at by the Board of Trade was considered favourable to electrical companies."

Two-Phase Transmission of Power Plant in America.—An installation of some interest has been erected at Fitchburg, Mass. The plant consists, says the *Electrical Engineer* of New York, of one 300-kilowatt Westinghouse two-phase generator, of the "plus two" type; that is, it has two more teeth on the armature than there are poles in the field. The current is generated at a potential of 2,250 volts. A 15-H.P. multipolar Westinghouse exciter is used, which is of sufficient capacity to excite two 300-kilowatt machines, as a second machine will be erected in a short time. The exciter runs at 1,150 revolutions, and is driven separately by a small Pelton wheel. The generator is direct connected to six Pelton double-nozzle 28in. water wheels, all on the same shaft, running at 375 revolutions. Water is supplied from the Wanoosnoc River under a 130ft. head at the rate of 2,000 cubic ft. per minute. The flow of water is controlled by a Doolittle governor, which consists of three separately actuated gears, one having large inertia, revolved by a separate water motor, and thus kept at constant speed, a second gear, driven by the generator shaft, and between these two is the third gear, connected by means of pinion and rack with levers that actuate butterfly valves controlling the admission of the water to the wheels. At present, all the power generated is used by the Simonds Manufacturing Company, whose works are about two miles from the power house. The transmission circuit consists of four stranded conductors. each having a cross-section of 0·4 sq. in. The wire is covered with weather-proof insulation, and carried on special poles, The current is transformed from 2,150 to 220 volts by means of two 100-kilowatt Westinghouse oil transformers, and supplied to 11 Tesla motors ranging from 75 to 7½ H.P.

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ATMOSPHERIC ELECTRICITY.*

BY PROF. A. SCHUSTER, F.R.S.

It is hardly possible to imagine that the first experimenter who obtained an electric spark sufficiently strong to produce a sensible sound should not at once have been struck with the fact that he was in the presence of thunder and lightning on a small scale. We find, indeed, in various writings from the early days of electrical machines, a number of suggestions that the thunderstorm was an electrical phenomenon, but the merit of having perceived that a direct experiment was needed to prove what so far was only a guess belongs to Benjamin Franklin. In an article entitled "Opinions and Conjectures Concerning the Properties and Effects of the Electrical Matter, arising from Experiments and Observations made at Philadelphia, 1749," the following passage occurs :—

"To determine the question, whether the clouds that contain lightning are electrified or not, I would propose an experiment to be tried where it may be done conveniently. On the top of some high tower or steeple, place a kind of sentry-box, big enough to contain a man and an electrical stand. From the middle of the stand let an iron rod rise and pass bending out of the door, and then upright 20ft. or 30ft., pointed very sharp at the end. If the electrical stand be kept clean and dry, a man standing on it, when such clouds are passing low, might be electrified and afford sparks, the rod drawing fire to him from a cloud.

"If any danger to the man should be apprehended (though I think there would be none), let him stand on the floor of his box, and now and then bring near to the rod the loop of a wire that has one end fastened to the leads, he holding it by a wax handle ; so the sparks, if the rod is electrified, will strike from the rod to the wire and not affect him."†

The experiment suggested by Franklin was successfully performed in Marly (France) by D'Alibard, on May 10, 1752,‡ in London by Carter, in Spital-square, on July 20, 1752, and by Wilson, in Chelmsford, Essex, on August 12th of the same year. Franklin himself describes having used a kite in Philadelphia in a letter dated October 19th, but he does not give the date of his observations. But this must be supplied in some passage which I have not been able to find, for Rosenberger§ mentions that it was done in June.

Franklin's disbelief in the dangerous character of the experiments must have received a severe shock when he heard of the death of G. W. Richmann, who, in the year 1753, was killed by an electric discharge drawn from the clouds by means of a kite.

The thunderstorm is the most impressive effect in atmospheric electricity, though it is rivalled in beauty by the aurora and in interest by the many phenomena of daily occurrence, which are only made perceptible to us by proper instruments. In a lecture delivered before this Institution on May 18, 1860, Lord Kelvin described the delicate electrical appliances constructed by him for the more accurate observation of atmospheric electricity. The problems there for the first time clearly stated, gave a powerful and still lasting impulse to its scientific investigation, and though no decisive answer can be given to all the questions raised in that lecture, recent researches have brought us somewhat nearer to their solution.

Observations which may be made every day and at every place have shown that the earth is electrified, whatever the weather may be. In the language of the older theories, which we cannot as yet altogether abandon, we say that the earth is covered with negative electricity, or, in modern phraseology, we express the same idea by the statement that we move about in an electrified field, that electric lines of force stretch through the air from the ground, from our bodies, and everything which is exposed to the sky overhead. The strength of this electric field is not at all insignificant. If we wish to produce it artificially between two parallel plates kept at a distance of one foot, we should have to apply an electromotive force sufficient—and sometimes more than sufficient—to light up the incandescent lamps which illuminate our dwellings. The electric field is comparatively weak in our country, but 50 volts per foot are constantly observed, and 100 volts are not uncommon ; but in dryer climates this amount may be considerably in excess of these figures.

If we fix our minds on the lines of force starting from the surface of the earth, we are at once led to ask, Where is their other end ? Do they curve round and back again to earth ? Do they end in the dust which everywhere surrounds us, or do they reach up to the clouds ? Do they pass through the clouds and end where invisible particles separate the sunset red from the midday blue ? Or, finally, do they leave the earth altogether, and form intangible bonds between us and the sun, the stars, the infinity of space ? These are not idle questions, and we cannot be said to have solved our problem unless some definite answer is given to them. The last-mentioned view, propounded originally by Peltier, and latterly supported by Exner, is the simplest. If we could allow that the earth, once electrified negatively, could remain electrified for ever, the corresponding positive electrification being outside our atmosphere altogether, the chief difficulty of atmospheric electricity would be removed, and the normal fall of potential at the surface would be explained by the permanent negative electrification of the surface.

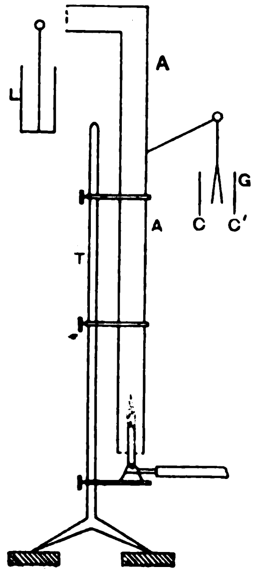

FIG. 1.

Unfortunately, this view, to be tenable, has to assume that the atmosphere is a complete non-conductor to the normal electric stress, and this is known not be the case. We know of several causes which break down the insulating properties of air. If two pith balls are electrified and repel each other, and a match be lit in their neighbourhood, the pith balls come together, showing that they have lost their charge, and consequently that the flame of the match has destroyed the insulating power of air. It is not only the flame itself which conducts, but also the gases rising from the flame.* The following experiment will prove this. In Fig. 1, A represents a metallic tube bent round at the upper end, and containing at its lower end a Bunsen burner in metallic contact with the tube, which is also connected to an electroscope. The tripod T which supports the tube is insulated from the ground by blocks of paraffin. A Leyden, L, on a separate support, is placed so that the knob stands at about the level of the upper part of the tube, which acts as chimney to the flame. The knob of the jar may be a few inches away from the opening of the chimney, and not necessarily in a line with it. The experiment succeeds, although the gases rising from the burner may not come into contact with any part of the jar. The jar is charged, and care

* Friday Evening Discourse delivered before the Royal Institution.

† "Experiments and Observations on Electricity made at Philadelphia, in America." By Benjamin Franklin, LL.D. and F.R.S. London : Printed for David and Henry, and sold by Francis Newbery, 1769. P. 66.

‡ *Ibid.*, p. 107.

§ *Geschichte der Physik*, Vol. II., p. 316.

* The most complete investigation of the conduction of gases rising from flames is contained in a series of Papers by Giese (*Wiedemann's Annalen*, Vol. XVII.).

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must be taken that no fibres of dust attach themselves either to the jar or chimney. I have found it convenient to join a piece of amalgamated zinc to the end of the chimney. Under these circumstances the charge of the jar will be found to leak across to the tube, and the leaves of it will diverge. If, as in Exner's form of electroscope, the leaves, on reaching a certain divergence, discharge by forming a contact with earth-connected plates, C C′, the charging and discharging can be watched for a long time. It will be noticed that the flame, being altogether surrounded by a tube of the same potential, cannot be active in this case, but the conductivity must be due to the gas as it escapes from the chimney.

It follows from these experiments that every fire burnt on the surface of the earth, and every chimney through which products of combustion pass, acts like a very effective lightning conductor, and slowly but surely, any electrification of the surface of the earth would, in consequence, pass into the atmosphere. The peculiar immunity of factory chimneys against damage by lightning, appears from statistics collected by Hellmann in Schleswig-Holstein,* for while 6·3 churches per thousand were struck, and 8·5 windmills, the number per thousand of factory chimneys struck was only 0·3.

Franklin was acquainted with the action of flames; he also discovered that no charge could be given to a red-hot iron ball, a fact which seems to have been forgotten until re-discovered in our own times by Guthrie. Franklin also tried the action of sunlight, but obtained no result. Had he performed the experiment with carefully-cleaned zinc, he would have anticipated one of the most striking of Hertz's discoveries. We now know that a negatively-charged surface will discharge into air when illuminated by strong violet light, and sunlight will be sufficient with specially-sensitive materials. This action has been investigated in detail by Elster and Geitel, who have not, however, succeeded in obtaining results with sunlight acting on such bodies as we know the earth's crust to be made of. So far, then, we have no experimental evidence to include light as an active agent in the phenomenon of atmospheric electricity.

We possess in the electric discharge itself a very powerful, and probably very generally active means of breaking down the insulating power of air. Some of the experiments† which I described some years ago to prove this, were objected to on the ground that it might not be the discharge itself, but the ultra-violet light sent out by the luminosity of the discharge, which was active. The following form of the experiment conclusively shows that the discharge acts independently of light.

In Fig. 2, R represents a Rhumkorff coil entirely surrounded by a metallic box B, which is connected to earth. The terminals of the coil lead to two electrodes inside a metallic tube T, which is also kept at zero potential. This tube is arranged so that a current of air can be blown through it. The air, on escaping through the tube, is made either to impinge on or to pass near a metallic plate connected to a charged electroscope. Under these circumstances, the electroscope is not discharged either by a current of air alone, or by setting the coil going, no air being blown through the tube. But as soon as the air is blown through the spark which the coil is giving, and made to pass into or near the plate C, the electrocope is instantaneously discharged. The experiment succeeds when a plug of cotton wool is inserted at W to stop the action of the dust; but a plug of cotton wool at the other end diminishes the action so much that I am doubtful whether the effect really exists there. But I am, so far, not inclined to believe that the action is due to dust, but rather that the cotton wool acts in increasing very considerably the interval which elapses between the time at which the spark acts and the time at which the sparked air passes out of the tube. The effect may be observed even though the tube L is lengthened by an addition of another piece 3ft. or 4ft. long.

Several phenomena, one of which had been known for a long time, can be explained by the fact that the electric discharge changes the condition of the gas into a state similar to that of gases rising from flames. It is mentioned, for instance, by Faraday that electric sparks are liable to succeed each other along the same path, as it is known that the same holds for lightning flashes, facts which themselves point to a higher conductivity of air along the path of the previous discharge. A curious instance of a similar effect is afforded by lightning conductors, which are sometimes put up to protect overhead leads used for conveying a high-tension current. Owing to the obvious impossibility of connecting the leads directly to earth, a small air gap is interposed, the idea being that the air gap will act as an insulator for the current the leads are intended to carry, but that if during a thunderstorm the potential rises sufficiently high to be dangerous, equalisation may take place through the air gap to earth by means of a small spark. So far, the air gap answers its purpose, but as soon as a spark passes through the gap, it destroys the insulating power of the air, and the main current consequently takes a short-cut through the gap. At Pontresina, in the Engadin, lightning conductors put up in this way are so sensitive that a flash of lightning several miles away causes a small spark by induction, and instantaneously puts out every electric lamp in the town.

If we accept the view that an electric discharge destroys the insulating power of the gas, it follows that the outer regions of the atmosphere must conduct, for we have ample reason to suppose that electric currents are passing continuously through those regions. The aurora borealis in the Arctic regions is, according to Nordenskiold's observations, a permanent phenomenon, and the diurnal changes of terrestrial magnetism show that in our latitudes currents traverse the air above us. However small a conductivity we may assign to the atmosphere under these circumstances, the earth could not remain permanently electrified inside such a shell of partially conducting gases. Lord Kelvin drew the same conclusion in his Royal Institution lecture—that gases at much-reduced pressures cease to insulate. We may leave it an open question whether the normal electric stress would in itself cause a discharge in the outer regions; but we cannot deny that under the existing conditions these regions do not insulate, and Lord Kelvin's argument still holds good.

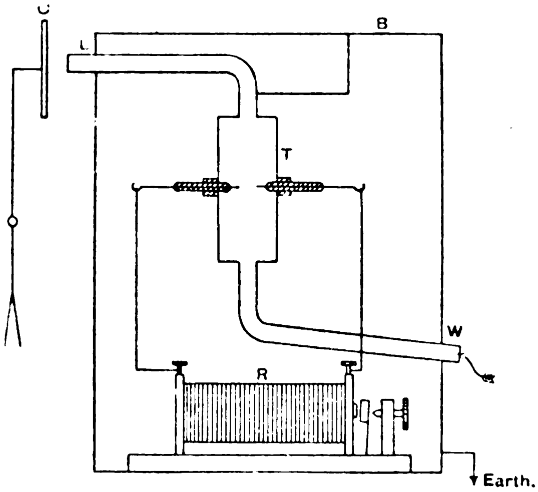

Fig. 2.

But the question of the ending of the lines of force—in other words, the location of the positive charge corresponding to the negative electrification of the surface of the earth—can only be solved by balloon or kite experiment, and we may shortly mention the more important results which have been so far obtained.

Observations made up to heights of about 1,000ft. seem to indicate a strengthening of the electric field, *i.e.*, the fall of potential per metre is greater at a height of, say, 200 metres than on the surface of the earth. We may mention especially the observations of Dr. Leonhard Weber (*Elektrotechnische Zeitschrift*, April, 1888), which bring out this point clearly. In one case the fall of potential at a height of 350 metres was found to be six times that at the earth's level. This increase is in itself not surprising, if we remember that every particle of dust raised from the ground must itself be negatively electrified, and possibly the observed increase in the electric field is sufficiently accounted for by the presence of electrified dust.

* "Veröffentl. des Kgl. Preuss. Stat. Bureaus," 1886, p. 177, quoted by Bebber, Meteorologie, p. 245.

† *Proc.* Roy. Soc., Vol. XLII.

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Observations made at greater heights in balloons, on the other hand, seem clearly to indicate that this increase soon ceases, and that a diminution takes place at moderate heights already. Thus the observations of Dr. O. Baschin (*Meteorologische Zeitschrift*, September, 1894) gave for the fall of potential in volts per metre the numbers 49, 28, 13 at heights of 760, 2,400, 2,800 metres respectively, and at a height of 3,000 metres no measurable fall at all could be obtained. These observations were made in clear weather. The balloon afterwards passed over a layer of clouds, and strong electric effects were noticed. Similar observations had been previously made by others (Andrée, Le Cadet, and Bornstein), and though the subject is by no means exhausted, we may take it as provisionally established that the lines of force of the normal electric field of the earth end within the first 10,000ft. or 15,000ft. This result is of great importance, for it shows that there must in fine weather be a layer of positively electrified air permanently above us. Currents of air in this layer must affect the field as we observe it, and possibly the daily changes may be due to changes in the currents of air at a moderate height. A fact discovered by Exner is of importance in connection with this subject. Observing at three different places (in a field close to Vienna; in St. Gilgen, on the Wolfgangsee; and in Venice, on the hills), he found that whenever there was a strong south wind, with a clear sky, the normal fall of potential was always increased, and sometimes considerably.*

The daily changes show, with few exceptions, a remarkable uniformity at different places. There are in general two maxima—one at 8 or 9 o'clock in the morning, and one in the evening. The evening maximum is the most marked, while at some places, and especially near towns, the morning maximum disappears. The same general features of the daily variation have been found to hold at a number of European stations, at Cape Horn, Melbourne, and in the Northern Arctic regions. If the variation is separated into two—one having a period of 24 hours, and the other of 12 hours—the latter is found to agree in phase at widely different places on the earth's surface, while the former is found to vary to a much greater extent, and hence to be probably more affected by local circumstances. The remarkable researches of Hann have given a similar result for the diurnal variations of the barometer, and we may reasonably conclude that the semidiurnal variation of atmospheric electricity is connected with that same circulation in the upper regions of the atmosphere which shows itself in the corresponding changes of pressure.

In addition to the more regular periodic changes, the electric stress observed in fine weather shows marked differences on different days and at different seasons. With respect to these the researches of Prof. Franz Exner† have led to the important result that there is a close connection, direct or indirect, between the amount of aqueous vapour present in the atmosphere and the fall of potential observed at the surface of the earth. If p_0 be the pressure of aqueous vapour present in centimetres, Exner deduces the equation for the fall of potential P

$$P = \frac{A}{1 + k\,p_0},$$

where $A = 1300$, $k = 13{\cdot}1$.

The formula agrees very well with observations in which the vapour pressure varied between 0·23 and 0·95, and it is especially to be remarked that it is the amount of vapour and not the humidity which determines the fall of potential. Observations made by Mr. E. Drory during a journey round the world fit in very well with Exner's formula, and observations made at such widely-different places as Suez, Albany, Sydney, Colombo and Penang showed a fall of potential practically identical with that calculated from the above formula, though the same constants were taken and the vapour pressure varied between 0·8cm. and 2·2cm.

Messrs. Julius Elster and Hans Geitel‡ have followed up this research. Their investigations have shown a satisfactory agreement with Exner's formula, if the mean values of a number of observations, in which the vapour pressure is approximately the same, is considered. But individual numbers differ very widely from the mean, so that the formula cannot be used to predict the normal fall of potential on any particular day. There is, perhaps, nothing surprising in the great divergence of such individual results if it is considered that we only observe the moisture near the surface of the earth, but know nothing of the total amount of water in the column of air over the district in which the observations are carried out. The same authors have shown that an equally good agreement can be obtained if, instead of the amount of aqueous vapour, we take the intensity of active radiation as the determining circumstance. The light might be supposed to act on the general surface of the earth, as it does according to Hallwachs' observations on a metallic body, dissipating a regular charge. There are some difficulties in the way of this explanation, the most serious being the absence of experimental evidence that sunlight actually does act in the manner indicated on any substance forming part of the earth's surface. It is impossible at the present time to enter more fully into this subject, but attention must be drawn to the very important indirect result, that there seems to be a connection between ultra-violet radiation and the amount of aqueous vapour present in the air.

The phenomena of atmospheric electricity have been studied at the mountain observatory established on the "Sonnblick," in Salzburg, at a height of 3,100 metres.

The important result has been established that the fall of potential is singularly constant. The great differences observed at low levels between the electric field in summer and winter, or on dry and wet days, seems to be completely absent, and these facts tend to support the conclusion derived from balloon observation, that the positive ends of the lines of force are situated at a height of something like 10,000ft.

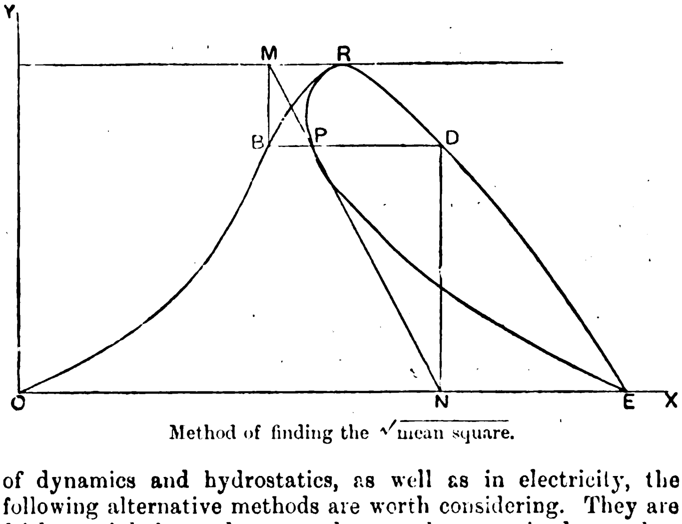
(*To be concluded.*)

* *Wiener Akad. Sitzungsberichte*, Vol. XCVI. (1887).
† *Wiener Akad. Sitzungsberichte*, Vol. XCVI. (1887).
‡ *Ibid.*, Vol. CI. (1892).

GRAPHICAL METHODS OF FINDING MEAN-SQUARE VALUES.

BY ALEXANDER RUSSELL.

Dr. Fleming, in *The Electrician* for May 10th, has given a valuable graphical method of finding the mean-square of a series of values of a varying quantity. As the problem is an important one, occurring, as it does, in many applications



Method of finding the $\sqrt{\text{mean square}}$.

of dynamics and hydrostatics, as well as in electricity, the following alternative methods are worth considering. They are fairly straightforward ones, and once the curve is drawn they involve very few measurements of length, and hence this source of error is reduced to a minimum. The latter of the two methods given is an instructive exercise for junior students, and when the precautions described are taken it gives accurate results.

Method I.—Let O R E be the curve (*see* figure), the ordinates of which give the values of the varying quantity. Draw a series of lines parallel to O X, like B D. If the curve be drawn on sectional paper, this part of the construction is unnecessary, as the ruled lines will do. Draw B M and D N perpendicular

to the tangent to the curve at its highest point R and to O X respectively. If we are using sectional paper, M and N can be marked without actually drawing the perpendiculars. Now mark the point P where M N cuts B D. Similarly, find other points, like P in the lines parallel to B D. Draw R P E, the curve passing through all these points. Measure h, the maximum height of the curve; l, the length of the base O E; and A^1, the area of the curve R P E D.

Then $$Y^2 = \text{the mean value of } y^2 = 2\frac{h}{l}A^1 \quad . \quad . \quad (1)$$

The practical rule is, therefore: Construct the curve locus R P E, find the area R P E D by the planimeter or otherwise, measure the height and breadth of the curve, and then use the formula (1) to get the $\sqrt{\text{mean-square}}$ of the height of the curve.

A short proof of (1) is as follows:—

The volume of the solid generated by the revolution of the the curve O R E round $OX = \pi\int_0^l y^2\,dx$.

It also $$= \int_0^h 2\pi y \,.\, BD\,dy;$$

$$\therefore \quad \int_0^l y^2\,dx = 2\int_0^h y \,.\, BD\,dy.$$

But from similar triangles
$$y \,.\, BD = h \,.\, PD;$$

$$\therefore \quad \int_0^l y^2\,dx = 2h\int_0^h PD\,dy$$
$$= 2hA^1;$$

$$\therefore \quad Y^2 = \frac{2h}{l}A^1.$$

In the second method we make use of the following theorem:—If y_m = the mean height of the curve, and y = the height of the centre of gravity of the area bounded by the curve,

then $$y_m = \frac{A}{l}$$

and $$2y = \frac{\int_0^l y^2\,dx}{A}$$ where A is the area of the curve.

$$\therefore \quad 2y \,.\, y_m = \frac{\int_0^l y^2\,dx}{l} = Y^2. \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This formula enables us to write down at once the $\sqrt{\text{mean-square}}$ when we know the area and the centre of gravity of the area bounded by any curve. Applying this rule to finding the $\sqrt{\text{mean-square}}$ of geometrical figures like triangles, trapeziums, arcs of circles, &c., is an instructive exercise and shows to a certain extent how the mean height and the $\sqrt{\text{mean-square}}$ value of the height of a curve vary with its shape. For example, in a triangle

$$2y = \frac{2}{3}h \text{ and } y_m = \frac{1}{2}h \;\therefore\; Y = \frac{h}{\sqrt{3}}.$$

It is to be noted that y_m, Y and $2y$ are in geometrical progression, and are, therefore, arranged in order of magnitude; many theorems follow from this, the interest of which, however, is more mathematical than electrical, such as finding families of curves which have the same Y's, &c.

Method II.—Whatever the shape of the curve is, we can always find its area A, and the position of the centre of gravity of its area, by well-known experimental methods. Measure the height of the centre of gravity above O X (y) and the breadth of the curve (l). Find $y_m \left(= \frac{A}{l}\right)$; then Y can be calculated from the formula $\sqrt{2y \,.\, y_m}$.

It is particularly easy to find the position of the centre of gravity of a plane area by experiment. First cut out the curve in stiff paper. Hang it up by means of a fine needle, round which the curve swings freely. Fasten a key or other heavy object to the needle by means of a silk thread forming a plumb line, and make a mark where this line cuts the lower edge of the paper. Displace the curve and see that when it comes again to rest the silk thread is over the mark. Then rule a fine line through the point of suspension and this mark.

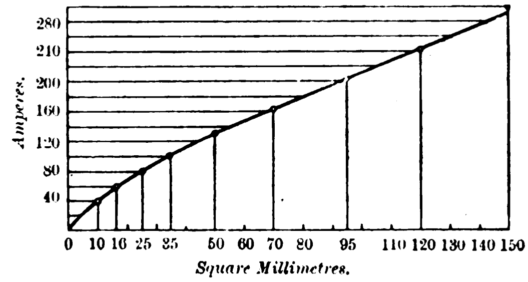
In a similar way rule another vertical line through another point of suspension. Where these lines intersect gives the centre of gravity of the plane area.

GERMAN INSTALLATION RULES.

A Committee of the Verband Deutscher Elektrotechniker has recently drawn up some rules relating to electrical installations, which will be submitted to the Verband for adoption at their annual meeting, which is to be held at Munich at the beginning of July. These rules, from which we abstract the most important points, apply to installations in buildings and private houses, in which the potentials from 25 to 250 volts, either continuous or alternating, are used.

The temperature of the wire of regulating resistances must not exceed 200°C., and the apparatus must be so erected that combustible objects close by are not heated above 60°C. For conductors it is laid down that copper should be generally used, the conductivity to be such that a 55-metre length of a wire of one square millimetre section has at 15°C. a resistance of 1 ohm. This works out at only about 93 per cent. conductivity according to Matthiessen's standard.

The highest admissible current for copper wires and cables is to be deduced from the annexed curve. An examination of this curve will show that, compared with English practice, a very high current density is permitted.



The smallest permissible cross-section for conductors is one square millimetre (about No. 18 S.W.G.); for fittings 0·5mm. (about No. 21) for each glow lamp. In places where the use of copper is not suitable, iron wires of at least four times the section of copper are allowed. The smallest admissible section for flexibles is one square millimetre.

The construction of fuses must be such that by fusing no permanent arc can be created. In lead fuses the contact must not be made by the lead direct, but contact-pieces of copper or other suitable material must be sweated to the ends of the lead wires or strips. Fusible screw-plugs of lead may only be used up to 25 amperes. Not more than 12 glow lamps or a current of 10 amperes may be protected by a single fuse.

The insulation resistance of two conductors against each other, and also of each conductor and earth, must give at least the value expressed in the following formula:—

$$R = 10{,}000 + \frac{2{,}000{,}000}{n} \text{ ohm},$$

where n is the total number of glow lamps (presumably 50-watt) connected, one arc being reckoned an equivalent of 10 glow lamps, the same ratio applying to every motor or other current-consuming apparatus. In making insulation tests to earth with continuous current, the negative pole of the generator should if possible be connected to the conductor which is to be tested. The readings must only be taken after one minute's electrification. All insulation tests must be made with the working pressure. In multi-wire systems the pressure at the lamp is to be taken as the working pressure. In all the insulation tests all glow lamps, arc lamps, motors and other apparatus must be disconnected, but all fittings, fuses and switches should be in the circuit.

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ON THE RECENT DEVELOPMENT OF THE SINGLE-ACTING HIGH-SPEED ENGINE FOR CENTRAL STATION WORK.*

BY MARK ROBINSON.

(*Continued from page 96.*)

20. *Brake Efficiency.*—Having fully dealt with the three special points of advantage peculiar to single-acting engines, enumerated in paragraph 11, it will be of interest to investigate the effect of the single-acting principle upon brake efficiency. Generally, a single-acting engine has higher brake efficiency, when fully loaded, than a double-acting engine. The perfect lubrication of all brasses and bearings in the spash chamber of a single-acting engine naturally reduces that part of the friction to a very small figure, and the total absence of back-lash, or "lost motion," is believed to tell as strongly in the same direction. On the other hand, singly-acting engines, or at least the Willans engines, though they have no stuffing boxes, have unusually numerous piston and other rings, mainly owing to the practice of putting a complete tandem engine over each crank—or three cylinders over each crank, if triple expansion. Nine complete cylinders,† as fitted in three-crank triple-expansion engines, with their valves and glands, imply a large number of rings, and even in a two-crank compound engine there are a good many. The special design of the rings, which has been fully described in paragraph 12, coupled with accuracy in manufacture, bring the total friction, however, to a reasonably small amount. After some months' running, it is not uncommon to find the brake efficiency of compound engines as high as 92 per cent. ; but on trial at the works, when the rings are new and not yet brought up to a good face, it is rare to get more than 90 per cent., and 89 per cent. would not be thought unsatisfactory. In a triple-expansion engine 87 or 88 per cent. is a good result when new. Though experiments are sadly wanting, it is believed that these figures are much about the same as those for good double-acting engines, in which there is less ring friction but more bearing friction.

21. Mr. Willans' diagram of total water consumption, shown in the discussion upon Mr. Crompton's Paper upon the "Cost of Electrical Energy,"‡ has familiarised everyone with the rather puzzling fact, that in almost all trials at Thames Ditton, with good dynamos, the lines representing total water per electrical horse-power and per indicated horse-power remain nearly parallel for all loads ; in other words, the combined engine and dynamo losses, and *à fortiori* the engine losses alone, are as great at light as at heavy loads. Makers of some double-acting engines are believed to have obtained results differing from this, and showing a considerably reduced engine friction at light loads. Probably both are right. In both types the ring friction is constant. In the single-acting engine the bearing friction is also practically constant, because its maximum is so small that variation in it is unimportant. In the double-acting engine the bearing friction§ at full load is relatively great, and as it falls off at light load, it considerably reduces the total friction. If the single-acting engine beats the other handsomely at full load (as it often does), the effect may only be to bring them together at light load ; but where the double-acting engine is exceptionally free from friction, and makes a more even fight with the single-acting engine at full load, it may have a distinctly higher efficiency at light load.

22. The value of improved efficiency at light loads is not large, for the unwisdom of running an engine at light load, for any permanent use, is too great to be redeemed by any probable saving in engine friction. If light loads have to be faced, there should be a smaller engine to undertake them, small enough to make a full load of them, or nearly so.

23. The possible higher efficiency of double-acting engines at light loads is well illustrated in a Paper read by Mr. Alexander Siemens before the North of England Institute of Mining and Mechanical Engineers, in December last. It describes fully a series of trials in the central power-station belonging to his works at Woolwich, between a Willans engine (3-crank) of 300 I.H.P. and a Belliss double-acting engine (2-crank) of the same power, and running at the same speed, 350 revolutions per minute. The dynamos were apparently identical, and all the conditions appear to have been as favourable to a fair test as they can ever be in a commercial engine room. There are anomalies in the very interesting figures given, but there is no reason to mistrust their general tendency. At 270 I.H.P., the highest power used, the combined efficiency of the Siemens-Willans plant was 86 per cent., against 85·1 per cent. in the Siemens-Belliss, but at light loads the advantage of the latter was considerable, as appears below :—

——	Electrical H.P.	Indicated H.P.	H.P. lost in engine and dynamo combined.
Willans set	231·2	268·9	37·7
Belliss „	230·4	271·6	41·2
Willans set	114·6	149·2	34·6
Belliss „	120·3	144·7	24·4
Willans set	60·9	95·7	34·8
Belliss „	60·5	79·4	18·9

There is much in these figures which is with difficulty reconciled with any probable assumption as to the respective engine and dynamo losses ; but there is no doubt that in the double-acting (Belliss) engine the friction became very small at light loads. As it had but two cylinders and ran at high speed, there could be but little ring friction at any load, and it looks as though, *at light loads*, the bearing friction almost disappeared ; probably the crank-pins and shaft "floated" in their brasses, permanently separated from them by the oil which was forced in under pressure. It is, however, instructive to notice that with increasing load, and notwithstanding its great advantage in regard to ring friction (it probably had little more than one-third as much ring friction as the other engine), the total friction of the double-acting engine rapidly overtook that of its rival, and it is evident that had trial been made at the much higher mean pressures frequently used in non-condensing stations, the advantage of the single-acting engine would have been very marked indeed. It seems possible that, although the exceedingly elegant system of lubrication adopted in this double-acting engine is effective when the pressure per square inch on the brasses is light, yet the alternating pressures of the parts begin to produce their natural effect at heavier loads. In the single-acting engine security from wear and knock is obtained by ensuring that the revolving journal shall remain always in steady contact with *the same* brass : in the remarkable double-acting engine described, an even more perfect result is perhaps obtained *at light loads* (which, however, are not of the highest importance) by providing that the revolving journal shall touch *neither* brass ; but it remains to be seen whether in continuous running at heavy loads, the brasses will not relapse more or less into the condition of those of an ordinary double-acting engine. It is at least plain from the Woolwich figures that even at 270 I.H.P. the bearing friction (as distinguished from ring friction) of the double-acting engine is enormously greater than that of the single-acting engine, and the law of its increase might well repay investigation. Provisionally, it is difficult to resist the conclusion that bearing *friction* —*i.e.*, the actual rubbing of the journal upon the brass—is of small importance in engines in which the lubrication is very perfect, as in the Willans engine through its oil bath, or in the Belliss engine through the forcing-in of oil under pressure,* and that, in double-acting engines, at heavy loads, the most important element of friction-loss—or, it may be safer to say, of power-loss—is to be traced to the knock of the journal as it changes over from one brass to the other—a source of loss which the single-acting (constant-thrust) engine avoids altogether. Whatever be the ultimate verdict, no one can withhold admiration from the ingenuity and indeed beauty of the device by which it is sought to overcome so great a difficulty, and it is most satisfactory that in such an interesting and important trial, the double-acting principle has been, and continues to be, represented by so perfect an example.

24. Passing to the results of experience with single-acting engines in the last few years, it may be well to deal separately with—

(*a*) Steam Consumption. (*c*) Lubrication.
(*b*) Durability. (*d*) Vibration.

25. *Steam Consumption* (*a*).—The consumption of the best-known type of single-acting engine, under all loads, is known not only from the almost historic series of tests conducted by Mr. Willans, but from numerous other trials carried out at Thames Ditton.

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* Paper read before the Institution of Electrical Engineers

† *Twelve* complete cylinders, has been unkindly said, reckoning the guide or cushion cylinders. But the reproach is not quite just, since the guide cylinders, with their ring-less pistons, merely represent the guides and cross-heads of other engines, and are quite as simple.

‡ *Proceedings* of the Institution of Civil Engineers, Vol. CVI., 1890-1.

§ In "bearing friction" is here included that which is assumed to be due to back-lash, *i.e.*, to the incipient "knock" necessarily present where there is alternation of stress. It is to be remarked that the heat generated by knock upon brasses is wholly lost ; but heat generated by piston-ring friction is partly utilised in heating the cylinder walls and pistons, and so reducing condensation. In the single-acting engine, therefore, a greater proportion of the friction loss is returned in reduced consumption of steam, than in a double-acting engine having the same total friction.

* If the mere rubbing of the journal and brass together, at heavy loads, were seriously important in a thoroughly lubricated engine, the Willans engine would show increasing friction at heavy loads. It does not do so, and even the moderate increase (in engine and dynamo together) shown in the figures extracted from Mr. Siemens' Paper, is exceptional. The increase in the Belliss engine, therefore, can hardly be due to this cause, and other reasons must be found for the increase which undoubtedly occurred.

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It is, however, a frequent objection that the small consumption of steam per kilowatt upon test, bears little relation to the actual consumpton of coal per kilowatt sold : and doubt is often expressed whether the engine consumption does not increase with use and wear, or whether test figures are not vitiated later by variation in load. It is satisfactory to be able to answer this question. At the stations of the Westminster Company, Dr. Kennedy, F.R.S., has for a long time had accurate records kept of the quantity of water supplied (by meter), as well as of the load upon each engine separately. The "Thames Ditton" consumption for every engine at all loads is, of course, known, and has been compared with the actual consumption, and after allowance for steam known to be condensed in pipes and used in pumps, &c. (mostly ascertained by experiment), the result is *an almost exact balance.* Probably there really are unrecorded losses for which a margin would have to be provided, if it were not that the engines work at a little less than the calculated consumption, since the latter is, of course, based upon the trials of the same engines at the makers' works, when new and stiff. Some of the engines at the stations had been at work for over five years, and few for less than two years, so all had had time to bring the rings and other wearing surfaces into the best condition for economy.

26. At the meeting of the Institution of Mechanical Engineers, on April 24, 1895, the above facts were well shown in a diagram exhibited by Mr. G. M. Clark. Two cases were taken, from the same station : one for a heavy winter load, covering 24 hours ; the other for a week's load in summer. The leading particulars were :—

—	Winter load (24 hours).		Summer load (one week).	
Output in kilowatt-hours........................	3,350		9,000	
Measured total water consumption per kilowatt-hour .... lbs.	...	46	...	48
Measured steam consumption of engines at Ditton trials (full load, non-condensing), per kilowatt-hour .... lbs.	32·5		32·5	
Calculated addition to steam consumption (non-condensing) on account of low load factor .... lbs.	8·0		9·5	
Total calculated engine consumption per kilowatt-hour .... lbs.	40·5		42·0	
Measured consumption of steam in pumps per kilowatt-hour .... lbs.	1·5		1·5	
	42·0		43·5	
Balance, attributable to condensation in pipes, leaks, &c., ascertained by previous trials to vary from 7 per cent. to 11 per cent. of total consumption .... lbs.	4·0	46	4·5	48

These figures may be commended to those gentlemen of the technical Press who tell us that theory never helps anyone ; that no engine builder knows within pounds what weight of steam his engine is likely to use in practice ; and who apparently reckon no man practical if he knows the reason for what he does or is able to forsee the result.

27. It is important to inquire whether the economy of the single-acting engine may be expected to make any notable advance beyond the results hitherto obtained. The answer is Yes, but here (speaking of the Willans engine only) it is necessary to distinguish between actual engines as fitted in the majority of stations, and the new type only recently made. Owing to various circumstances, the demand for the central-valve engine came at first chiefly from users who desired to work without condensation, and its fame was first established by Mr. Willans' Paper upon Non-condensing Trials, in which he showed figures not before supposed to be possible for non-condensing engines (such as a consumption of 18·45lb. of steam per indicated horse-power with 170lb. pressure, triple-expansion ; and 19·45lb. with 150lb., compound). But Mr. Willans' Paper, and his practice at that time, did more than this—they pricked the bubble of over-expansion. Here was a little non-condensing engine which, with five or six expansions, used scarcely more steam per indicated horse-power, and obviously less per brake horse-power, than many large (not to say overgrown) condensing engines which expanded their steam twenty-fold or even thirty-fold. But the ease of the triumph tended to mislead, and the same ratio of expansion, without the moderate increase which was really desirable, was provisionally attempted in condensing work. A few months before his lamented death, Mr. Willans carried out a complete series of condensing trials, which proved that, while nothing could justify the excessive expansion formerly allowed by some makers, the Willans engine, as then made, erred, though less seriously, in the other direction. A new series of engines has since been designed in which the necessary greater expansion is provided for, the ratio of the cylinders being altered at the same time ; and in which a number of minor improvements, tending to the suppression of petty losses, considerable in the aggregate (but much less important in a non-condensing than in a condensing engine), have been introduced. From these engines, which have but just commenced to find their way into station work, great economy may be expected. The earliest was a triple-expansion mill engine indicating up to about 500 H.P., driving the flax mill of Messrs. Gunning and Campbell (Limited), at Belfast, at 300 revolutions per minute, and in some very complete trials carried out last year by their consulting engineer, Mr. A. Basil Wilson, M.Inst.M.E., after the engine had been at work for about six months, a consumption of 12·48lb. of steam per indicated horse-power was recorded. This places the single-acting engine, to say the least, in the very foremost rank of economical motors. Evidently electrical engineers need not fear that they must abandon economy if they do not "stick to the builders of mill engines and marine engines." In fact, it seems not impossible that, while advocates of the "mill engine" are pleading for central-station work, they may find themselves the victims of a flank movement, and learn too late that their special patrons, the mill engineers and owners, are becoming as open minded as the electricians, even to using "electric light engines" for driving their mills.

28. It may be remembered that in Mr. Willans' Paper on Non-condensing Trials, figures were given for one condensing trial at 170lb. pressure, carried out with the same triple-expansion engine as had been used for the non-condensing trials : the consumption was 15·1lb. per indicated horse-power per hour. With the old engine that result has not been much improved upon, so it may be reckoned that the new series are about 15 per cent. better in steam economy than the old, *when condensing.* For non-condensing work, and for condensing work in special cases, the old series engines are still the most suitable, while from the smaller cylinder capacity they are less costly to make. The engine at Messrs. Siemens' works at Woolwich, the trial of which against a Belliss engine has been before referred to, was of the old pattern, compound, but fitted with the "transfer" arrangement : in other respects it was of the proportions now recognised as suitable for non-condensing only. The steam consumption at full load is given by Mr. Siemens, in his Paper before quoted, as 19·5lb. per indicated horse-power, against 22·4lb. in the double-acting engine. It is understood that these figures of steam consumption are based upon the total water actually supplied to the boilers, with a deduction only for steam used in pumps ; they presumably include pipe condensation and leakages of all kinds, and it is probably from some such causes, rarely absent from a commercial engine room, that the water used comes out some 2lb. per indicated horse-power per hour above that due to the proper steam consumption of the old-type Willans engine at the load and pressure stated. (The vacuum is not given.) Of course, the Belliss engine was similarly affected.

29. Reference has been made, in paragraph 20, to the numerous cylinders of the Willans engine, due to the practice of erecting a complete engine over each crank. By adding to the number of pistons and valves the ring friction is, of course, increased, and it is equally certain that condensation is increased, and economy affected unfavourably, owing to the larger aggregate surfaces of the two or three small cylinders which take the place of what might otherwise be a single large one. On the whole, however, the advantages appear to outweigh the drawbacks. The first and most obvious is even turning moment. Whatever the change in load, in pressure, or in cut-off, it is at least certain that the cranks will be driven equally, and this is an advantage not to be lightly surrendered for only a small gain in economy. But the same tandem arrangement of cylinders is also the condition of the complete application of the Cornish cycle to all the cylinders except the low-pressure one : the perfect separation between the temperature ranges of the successive cylinders is impaired if their strokes do not succeed each other at intervals of exactly a revolution—as they now do in the tandem pattern ; even economically, therefore, there is something to be said in favour of the many small cylinders. Turning to other considerations, it may be thought at first that the large number of small cylinders and multiplication of parts must lead to increased weight and cost, as well as to difficulty in dismantling and overhauling. As to weight, it is almost certain that it is not increased. Cylinders weigh roughly in proportion to volume, but the weight of a piston tends to increase faster than the area ; three pistons, each of one square foot area, will weigh less than one of three square feet area. To cylinder covers the same consideration applies. Piston-rods, connecting-rods, and crankshaft should be unaltered. There may be some saving in machine work, but small pieces are after all easier to machine than large ones, and pieces which are made in batches of say, 36, are more economically manufactured than

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larger pieces made in batches of 12 only. Then the identity of the several lines of parts, and their interchangeableness, are often helps to the user (especially in case of repairs), while the lightness of the individual pieces and the regular and simple routine in removing them make dismantling easy. A Willans cotton mill engine of 650 I.H.P. pulled up one day after the dinner hour with brasses cut to pieces and crankshaft badly scored. (Of the cause, it need only be said that emery powder was found in the bearings and in the crank-chamber.) *Next morning*, after breakfast, it started again with new brasses, and crankshaft in good order. By good luck another engine of the same size was being erected in the same town, and its brasses were at once appropriated for the disabled engine, and every necessary repair thoroughly carried out during the night. It is true that in this case the cylinders did not require to be lifted, but there have been as rapid repairs to cylinders, pistons, &c., where internal damage has been done by water. Some years ago, three 3-crank triple-expansion engines of 300 I.H.P., to save the reproach that they had nine cylinders each, were designed with only six cylinders, viz., one high-pressure, two intermediate, and three low-pressure. It is remarkable that not only have all later engines of the same type been fitted with the orthodox nine cylinders, but the original engines in question are now being altered to the standard pattern. With larger sizes may, possibly, come different views, but as regards the present standard patterns 700 I.H.P. or 800 I.H.P., experience gives little support to objections against the number of cylinders.

30. A discussion upon the economy of the single-acting engine should include running expenses other than steam, but this would greatly lengthen the Paper. Moreover, it is only users who can pronounce upon this question finally and with authority. That single-acting engines of the closed type are very economical in oil is generally allowed, and economy in attendance is also conceded. An engine which oils itself cannot want much looking after. Repairs are the only point which really admits of dispute, and these are dealt with under "durability" in the succeeding paragraphs.

31. *Durability*.—The idea that because a machine makes many revolutions a minute it must wear out more rapidly than a slow-running machine, seems to have the force of an axiom for some minds. Yet there is nothing axiomatic, nor even, to the instructed, probable about it. In the first place, high speed is a very winnowing fan in the matter of workmanship. It is surprising what a slow-speed engine can endure, for a season, in the way of bad workmanship; but not so the high-speed engine. If it will run at all, there is probably no reason it should stop, so far as workmanship affects the question. In the next place, the piston speed is usually much lower than in slow-running engines, owing to the short stroke; about 525ft. a minute is the highest piston speed in any single-acting electric light engine. The wear of piston rings and cylinders is bound, other things being equal, to be proportional to the piston speed, and this applies also to valves and glands. In one important point, however, other things are not equal, but are largely in favour of the single-acting engine. The system of packing rings described in paragraph 12, which cannot be used in double-acting engines without much complication, has decisive effect upon cylinder wear, and even if one went back to the records of the old vertical beam engines, which used steam at 30lb. per square inch, and have been described as "revolving occasionally," it may be doubted whether such evidence of good wear could be found as is now to be quoted in favour of the fastest running engines.

32. The makers of the Willans engines have for some years past lost no opportunity of obtaining and recording exact measurements of wear where they have been called in to carry out overhauls or examinations. The results are systematically recorded, and they show, speaking generally, an absence of wear beyond all claims made or expectations formed by those interested in the engine. On March 9, 1895, a G.G., or 80-I.H.P. compound non-condensing engine, No. 906, used for lighting one of the largest hotels in London, and stated to have run (at about 400 revolutions per minute) for 14 hours per day, including Sundays, was taken down for overhaul—never having been so much as taken down for examination since its erection in April, 1890—that is, *five years* previously. The report states that "all the parts were carefully measured, and the high-pressure and low-pressure trunks showed no perceptible wear, and were replaced the same as they were taken out. On measuring the high-pressure cylinders we found they were two-thousandths of an inch larger than our standard size, and the low-pressure cylinders were the same; still they were quite round. All piston rings and gland rings were replaced without any repairs whatever. The whole of the repairs to this engine, including taking down and re-erecting, were executed in 24 hours."

33. It will be justly said that if such a report reflects great credit upon the engine, it reflects no less credit upon the engineer who has charge of it. The constant and heavy work in this case is no real disadvantage: the chances of corrosion during stops of a few days are much more injurious. In a lighting station where work is more intermittent, and where during the summer engines are liable to be laid off for comparatively long periods, the wear (or corrosion) is greater, and the following is an instance of what is looked upon as heavy wear under such circumstances. The engine is of H.H.-12 size, No. 999, being of an exceptional type—that is, having 12in. stroke instead of 8in. (as usual in H size), and running under 200 revolutions instead of at about 380; it was one of a pair ordered to a special specification, and from the point of view of objectors to high speed it should give good results. It was erected in March 1891, at one of the London electric lighting stations, and in February last it was taken down for an ordinary overhaul, and was re-erected. As the condition of the engine was manifestly good, and as it was non-standard, so that information about it had not the usual value, it was not measured, but hearing that a visitor to the station had measured the high-pressure cylinders while lying about, and had stated them to be much worn and considerably oval, the makers, though certain that the statement was a mistake, asked permission to take the engine down again, and made unusually full measurements, checked by more than one observer, in the presence of the chief engineer of the station. It appeared that in one cylinder, though the ovalling ranged only from two to seven 1,000ths, there was in one part wear (in four years) of 28 1,000ths, or nearly 1-35th part of an inch; the other cylinder showed about half this wear, and no ovalling.*

34. The third instance is of an engine working under really good conditions—that is, driving a cotton mill, and working therefore for long hours, and with scarcely any stops exceeding two days. This engine, No. 1,253, of 650 I.H.P., commenced work in April, 1892, and though the cylinders had been taken down before, they had not been closely examined or measured. At Easter, 1895, it was thought desirable to have the engine closely examined, and between the Thursday evening and the following Sunday afternoon it was completely dismantled, thoroughly examined and measured over, cleaned, re-erected, and started under steam. There was no repair of any kind to be done, and but for the accidental breakage of some studs during re-erection it would have been running a few hours earlier. The report upon wear was most satisfactory, but the facts are best given in the words of the inspector sent by Mr. Michael Longridge, who supervised the examination on the part of the owners of the mill. This gentleman wrote:—

"The cylinders were taken down and pistons and valves out; the cylinders are 17in., 28in., and 40in., with 1ft. 6in. stroke. Revolutions, 206; boiler pressure, 160lb. I examined and gauged all the six cylinders with a very fine gauge, one that can be set to one 10,000th part of an inch, and found high-pressure cylinder about one 1,000th part of an inch worn; intermediate-pressure cylinder one 3,500th part, and low-pressure one 7,000th part of an inch worn; indeed, the tool marks had not properly worn out. The surfaces as smooth as glass. The pistons and rings seem to be very good, and the rings of the piston-valves also appear to be very good, all bearing well round; the piston-rods or trunks also appear to have good surfaces; also internal surfaces, where the valves work, seem good, and the rings of the piston valves also appear very good, so that they scarcely appear to have been at any work. I must say that I never came across anything so accurately fitted together; even gauging the cylinders with the above-named fine gauge, I cannot say that I even found a slack place one way from another. Whether the engines are of good principle or not, the workmanship is good, which contributes to small wear and little friction. Crank-shaft necks and crank-pins seem very good, being very smooth." "Whether the engines are of good principle or not" is valuable; clearly the giver of this emphatic testimony is no devotee of the single-acting engine. All brasses and journals, eccentrics, &c., were stated by the overhauling staff to be in perfect condition.

35. When the single-acting engine has run n years it is always open to objectors to say (as they do) that no doubt it is good for n years, yet $n+1$ years will finish it. The argument admits of no refutation; that is, the present objectors may be right—for a year, though those of last year are refuted already. But reasonable men with such evidence as the foregoing before them will pay more heed to the counter-claim, which is, that the durability of the high-speed single-acting engine is not inferior to, but enormously exceeds, that of the best double-acting engines, unless the

* The statement which gave rise to the re-measurement was that one cylinder was fully an eighth of an inch oval, and that there was much tapering and wear generally. It was made beyond question in absolute good faith, probably from using inadequate or extemporised measuring appliances. The remarkable point was that the visitor was an engineer, and stated that he had been provoked to measure the cylinders by being told that no wear would be found in them; but that, "as an engineer himself, and accustomed to measure cylinders," he did not consider the wear, *as he supposed it to exist*, was excessive for the time the engine had been running.

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latter revert to an archaic slowness of running, in which case their enormous size and cost will exclude them from practical consideration.

36. With many hundreds of single-acting engines at work, there are, of course, some cases of trouble. There have been broken crankshafts, though not in an unusually large proportion, if we exclude a succession of breakages in a single important station which attracted much attention. There were special reasons in that case which contributed to the result; but the plain and honest reason why the cranks broke (as with all other cranks which have broken since cranks began) is that they were simply not strong enough. The engines, which formerly had a 4-in. shaft, have for some years past had 5-in. shafts. The 4-in. shafts have broken, and the 5-in. have not, and are not likely to—apart from the effect of those occasional flaws against which no steel forging can be absolutely guaranteed.

37. Other cases of excessive wear, or of damage, when not referable to defective lubrication, may usually be traced to under-loading, *i.e.*, to running with so light a load that the pressure in the steam-chest becomes insufficient to hold down the lines of valves in constant thrust against the eccentrics. The single-acting engine has, of course, the defects of its qualities. Constant thrust is perfect so long as it lasts, but without it, the single-acting engine has no claim to admiration. For the pistons, and main moving parts generally, the question was settled once for all, so far as regards the Willans engine, by the well-known "air-buffers," which provide completely for cushioning, irrespective of change either of load or of back-pressure, the distribution of the steam by the valves being absolutely untrammelled by any consideration of cushioning. Unfortunately, the air-buffers do not cushion the valves, and it is as important that the latter should be held closely down upon the eccentrics as that the connecting-rods should not leave the crank-pins. The line of valves is fairly heavy, and owing to the eccentric being seated on the crank-pin, though the stroke of the valves relatively to the ports is moderate, yet the total stroke is nearly as long as that of the pistons. "Holding-down power" is intended to be given by the pressure of the steam in the steam chest upon the topmost valve, but if the pressure is too much throttled down, the "constant-thust" element is wanting, and the parts have to be checked upon the up-stroke, more or less, by the underside of the eccentric strap bearing against the sheave—a state of things which, at least in theory, is inadmissible in a constant-thrust engine. In practice, however, if there is good surface on the eccentric sheave, and a well-hardened pin at the small end of the eccentric rod, no serious results follow, provided the defect of pressure in the steam chest is only occasional, and is not too considerable. Under such circumstances, however, it is necessary to look now and then to the eccentric straps, and take up the wear if necessary, and to be warned in time if the engine begins to run noisily. The lesson of the wastefulness of running an engine at light load, if it can possibly be avoided, has now been so well learned, that in lighting stations at least (except, perhaps, in alternating stations where parallel running is not practised) there is little danger of the load, and consequently the steam-chest pressure, being allowed to fall low enough to jeopardise the "constant thrust" of the eccentric straps; but where such a probability exists it adds a reason for using variable expansion gear, which, of course, secures the maintenance of high pressure in the steam chest. In a throttling engine it is also easy to secure the required holding-down pressure on the valves by forming the little steam chest dome which tops each line of parts, as a cylinder, in which the uppermost of the line of valve pistons works. The top of each little cylinder is in communication with the steam pipe outside the throttle valve, and so gives a constant down pressure on the valves, irrespective of throttling. Of course, these fittings cost something, and they need special lubrication, so that it is only in very exceptional cases that it is worth while to fit them, and in such cases there are probably other sufficient reasons for using variable expansion gear instead. It is well to bear in mind, however, that in special cases, the durability of the valve motion may require to be secured by special precautions; it is not absolutely assured under all circumstances like that of the main working parts.

38. *Lubrication* (*c*).—Where the parts of an engine lie permanently in the lubricant, both when running and when standing, the quality of the oil is of more importance than where it is used in the old-fashioned way. Free acid in oil, which is more common than is usually supposed, leads to corrosion, and in some few cases has caused serious trouble; the quest for a perfect crank-chamber lubricant, which shall always be the same, is not quite ended yet. Cylinder lubrication has long ceased to trouble (if the user does not sacrifice everything to cheapness), but not so the other. Sometimes it would appear that acid is brought over in priming water from the boiler; in some cases it has been traced, with tolerable certainty, to special boiler compositions containing acids, which may find their way with priming water past the valves into the crank chamber. The tests for acid, however, are comparatively easy, and its presence is soon shown by the rusty red colour which the lubricant begins to assume, and, in worse cases, by the condition of the parts. Prevention also is usually easy, as by the use of small quantities of soda, or of soft soap, added daily to the crank-chamber in very minute quantities; if there is much of it, it "lathers" so successfully that it drives everything else out of the crank chamber. The "personal equation" enters much into this, as into other questions of engine management. There are many hundreds of closed engines running where trouble with lubrication has never been heard of; yet in a few, working apparently under identical conditions, everything is different. Where oil is of doubtful quality, temperature plays, or may play, an important part, and the advantage of keeping the crank chamber cool has for some years been recognised. In the Willans engine, cooling pipes are usually fitted in the crank chamber, through which, if the engine works non-condensing, it is well to run a small stream of water; about one-fourth of the quantity which is supplied to the engine as steam, per hour, is generally enough, but it is sometimes a convenient plan to run all the feed water through. In a non-condensing engine the crank chamber is hotter than in a condensing engine, because the main source of heating is conduction, by the walls of the crank chamber, from the "exhaust chamber" above. When the exhaust temperature is about 215deg., as in a non-condensing engine, the crank chamber, of course, grows hotter than where the exhaust is at condenser temperature. 170 F. is a perfectly safe temperature for the crank chamber; but the lower it is, the more one has, so to say, in hand, and it is such an advantage to have complete control over the temperature, that it is generally worth while to adopt the cooling pipes, even in condensing engines. The large ones are made, as shown in the section in the appendix, with a kind of water jacket to the crank chamber base. It is evident that the engines might be constructed with a more complete separation between the hot cylinders and exhaust chamber, and the cool crank chamber; there might, for instance, be an air space and columns between those parts. But, as is true of many other possible minor improvements, the gain from this arrangement might be bought too dearly; it is cheaper to take easy precautions against small and infrequent troubles, than to make the engine larger and more costly, even if theoretically more perfect.

39. *Vibration* (*d*).—The increase of town lighting stations gives great importance to the subject, but as it has recently been somewhat fully dealt with, as regards both engines for lighting stations and marine engines, in a Paper contributed by the author jointly with Capt. Sankey, R E., to the Institution of Naval Architects, it is not proposed to treat it at length on the present occasion; it will suffice now to say only enough to show in what direction improvement is most probable.

40. In a recent well-known case, several single-acting engines, supposed to be remarably free from vibration, have been removed from a London station, and replaced by steam turbines, as the only certain means of meeting the objections of persons living close by. What was the cause of the vibration, and how can it be avoided, without abandoning altogether the accepted reciprocating form of steam engine?

41. The station contained 10 engines of 200 I.H.P. each, and it is no exaggeration to say that a person standing on the great concrete block which formed the foundation for all the engines, could scarcely tell whether those near him were running or standing. Yet complaints from houses at some little distance (rather than from closer neighbours) were evidently well founded. The engines had two cranks each, 180deg. apart, as shown in Fig. 8, where there is an obvious couple, A B, which tends to set the engine rocking endways, and to give rise to vibration. But it was incredible that the huge block of concrete, measuring 88ft. by 24ft. by 7ft., could be tilted crossways by the couple between sets of pistons moving in lines only 2ft. 3in. apart. Besides, the effects produced, and the known nature of the subsoil, led to the belief that the block was not so much rocking as lifting up and down bodily, and acting like a pump upon the water-laden soil below (the complaints were most serious after periods of heavy rain). It would have been easy to balance the "couple" if that alone were the cause, by dividing one of the lines of pistons into two, each of half the weight, and using cranks as in Fig. 9, where B and B^1 are both at 180deg. from A, and the parts connected with them are collectively of the same weight as the one line connected with A. This plan is described in Lowrie's Patent No. 3,040, of 1885, and it has also attracted attention recently. The engine showed in Fig. 9 would have no tendency to rock endways, but it was soon seen that it would effect no improvement in the station referred to, for on closely examining the matter mathematically (in February, 1893), Capt. Sankey found that in the engines in question, and broadly speaking in all vertical engines, the tendency to rock endways, by reason of an unbalanced couple, was much less important than the tendency of the engine, as a whole, to move vertically up and down, through a cause depending upon the obliquity of the connecting rod. Previous calculations had usually been addressed

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to balancing the couple, as a practical solution of the whole vibration question, and though it was known that the obliquity of the connecting rod had an effect on the result, it was believed to be disposed of by the statement that "the slight and immaterial errors due to the finite length of the connecting and eccentric rods need not be considered."*

42. The engines were central-valve engines of I.I. size, having lines of parts each weighing 420lb. They ran at about 350 revolutions per minute, and had a stroke of 9in.; the ratio of connecting-rod to crank was 4·77 to 1. The two points of maximum piston velocity are, of course, above half-stroke, hence the changes of piston velocity, and therefore the inertia forces, are greater in the upper half than in the lower half of the revolution. Without going into details, it appeared that when each line of parts was near the top-centre, it exerted an upward pressure upon the engine of 3·54 tons, but when near the bottom centre, it pressed downwards with only 2·31 tons. A B, in Fig. 8, therefore represents not only a couple but a force, for A and B alternately exceed each other by about 1¼ ton, twice per revolution. Twice per revolution there is a force of 1¼ ton trying to lift the engine; and twice per revolution this changes into a nearly equal force acting downwards. (The inertia curves establishing these results are

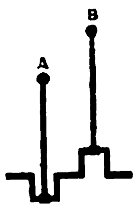

Fig 8.

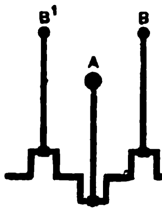

Fig. 9.

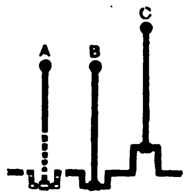

Fig. 10.

given with the Paper before mentioned.) A number of engines developing these unbalanced forces, and synchronising every few seconds, were probably well calculated to produce the results complained of. Needless to say the engine shown in Fig. 9, if comparable with that in Fig. 8, as regards revolutions, stroke, and total weight of moving parts, would give exactly similar results in respect of the unbalanced vertical inertia forces acting upon the engine as a whole.

43. At the same time Captain Sankey investigated the inertia forces in a three-crank (I.I.I.) engine, having the same revolutions, stroke, and weights of parts, but with three cranks at 120deg. instead of two at 180deg. Here the unbalanced vertical forces entirely disappeared, or rather, so nearly disappeared that they amounted to about two pounds only, as against 1¼ ton. It was concluded that if three-crank engines were substituted for the two-crank engines, the vibration difficulties would be ended, but the engineer of the lighting company naturally hesitated to adopt a remedy based chiefly upon calculation, for, although such three-crank engines were running elsewhere and with remarkable absence of vibration, there was nothing to show with absolute certainty

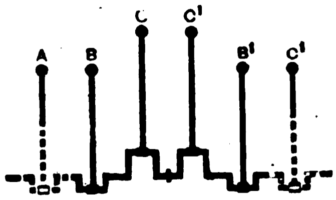

Fig 11.

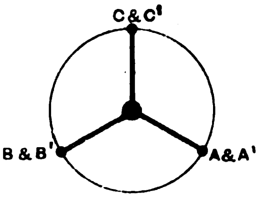

Fig. 12.

that the mathematical reason was the right one. He therefore shifted the engines to another station and put down steam turbines instead, feeling sure that they would at least secure the object of getting rid of vibration. The result was naturally to give an impulse to the use of three-crank instead of two-crank engines for lighting stations.

44. In 1894 the proprietors of the Heilmann system of electric traction were in search of vibrationless engines to mount upon two very powerful electrical locomotives they intended to build, and they applied to the author's company. The engines were to be of 1,400 H.P. each, and as they were to stand fore and aft on the engine framing, and as no weight could be allowed in the nature of "foundation," it was desired to eliminate the "couple" as well as the vertical inertia force. This, it is hoped, will be effected by the design shown in Figs. 11 and 12, proposed, in letters which crossed each other, both by the author and by Mons. Mazen, of the Compagnie des Chemins de Fer de l'Ouest, who is interested on the part of that company in the development of the Heilmann system. There are six cranks, virtually forming two groups, each

* Quoted from a patent specification.

representing a three-crank engine, with cranks 120deg. apart, and therefore, according to Captain Sankey's investigations, free from any tendency to vertical movement; if the two halves of the engine are thus free, the whole must be so. Each half of the engine, however, has a "couple," and tries to rock endways. It is designed to neutralise this effect by arranging the cranks as in Fig. 12, that is to say, by inverting the two groups relatively to each other, so that they shall rock systematically towards and away from each other. Both groups being mounted on one base, and enclosed in one crank-chamber, stiff enough to prevent deformation, it is clear that the engine as a whole will be subject to no rocking effect, and as it is also free from any unbalanced vertical forces due to the finite length of the connecting rods, it is believed that complete success will be attained. A dynamo is mounted at each end of the engine, so that each half of the crank shaft has only to transmit its own half of the power. It is evident that the two centre cranks, C and C', might be replaced by one, their two lines of parts being also replaced by one of the same total weight; the engine would then be five-crank, but it would lose certain advantages of interchangeableness of parts and of manufacturing facility.

45. Two such double engines are now under construction for a large London station, but inasmuch as longitudinal stiffness is amply provided by the concrete foundation, it is unnecessary to place the two groups of cranks in one crank chamber. Each set consists of two I.I.I.—S engines, each of 360 I.H.P., and each engine coupled to a dynamo. The engines are to stand end to end, the bases being bolted together, and the crank shafts connected by a detachable coupling (the governors are driven by gearing, so as not to interfere with the coupling). The cranks are arranged as in Fig. 12, and the coupling does not admit of their going together in any but the right position. Either engine may be used, for light loads, as a single unit up to 360 I.H.P., in a form little likely to give rise to vibration, while at full power, when under ordinary circumstances vibration might become more serious, it is hoped that by coupling together as explained, it will be entirely got rid of. The more conclusive experiment, however, will be in the Heilmann locomotives, where the engines, instead of being on solid foundations, will be, of course, suspended on springs.

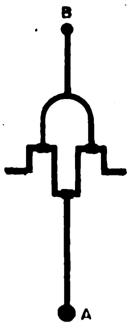

Fig. 13.

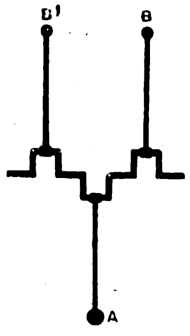

Fig. 14.

46. Perhaps the very simplest form of completely balanced engine is one which was used in the earliest Heilmann locomotive. It is shown in Fig. 13, which represents a compound engine. Fig. 14 shows a variation which might be used for a triple-expansion engine. Of course, in both cases the total weight of the moving parts must be the same on the two sides of the crank shaft, and the cranks must be 180deg. apart, and the connecting rods and cranks of equal lengths. Both figures are really a development of Fig. 9; but they provide, as Fig. 9 does not, for the varying inertia forces due to the finite connecting rods. The forces vary at the same times and in opposite directions, and so neutralise each other completely, instead of only partially, as in Fig. 9. This form of engine needs to be horizontal. If used as a vertical engine, one crank must be driven from below, which is practically impossible in a marine engine, and cannot be generally convenient in other situations. Since the cranks must be opposite, such an engine also cannot have the even turning moment of an ordinary three-throw engine, and for marine purposes it would require to be duplicated (*i.e.*, to have six cranks) for the sake of avoiding dead centres.

47. Numerous proposals have been made to balance engines by "bob-weights"—dummy pistons driven by eccentrics. The couples in an engine can be thus balanced: not the other forces, unless the bob-weights are placed below, as in Figs. 13 and 14, and are as heavy as the pistons. The subject is, however, far too complicated to receive more than superficial notice here.

48. In addition to the foregoing matters, it might be of interest to say something about the governing of central-station engines. This subject, however, needs a Paper, to say the least, to itself; moreover, experience with single-acting engines can teach no lesson substantially different from what may be learned from double-

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acting engines, unless it be that the former, by reason of high speed and many impulses per minute, and the small amount of steam contained within the engine at any one time, are somewhat easier to govern. As regards steady running, in the sense of smallness of variation in speed during each revolution, the high-speed engine has, of course, enormous advantage. The engine before referred to as driving a flax mill in Belfast gives an almost perfectly straight line upon the recorder, although the instrument used could be set to feed the paper so quickly that the change of speed in each separate revolution was apparent; its effect was limited, however, to the width of a narrow line. In this engine, with three cranks, there were 900 impulses per minute, all exactly equal, and it was not wonderful that with a pulley flywheel weighing only 6 tons, and of 5ft. diameter, better results were attained than in slow-running engines with flywheels many times as heavy. The same remarkably steady drive has been observed in another engine of the same type (but with two cranks only) driving a cotton mill. This, of course, is not governing, but merely testimony to flywheel efficiency. It is a subject, nevertheless, of great importance, and one which perhaps was somewhat neglected in the earlier days of the high-speed engine, when flywheel power was certainly cut fine.

49. As the flywheels have been made more powerful, so have the governors. If central-station experience tells anything, it is that if you want prompt and sensitive governing and freedom from hunting, you must first provide a very powerful governor, and then give it next to nothing to do. The Willans governors are now, owing to the high speed of rotation, and the much heavier balls in use, enormously powerful in proportion to the work to be done, which consists only in moving the (piston) throttle-valve, and, in automatic expansion engines, the very small steam valve which controls the relay cylinder. The consequence is that a very restricted movement of the balls makes the desired change in minimum time, while leaving plenty of margin to deal with unaccustomed resistance, due to such causes as dirt or neglect. It is hardly possible that the most powerful shaft governor can have as much power, relatively to the calls upon it in shifting eccentrics, links, &c., as is possessed by the governor of any recent Willans engine.

50. There is no subject about which more confusion exists in engine-rooms than the relative parts played by the governor and by the flywheel. They are certainly closely allied, but very often when the governor is blamed, it is really the flywheel which is in fault, that is to say, with reference to the particular work the engine is called upon to do. On the other hand, many a governor owes its reputation to the flywheel, whose huge weight forbids the engine to take serious notice of a change of a load until the governor, possibly in itself neither a powerful one nor a good one, has had time to adapt itself to changed conditions. Of course, a heavy flywheel cannot affect the permanent change of speed due to a change of load, but it depends largely upon the flywheel whether the momentary variation shall be great or not.

51. The great question of throttling *versus* variable expansion has been fully dealt with by Capt. Sankey in a Paper read at the spring meeting this year of the Institution of Mechanical Engineers. It must suffice to say here that variable expansion is desirable for practical convenience, rather than for economy, in a great many cases, and for economy in some, but that in no ordinary case does the economy rise beyond a very moderate percentage, and that only through a small part of the range of variation of load. It is also established, upon the basis of Mr. Willans's experiments, that at very light loads (say quarter load, or even more) it is distinctly more economical to throttle the steam than to continue to make the cut-off earlier, and maintain the full pressure in the steam chest—since in the latter case, for only a small useful load, the full initial condensation is maintained, and the full loss by radiation. When the initial temperature in the first cylinder is reduced (as it is by throttling) both these sources of loss are diminished. Perhaps the most useful effect of automatic gear is that, by its aid, an engine can be occasionally overloaded without having to carry the same late cut-off at all times. Where the normal load is also the maximum load (as it should be in lighting stations, where the plant works in parallel) the engine is, of course, designed to give that load economically, *i.e.*, with cylinders of such size as to give the full load at a moderate mean pressure. In this case when light loads are carried—if they ever are carried: it would be better to avoid them—it is not of much importance whether the power is reduced by throttling or by altering the expansion. Now take such a case as that of electrical traction, where the average load is small, perhaps only half or two-thirds the maximum; it is evident that the cylinders, and the normal expansion, should be designed to suit the average load —but this cannot be done without the use of automatic expansion, because provision has to be made for the occasional overload. By automatic expansion it is possible to keep the cylinders of such an engine small, and suitable for the normal load, and yet readily take more power from it for short periods. The periods of overload are, of course, wasteful; but this is far less important than wastefulness during the much longer periods of average load.

52. The mode of varying the cut-off in the Willans engine is by a sleeve working upon the trunk or hollow piston rod, where it passes into the steam chest at the top (*see* description in Appendix). There are inclined ports in the trunk and in the sleeve, and by rotating the latter by means of gear outside (or sometimes inside) the steam chest, the cut-off is made early or late. The system adopted is one originally planned by the author, but which owes its practical form to improvements carried out by Capt. Sankey. A throttle valve is used, and on, say, a drop in load, reduces the pressure in the steam chest in the usual way. The rotating sleeves are controlled by a small steam cylinder, the piston of which is exposed to boiler pressure on one side, and to steam-chest pressure on the other. On the drop referred to taking place, the piston moves towards the steam chest, and the cut-off is altered, in the sense of being made earlier; means are provided to prevent too rapid movement of the cut-off gear in this direction; slowness or jerkiness of action is immaterial, because the throttle-valve has always control over the speed. As the cut-off changes the pressure in the steam chest gradually returns to what it was before, or nearly so. The return journey of the relay piston offers more difficulty, and, if effected only with the apparatus as yet described, it would require a considerable permanent difference of pressure between the steam chest and the boiler. Captain Sankey has made this unnecessary by providing that, when the engine speed *falls*, the spindle which moves the throttle-valve shall also move a small valve which both cuts off the boiler steam from the relay cylinder and allows the steam already in this cylinder to exhaust into the receiver, or some other place of lower pressure; as the relay piston moves it makes the cut-off later. The point of cut-off is at all times indicated externally by an index and pointer, the latter forming also a handle to enable the gear to be worked by hand, if preferred. The gear has the great advantage that by merely fixing a stop the range of variation of cut-off can be limited, so that on the one hand the engine may not be grossly overloaded, and on the other the expansion may not be carried too far for economy. In fact, the engine governs by varying the expansion down to a certain mean pressure (dependent, of course, upon boiler pressure and other circumstances), *and below that by throttling*, which is exactly the ideal arrangement for economy.

In conclusion, the author thinks it may fairly be claimed that the single-acting high-speed engine has justified the favour shown to it by electrical engineers, in regard both to that which it has already accomplished and to the prospect which it holds out of further successful development. Its success, as in all similar cases, has but fostered improvement in other engines, and it may be doubted whether central-station engines in this country, either of the slow-speed class or of the high-speed double-acting class, or even the deeply interesting steam turbine, would have attained to their present perfection had they lacked the spur applied by the progress of the Willans engine, and of others like it. For good or ill, the wide adoption of the single-acting high-speed engine marks a bold step in engineering. It is essentially of English origin and development, and its success bears witness that English engineers, though cautious, are also bold when boldness is called for. That it has fallen to members of this Institution to be leaders in so striking an innovation may, perhaps, earn a friendly tolerance for the many shortcomings of this attempt to place on record the more salient features of the system.

(To be concluded.)

PHYSICAL SOCIETY.

At the ordinary meeting of this Society on May 10, 1895, Captain W. de W. Abney, President, in the chair, Mr. HERROUN read a Paper on

"The Iodine Voltameter."

After referring to the usual methods of determining the value of the small currents used in calibrating galvanometers and other apparatus for measuring small currents, and discussing the errors to which they are subject, the author gave his reasons for selecting iodine. He did this since, with the exception of mercury in the mercurous state, iodine has the largest electro-chemical equivalent, and, in addition, by titration with sodium thiosulphate, it is possible to determine the quantity of iodine liberated with a greater accuracy than can be obtained by weighing a deposit of copper or silver with the balance. The solution employed in the voltameter contains 10 to 15 per cent. of zinc iodide. If care is taken to leave a small piece of metallic zinc in this solution, no free iodine is liberated on keeping unless the solution is exposed to a strong light for some time. The anode consists of a plate of platinum at the bottom of a tall and fairly

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narrow beaker. The wire leading the current to the anode is encased in a glass tube, so that the iodine is only liberated at the bottom of the beaker, where, on account of its great density, it tends to collect. The cathode consists of an amalgamated zinc rod, which, to prevent loose particles of zinc falling down into the iodine, is surrounded by a piece of filter paper or vegetable parchment. In an electrolysis lasting for as long as two hours none of the iodine is found to diffuse up to the part of the solution near the zinc cathode. Where, on account of the extreme feebleness of the currents employed, it is necessary to allow the electrolysis to continue for longer than two hours, a U tube is used with two small plugs of asbestos at the bend, the anode being in one limb and the cathode in the other. With this form of voltameter, even after the current has flowed for several days, no signs of iodine have been found in the limb containing the cathode.

On account of the production of electric convection currents, the iodine voltameter does not seem to be quite so suitable for accurate measurements of strong currents. After the current is stopped the zinc electrode is immediately removed, the solution stirred, and the amount of iodine liberated determined by titration with sodium thiosulphate. The author finds that a convenient strength of the thiosulphate solution is one in which 1 cubic cm. corresponds to the amount of iodine liberated by 5 coulombs of electricity. This solution contains 12·8375 grammes of pure recrystallised sodium thiosulphate per litre. It is possible to perform the titration to within 0·1 cubic cm., which corresponds to 0·5 coulomb, or, if the electrolysis lasts one hour, to one 7,200th of an ampere. In a comparison made with a silver voltameter, the current as deduced from the silver was 0 0264 ampere, and that deduced from the iodine 0·0266. The author considers that part of the difference may be due to the effect of oxygen dissolved in the solution of silver nitrate.

Prof. CAREY FOSTER considered that this process for measuring currents a most valuable one. The idea of using a volumetric method for measuring currents was to him new. He did not, however, see the advantage of using a substance with a high electro-chemical equivalent if a volumetric method was going to be employed to estimate the quantity of the substance liberated. It would be possible to use a chloride, though in this case the titration would probably be less accurate.

Prof. SILVANUS THOMPSON said he thought the method would be very valuable, but he would like to know if any error was likely to arise if too great a current density was employed. The number the author had assumed for the atomic weight of silver (108) was only approximate ; if the more accurate value 107·7 were used the agreement between the results obtained with the silver and iodine voltameters would be improved.

Mr. TROTTER asked what was the largest current that could be accurately measured.

Mr. ENRIGHT said he had used porous diaphragms in iodine voltameters and found that the iodine collected in the positive compartment, while the water was driven over into the negative compartment. With strong currents it was possible to get almost pure iodine left in one compartment.

Mr. WATSON thought that, since the value for the electro-chemical equivalent of iodine used by the author was deduced from Rayleigh's value of the electro-chemical equivalent of silver, and that Rayleigh's experiments were performed in air, the difference obtained with the silver and iodine voltameters could hardly be due to the cause suggested.

Mr. ELDER warned the members that volumetric measurements were not so accurate or easy as they seemed. He particularly mistrusted a solution of sodium thiosulphate, since he had found a solution of this substance to change even in 24 hours. The difficulty of accurately reading the burette might be overcome by weighing the burette and its contents before and after the titration. The author, in his reply, said that with the size of electrodes he used (about 9 sq. cm. surface) 0·1 ampere was the maximum current it was safe to use. The only substance likely to be produced by too great a current density was periodate, which, since it was insoluble, would immediately be noticed. The influence of the dissolved oxygen was only appreciable with small currents where the electrolysis lasts some time, while in Rayleigh's experiments large currents were employed.

The CHAIRMAN, while returning thanks to the author for his Paper, mentioned that in his experience he had found zinc salts to be very untrustworthy.

Mr. A. SHARP read a Paper entitled

"A New Method in Harmonic Analysis."

The author, in this Paper, applies the principle of the form of harmonic analyser for giving direct readings of the amplitude and epoch of the various constituent harmonic terms, previously described by him, to the performance of harmonic analysis without the use of an instrument. The kinematic principle is as follows :—Let the curve to be analysed be drawn with a scale of abscissæ such that the period is 2π. Let a wheel roll on the paper and be connected with a tracing-point, P, in such a manner that as P moves uniformly in the x direction the axis of the wheel w turns uniformly counter-clockwise in a horizontal plane, and the distance rolled through during any short interval is equal to the corresponding displacement of the tracer P in the y direction. The curve traced out by w the author calls the roller curve, and from the vector joining the initial and final points of this curve the amplitude and epoch can be determined. Suppose the periodic curve consists of a portion of the curve $y = a + a_1 x + a_2 x^2 + a_m x^m$ repeated over and over again. Then if the tracer is taken round this periodic curve you get a rolled curve which may be called the first roller curve. If now the curve whose ordinates are $\frac{dy}{dx}$ is traced out, the roller curve obtained is the evolute of the first, and so on for $\frac{d^2 y}{dx^2}$, &c. The author gives two worked examples, and compares the values of the coefficients obtained with those given by the harmonic analyser of the Guilds Central Technical College.

Prof. HENRICI said he had not received the Paper in time to thoroughly master it, but he thought that, at any rate for curves where no discontinuity occurred, the relation found by the author between the roller curves was always true, the last evolute being a point and the one before that a circle. The interesting point was whether the method was capable of being used for practical purposes, for it occupied a place with respect to harmonic analysis similar to that occupied by Simpson's rule in planimetry.

Prof. SILVANUS THOMPSON asked if the author had devised a form of mechanism capable of fulfilling the kinematical conditions given at the commencement of the Paper.

The author, in his reply, said he had devised such a mechanism, and that it was described in his previous Paper. In addition, he had since invented a more practicable form, which he had patented.

The CHAIRMAN said the Society ought to congratulate itself on the large number of important Papers dealing with harmonic analysis and planimetry that had lately been communicated.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, May 24th.

Physical Society.

5 p.m. Meeting at Burlington House. Papers to be read : (1) "On Mixtures of Ethane and Nitrous Oxide," by Dr. Kuenen ; (2) "The Measurement of Cyclically Varying Temperatures," by H. F. W. Burstall.

Royal Institution.

9 p.m. Friday Evening Discourse : "The Absolute Measurement of Electrical Resistance," by Prof. J. Viriamu Jones, F.R.S.

MONDAY, May 27th.

Northern Society of Electrical Engineers.

8 p.m. Ordinary General Meeting at the Palatine Hotel, Hunt's Bank, Manchester. Adjourned discussion on Mr. J. C. Howell's Paper on "The Uses of Accumulators."

TUESDAY, May 28th.

Institution of Civil Engineers.

8 p.m. Annual General Meeting of corporate members only in the theatre of the Royal United Service Institution, Whitehall.

THURSDAY, May 30th.

Royal Institution.

3 p.m. Afternoon Lecture. "The Instruments and Methods of Spectroscopic Astronomy," by William Huggins, F.R.S.

FRIDAY, May 31st.

9 p.m. Friday Evening Discourse : "The Radiant Heat from the Moon during the Progress of an Eclipse," by the Earl of Rosse, F.R.S.

Electrical Communication with Lightships.—In a letter to the *Standard* of the 16th inst. Mr. F. Le B. Bedwell, R.N., referring to Mr. F. Higgins' letter claiming that the "Sunk" method was designed and recommended by him in 1881, a claim to which we called attention last week, states that this is a most unfounded claim. Mr. Higgins' plan is, says Mr. Bedwell, on an entirely different principle, and has not the remotest resemblance to the method now in use, viz, a Bedwell swivel and apparatus known as the "Sunk" system.——In reply to Admiral Field, Mr. Bryce stated in the House of Commons on Monday that, in addition to the works recommended in the recent Report of the Royal Commission, there were still some works, recommended in the first report, which had not yet been carried out. A sum of £11,000 had been placed at the disposal of the Board of Trade for the purpose of effecting electrical communication with light vessels, &c., during the present financial year, and the Board were at present considering on which of the works recommended that amount—which was not sufficient for all—should be expended.

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The Electrician.

(The Oldest Electrical Journal, 1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny. Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

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SPECIAL NOTICE.

Owing to the growth of the electrical and allied industries the demands for space in "THE ELECTRICIAN" are, for the greater part of the year, so pressing that a permanent increase in the size of the journal has become necessary. To meet the increased cost involved by this step, and by other improvements, such as heavier paper and more numerous illustrations, the price of "THE ELECTRICIAN" has from May 3rd been advanced to 6d.

The Subscription to "THE ELECTRICIAN," commencing with Vol. XXXV. (May 3, 1895), is as follows:—

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A POORLY-CULTIVATED FIELD OF RESEARCH.

If science consists, not merely in the mechanical observation of phenomena, but in the co-ordination and correlation of facts, and if a fair test of the completeness of this co-ordination and correlation be the accuracy with which a given result may be predicted as certain to follow from a given set of conditions, meteorology, and with it atmospheric electricity, must be held to be, even at this late hour of the day, hardly within the scientific pale. Nothing strikes anyone who has dealt all his life in ohms and volts and amperes with more astonishment, when he passes from the well-ascertained laws and super-accurate measurements of physics, than the chaotic state in which the foundations of meteorology still remain, and the comparative crudity of the apparatus with which atmospheric conditions continue to be gauged. And when we come to apply the test of arguing from ordinary everyday phenomena to the consequences that will ensue, the dubious nature of the claim of meteorology to be considered a science is even more apparent. "No important rules," says Mr. THOMAS RUSSELL in his recently published work, "have ever been formulated as the result of the investigations of cloud forms as indicating weather changes or approaching storms, and yet every observer and predictor makes use of them." Again, towards the end of his book the author winds up his chapter on weather predictions by the truly mournful, or it may be unduly modest, statement that "the most that can be said in the way of prediction is, that the rain will continue for some indefinite time at places where it is already raining": as he sardonically remarks, as much as this "can be said on general principles, on the ground of probability, without the aid of a weather map." But though they have not as yet endowed us with a science, our modern meteorologists have spoiled us of our ancient superstitions. The time-honoured belief that forests have not a little to do with increasing the rainfall in their vicinity is, we are told, "to be relegated to the infinitely little things of

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meteorology;" whatever that may mean; likewise we are forbidden to put our trust in the twinkling of the stars, the ruddy glow at sunset, or the transparency of the air as reliable indications of approaching rain. In short, we have been deprived of our inbred meteorological instincts, and have not as yet been provided with any rigid rules in their stead. Hasty generalisation is, of course, to be deprecated, but meanwhile this state of transition is somewhat perplexing.

A perusal of the lecture by Prof. Schuster on "Atmospheric Electricity," which will be found in another column, will reveal tolerably clearly the existence of much the same state of "glorious uncertainty" in a branch of electrical science closely allied to meteorology. The clearing up of the enigma of the origin of atmospheric electricity could hardly fail to throw light on the still more important problem, the nature of electricity itself; yet it cannot be said that we have made appreciable advance in this direction. The theory originally propounded by Peltier that the earth possesses a permanent negative charge is indeed a simple one, explaining many facts; but it gives us no clue as to the source of this charge, although the recent observation of Lenard that every sea wave breaking into spray under the action of a strong wind leaves the water negatively electrified might be turned to account. Again, in a recent lecture, an abstract of which we published on May 10th, Lord Kelvin stated his belief that "the rain itself is the real restorer of the normal fair weather positive (of the air). Rain or snow, condensing out of the air high up in the clouds, must of itself become positively electrified as it grows, and must leave positive electricity in the air from which it falls." But, as Prof. Schuster points out, this permanent charge view rests on the assumption that the earth is perfectly insulated, or that gain and loss of charge are equilibrated by some means as suggested above. As regards space, it may be so insulated; as regards the lower regions of the atmosphere, it certainly is not; every column of ascending hot air, every lightning flash, undoubtedly helps to dissipate the terrestrial charge, and the ultra-violet rays in all probability also assist. But, assuming the permanency or the equilibrium of the negative charge, where is the positive? The observations of Dr. Baschin, and those made on the Sonnblick, seem to point towards the existence of a layer of positively electrified air some 10,000ft. or 15,000ft. above us—that is to say, just below the level of the lowest cirrus clouds. On the other hand, the existence of cloud formations at much higher altitudes (25,000ft. to 50,000ft.) and the phenomenon of the aurora at still greater heights do not tend to corroborate the idea that, electrically speaking, the world comes to an end at a few thousand feet above the ground. We are, therefore, in this position: we have a bare clue as to the origin of the earth's supposed negative charge, and we have "provisionally established that the lines of force of the normal electric field of the earth end within the first 10,000ft. or 15,000ft." But we are still without an entirely satisfactory theory connecting the daily double maxima of potential gradient with the coincident barometric maxima; we are still, in spite of Prof. Schuster's ingenious suggestion of a sort of "replenisher" action, without any complete explanation of the generation of the enormous differences of potential apparently necessary to account for lightning discharges; we are still quite unable to connect alterations in the potential gradient with weather phenomena, on the other hand we know all manner of curious little facts, and "it is quite likely that there is some truth" in the various theories propounded to fit them. As Prof. Schuster rightly remarks, what is wanted now is a series of continuous observations on the same plan by means of recording instruments, which, we would add, should be situated in various parts of the world, and at various distances from and heights above sea-level; the co-ordination of the observations being undertaken by a properly constituted central bureau. England, with its many possessions in both hemispheres, would seem to be specially called upon to aid the good work of educing something approaching order out of something not unlike chaos.

NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(Continued from page 89.)

39. Mance Test for Fracture: Kennelly's Modification.— When a cable is fractured the resistance of exposure is usually very different at the two broken ends. Therefore, it is no use comparing results from both ends, even though a duplicate cable permits of the results being communicated. Each end must independently localise position of break, and the ship when it cuts in depends only on tests on board. Now, as stated above, the Mance test from one end only gives the resistance up to fault, plus something less than the true resistance of fault. Without some means, therefore, of eliminating the resistance of the break, the test is not satisfactory.

Mr. Kennelly has shown (*Electrician*, Oct. 14 and 21, 1887) that it requires *three* observations from one end only to eliminate resistance of break, and he takes three readings on the bridge to instrument zero with different currents to line.

The current is varied by resistance in battery circuit, taking the first reading with a fairly high resistance, and then reducing it so that the current in the second reading is, say, four times, and in the third reading nine times, that in the first. The battery should be a low resistance one and of 30 or 40 volts. Key clamped down zinc to line. Let A, B, and C be the readings on the bridge for a set of any three different currents, C being the balance with the largest current and A with the least. When these currents are in the proportion of 1:4:9 the formula for distance of break is

$$\frac{A+C}{2} - 4\,(B-C) \text{ ohms.}$$

When they are in the proportion of 1:4:16 the formula becomes

$$\frac{A+2C}{3} - 2\,(B-C) \text{ ohms.}$$

If anything the readings with ratio 1:4:16 gives the most accurate results. It is well to take a series of readings with different currents from one up to, say, 40 milliamperes, sufficient to provide for a few sets of each. The resistance to add to the battery for a given current in milliamperes to flow to cable can be calculated very closely. The first approximation is

$$\frac{500\,E}{\text{Number of milliamperes}} - \left(b + \frac{a}{2}\right) \text{ ohms,}$$

where b is the battery resistance, a is the resistance of one of the proportion arms of the bridge, and E is battery E.M.F. With this inserted we get a preliminary balance on the bridge. The correct resistance is then the above, reduced by half the balance so obtained.

The added resistance then being corrected accordingly, the correct result is obtained by readjusting the balance. Four sets, each of 1:4:9 and 1:4:16 proportional currents, can be obtained by the eighteen currents given in the Table on next page, for each of which is worked out the first approximation to the added resistance, taking as an example:

E.M.F. of battery	= 50 volts.
Resistance of battery	= 120 ohms.
Bridge arms........................	100/100.

The first approximation to the added resistance is then:—

$$\frac{25{,}000}{\text{Number of milliamperes}} - 170 \text{ ohms.}$$

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The approximate resistance in the second column is added to the battery, and a balance obtained, which is entered in the third column. Then, the added resistance having been reduced by one-half the balance so obtained, a second and final balance is obtained, which is the correct result. This is entered in the fourth column.

Milliamperes to line.	First approximation added resistance.	Balance, with approximate added resistance.	Final balance, with corrected added resistance.
1	24,830		
1½	16,496		
2	12,330		
2½	9,830		
3	8,163		
4	6,080		
6	3,996		
8	2,955		
9	2,607		
10	2,330		
12	1,913		
16	1,395		
18	1,220		
27	758		
32	614		
36	525		
40	457		

It is not desirable to go above 40 milliamperes, as the heating effect on the low resistance coils of the bridge may injure the insulation. With the above series of balances we have the following choice of combinations.

For ratios of 1:4:9 the following four sets:—

1: 4: 9
2: 8:18
3:12:27
and 4:16:36

For ratios of 1:4:16 the following four sets:—

1 : 4:16
1½: 6:24
2 : 8:32
and 2½:10:40

For these ratios the two formulæ given above for distance of break are applied respectively.

In this formula Mr. Kennelly has taken into account the variation in resistance of the fault with the different strengths of currents used. That is, on the basis of the law which he established by experiment—that the resistance of an exposed conductor varies as the square root of the current. This law, however, was not found to hold good in exposures under a certain limit, which may be roughly stated as half a square centimetre; and, therefore, the formula is not strictly correct for fractures with small exposures. Another cause of error, also prevalent in the foregoing Mance tests, is that the polarisation current increases as the testing current is increased, whereas the formula assumes it to remain constant.

The effect of these two sources of error is least apparent in the result when the current used in the third balance largely exceeds that in the second.

Another convenient way of calculating the resistance to add to the battery for various strengths of current through the break is as follows: The actual value of the currents in milliamperes need not be known, so long as there is the required ratio between them, and the largest current used does not heat the bridge coils. Generally speaking, currents up to 50 milliamperes may be used with safety, but it depends upon what proportional coils are used in the bridge arms. Any small current is taken to start with (the actual strength of which need not be known), and resistances are adjusted in the battery circuit to give multiples of this current. Say a balance has been obtained on the bridge to instrument zero with equal ratios (each ratio arm being a ohms) and a battery of resistance b, to which has been added a large resistance ρ. The resistance unplugged to balance is, say, A ohms.

Now, to obtain a current to line of n times the strength of the above the resistance added to the battery must be less than at first. This resistance evidently depends upon the resistance unplugged to balance, and, consequently, a trial test has to be taken first with an approximate estimate of this resistance, which is

$$\frac{2\rho + A - (n-1)(2b+a)}{2n} \text{ ohms.}$$

Putting this in circuit with the battery, a balance is obtained, and then the approximate resistance is reduced by half the amount unplugged to balance. This correction being applied, we have the right resistance in circuit to produce n times the current to line, which gives the balance reading B.

By a similar process we obtain the balance reading C, and then apply the values of A, B, and C to the formulæ given above and obtain distance of break. For instance, suppose that for the first reading A we put 10,000 ohms in circuit with the battery, the latter having 50 ohms internal resistance. With a ratio of 100/100 the bridge is balanced, say, with 900 ohms unplugged.

Here $b = 0{\cdot}50$; $\rho = 10{,}000$; $a = 100$; and $A = 900$.

Now we require to obtain the readings B and C with, respectively, four and nine times the current used in obtaining A.

The resistance to add to the battery for four times the current ($n = 4$) is, approximately:—

$$\frac{20{,}000 + 900 - 3\,(100 + 100)}{8} = 2{,}537 \text{ ohms.}$$

With this resistance added to the battery (instead of the 10,000 ohms) a balance, say, of 820 ohms is obtained. Reducing the resistance of 2,537 ohms by half of 820, we have the right amount of resistance to give four times the current. The bridge is then balanced again, giving, say, 800 ohms (B). For nine times the current ($n = 9$) the added resistance is approximately,

$$\frac{20{,}000 + 900 - 8\,(200)}{18} = 1{,}072 \text{ ohms.}$$

With this resistance in circuit the balance is, say, 730 ohms. Then, reducing the resistance of 1,072 ohms by half of 730 we obtain the balance (C), say, of 700 ohms. Then

$$\text{Distance of break} = \frac{A + C}{2} - 4\,(B - C)$$

$$= \frac{1600}{2} - 400 = 400 \text{ ohms.}$$

For the ratios of current of 1:4:16 we should have to take a reading with 16 times the current. The approximate resistance to add for this current ($n = 16$) is

$$\frac{20{,}000 + 900 - 15\,(200)}{32} = 560 \text{ ohms.}$$

With this resistance in circuit the balance obtained is, say, 650 ohms. Then, reducing the resistance of 560 ohms by half of 650 we obtain the balance (C), say, 640 ohms. Then

$$\text{Distance of break} = \frac{A + 2\,C}{3} - 2\,(B - C),$$

$$= \frac{900 + 1{,}280}{3} - 2\,(160),$$

$$= 727 - 320 = 407 \text{ ohms.}$$

By starting with other resistances instead of 10,000 ohms, the unit current can be varied and the resistances to insert for 4, 9, or 16 times the unit current can be found in the manner described, so that as large a range of currents as desired can be used.

(To be continued.)

VARIATIONS OF ELECTRICAL PRESSURE IN LONDON.

BY A. A. C. SWINTON.

The accompanying diagram has been prepared from records obtained with Major Holden's form of hot-wire recording voltmeter. This instrument is exceedingly sensitive, and at the same time very dead beat in its action, and the fluctuations shown on the diagram consequently very accurately represent the actual fluctuations in the electrical pressure in each case.

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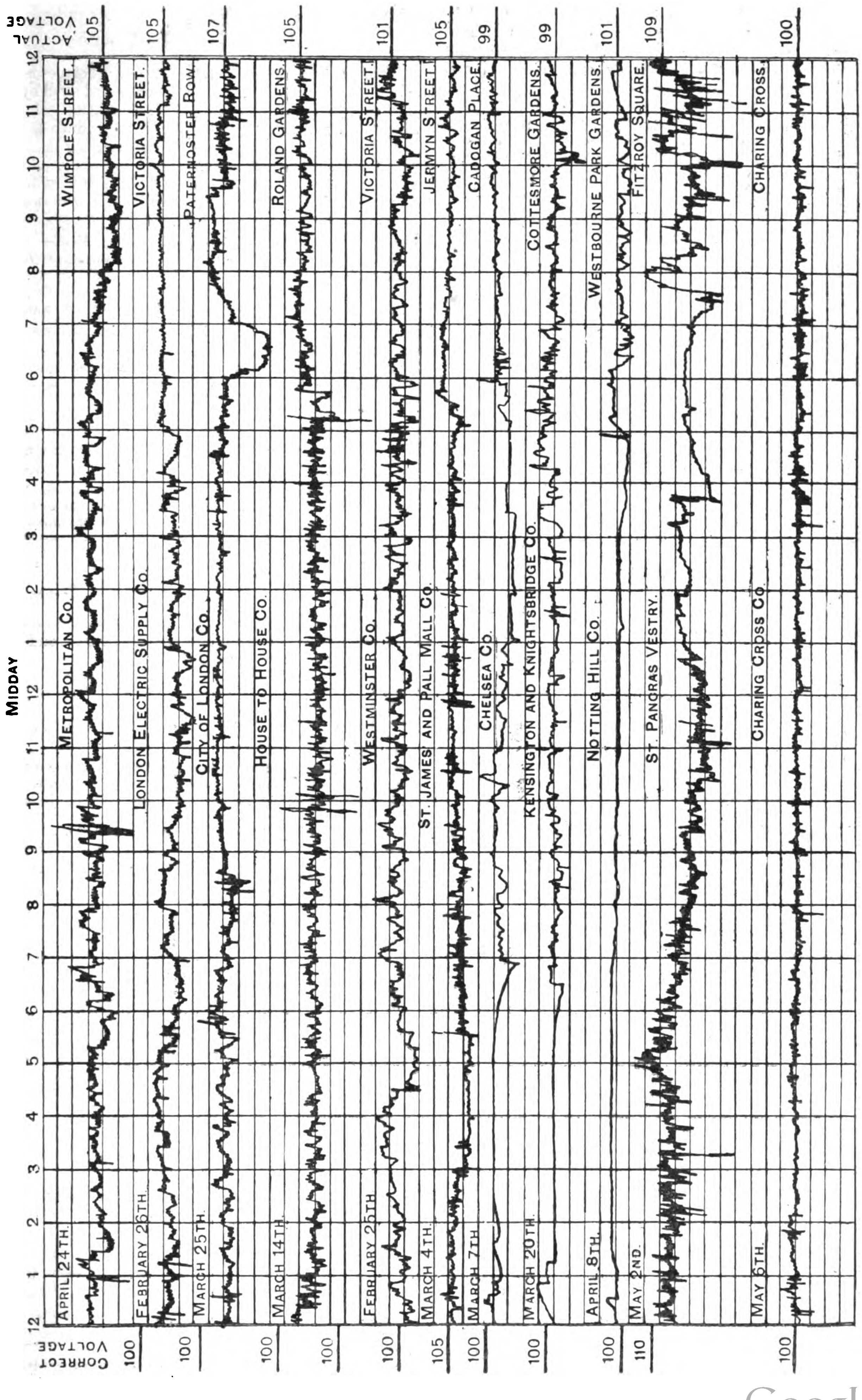
DIAGRAM SHOWING VARIATIONS IN ELECTRICAL PRESSURE.



In order to ensure correctness, the recording voltmeter was from time to time checked with an Evershed voltmeter, which in turn was calibrated through the kindness of Major Cardew at the standardising laboratory of the Board of Trade.

As will be observed, all the chief London companies, as also the Vestry of St. Pancras, are represented, mention being made of the dates and localities where the records were taken. In the diagram in each case the curve represents the electrical pressure from midnight to midnight, the horizontal lines being drawn at a distance apart corresponding to two volts. On the right-hand side of the diagram are marked the actual volts of each curve at that point, while on the left-hand side are marked the correct voltages that the several undertakers claim to supply.

It will be seen that in many cases the variation from this correct voltage is considerable, being much more than is compatible with the regulations of the Board of Trade, the comfort of the consumers, or fair play to the lamps. It will be observed that so far as fluctuations from the average are concerned there does not appear to be much to choose between the alternating and the continuous-current systems of supply; but it will be noticed that while with continuous currents there seems to be in some instances a tendency for the average volts to be below the correct voltage, with the alternating current it is the other way, and the average volts supplied are in each case very considerably higher than they should be. Where the supply is maintained by accumulators during some portion of the 24 hours, this is well indicated by the smoothness of the curve.

The writer is, of course, well aware that a single record on a particular date taken in only one locality cannot be considered as in any way a fair criterion of the uniformity of any supply; still, undertakers should maintain a uniform pressure in all parts of their area of distribution and at all times. Consequently, while the fact that a certain amount of luck may enter into the reason of the record of one undertaker being better than that of another should prevent undue elation on the part of those whose curves are best, it is hoped, on the other hand, that the publication of these records will have the effect of stimulating those undertakers whose curves show the greatest variations to the attainment of a more uniform pressure.

THE BUREAU DE CONTROLE DES INSTALLATIONS ELECTRIQUES.

The numerous accidents caused by the defective installation and careless management of electric lighting plants, as well as the frequent complaints received by electric supply companies from their customers relating to their meters, called for the necessity of organising an official "Bureau de Contrôle des Installations Electriques," free from any commercial connections, and having for its object the inspection of electric lighting installations, and the testing of meters belonging to electric supply companies and private concerns, also providing to its customers all the desired information concerning the safe operation of their installations. The Société Internationale des Electriciens proposed to meet this want by arranging the "Laboratoire Centrale," on the lines of the Physikalische Reichsanstalt of Charlottenburg, but the "Laboratoire" having confined its work almost exclusively to measurements of high precision, and the testing of instruments brought there, the field remained open for an office answering the above mentioned purpose of inspecting and controlling private and public lighting installations. In view of these facts, the Syndicat Professionnel des Industries Electriques resolved to organise such an institution. The insufficiency of funds, however, obliged them to make a call upon the generosity of its members in order to supply the necessary money to make a start with. The electric supply companies, worried by the very often unjustifiable complaints of their customers, gladly contributed; other donors answered the call, and the sum of 34,000fr. was collected, as follows: Compagnie de l'Air Comprimé, 4,000fr.; Compagnie Edison, 4,000fr.; M. Fontaine, 2,000fr.; Maison Breguet, 2,000fr.; Maison Menier, 4,000fr.; Sautter, Harlé, and Co., 2,000fr.; Schneider and Co., 2,000fr.; Secteur des Champs Elysées, 4,000fr.; Secteur Place Clichy, 4,000fr.; Société d'Eclairage et du Force par l'Electricité, 4,000fr.; Chambre Syndicale des Industries Electriques, 2,000fr. This amount allowed the Syndicat Professionnel des Industries Electriques to organise the Bureau de Contrôle, which began work on February 15, 1893, under the direction of M. R. V. Picou, the well-known consulting engineer, who agreed to manage the office on the following lines, proposed by the Syndicat Professionnel des Industries Electriques:—

(I.) The objects of the Bureau de Contrôle are:—(1) To insure the periodic control of its clients' installations in order to prevent any damage likely to compromise the security of the said installations; (2) to inspect installations at the request of any interested party; (3) to furnish all information, technical, commercial, legal, or official concerning installations, central stations, or any other electrical concern.

(II.) The work of the Bureau de Contrôle consists in calls made on the customers with a view of inspecting their installations; these calls are made by special men, or inspectors, who communicate to the customers the result of their inspection.

(III.) Although the Bureau de Contrôle is placed under the "patronage" of the Chambre Syndicale des Industries Electriques, who elect its manager and discuss its regulations, the establishment is entirely independent, the manager alone being responsible.

(IV.) In order to ensure impartiality, the manager of the Bureau de Contrôle is forbidden to act as a contractor or manufacturer of electrical supplies, or to take any interest whatever in a firm undertaking installations or the construction of electrical apparatus.

(V.) The Bureau de Contrôle agrees to give its clients two inspections of their installations per year. These inspections always include testing of the meter or meters, and are carried out without any preliminary notification, and at a minimum interval of five months or a maximum of seven months. The inspectors receive orders to give all necessary information to ensure the proper working of the installation. Every inspection is followed by a written report to the customer giving a statement of the general condition of the installation, and calling his attention to the special points necessitating modifications.

(VI.) In case of accident, the customers are requested to at once advise the manager, who immediately calls or sends an inspector to investigate the matter. This visit is always gratuitous.

(VII.) The customer is bound to inform the manager of the Bureau de Contrôle of any addition, modification, or repairs he intends to carry out in his installation.

(VIII.) The customers of the Bureau de Contrôle pay for the two regulation visits a fee mentioned hereafter.

(IX.) Beyond the regulation visits, the customer may demand supplementary inspections of his installation as often as he may think necessary, these supplementary visits to be charged for as mentioned hereafter.

(X.) The officers of the Bureau de Contrôle are, moreover, at the disposal of their clients and to people at large for the execution of work, such as testing of dynamos and storage batteries, testing of meters or measuring apparatus, this, of course, to be charged for according to regulation.

(XI.) The Bureau de Contrôle holds at the disposal of its customers all information relating to electrical installations. At their request, the office will furnish them a copy of such information for a charge agreed upon with the manager.

(XII.) The manager submits to the approval of the Chambre Syndicale each year the accounts of the preceding year, and sends in a report on all the work of the office. The report and the resolution are printed in the Directory of the Syndicate, and sent gratuitously to all clients.

(XIII.) Any owner of an electric installation who desires to subscribe to the Bureau de Contrôle, must fill and sign a policy in accordance with the regulations. Subscriptions commenced during the first six months of the year have to be paid in full. If the subscription is made subsequently to July 1st, the charge is made only for the remaining six months.

(XIV.) The regulation charges are as follows:—

(*a*) The annual subscription is based on the number of incandescent lamps in the installation, each arc lamp being equivalent to five incandescent lamps, and each motor or dynamo being equivalent to 10 lamps.

For less than	10 lamps	charge	5fr.
From 10 to	20	„ „	0·50 c. per lamp.
„ 20 to	23	„ „	10·0fr.
„ 23 to	50	„ „	0·45 c. per lamp.
„ 50 to	56	„ „	22·50fr.
„ 57 to	100	„ „	0·40 c. per lamp.
„ 100 to	115	„ „	40fr.
„ 116 to	200	„ „	0·35 c. per lamp.
„ 200 to	233	„ „	70fr.
„ 234 to	500	„ „	0·30 c. per lamp.
„ 500 to	600	„ „	150fr.
„ 600 to	1.000	„ „	0·25 c. per lamp.
„ 1.000 to	1,250	„ „	250fr.
Above 1,250		„ „	0·20 c. per lamp.

(*b*) The fee for supplementary visits one-third of the annual charge, with a minimum of 5fr.

(*c*) Fee for inspecting special parts of an installation, meter testing, 20fr. Supplementary fee for work done under Article X., attendant for one day, 30fr.; ditto, half a day, 20fr.

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(*d*) Fee for inspections of installations, for non-subscribers, two-thirds of the corresponding annual subscription, with a minimum of 5fr.

(XV.) The above charges are for the Department of the Seine; for other Departments the travelling expenses incurred by the manager or the inspector must be borne by the subscriber or subscribers.

(XVI.) The above regulations have been discussed and approved by the Chambre Syndicale des Industries Electriques, at their Board meetings of February 7, 1893, and February 5, 1895. They are subject to revision at the end of each year, as per decision of the Chambre Syndicale.

At the end of the first year the number of subscribers to the Bureau de Contrôle was 46, representing 13,276 glow lamps. The results of the inspections of electric installations and of the testing of meters were as follows:—

Installations inspected		101
Installations reported as being defective—		
With regard to insulation	23	
With regard to electric fittings	21	
With regard to putting up	18	
		62
Meters tested		77
Meters recorded as being defective		19

During the second year of operation, the Bureau de Contrôle secured 45 new customers, representing 7,000 lamps.

The following results were obtained by inspections and tests:—

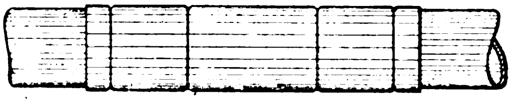
Installations inspected		168
Installations reported as being defective—		
With regard to insulation	40	
With regard to electric fittings	71	
With regard to putting up	37	
		148
Meters tested		172
Meters recorded as being defective		43

At the present time the Bureau de Contrôle numbers 110 customers, representing about 22,800 lamps. At the end of second year of his management M. Picou asked to be relieved of his duties, his time being very much taken up by his work as consulting engineer. His resignation was accepted, and M. Gaston Roux, electrical engineer, was chosen by the Chambre Syndicale on February 15, 1895, to take M. Picou's place for 10 years. Under the new management of M. Roux the organisation of the Bureau de Contrôle has been modified, in order to develop the operations. The office has been transferred to 12, Rue Hippolyte Lebas, agents have been appointed, and arrangements with insurance companies are being negotiated. M. Roux's belief in the prosperity and extension of the Bureau de Contrôle is so great that he has pledged himself, in taking its management, to return to the Chambre Syndicale the 34,000fr. given by them towards the organisation of the office. The operations of the Bureau de Contrôle are at present confined to Paris only, but the new manager hopes to extend them to the principal manufacturing and residential towns of France. In another article we hope to describe the method employed for testing the meters and insulation of installations.

INTERIOR CONDUIT WIRING.

A system of interior conduit wiring, the invention of Mr. E. H. Johnson, and for some time past used by the Interior Conduit and Insulation Company, of New York, has recently been introduced into this country, and was briefly noticed in our issue of March 29th. The system consists in wiring through a series of insulating tubes which can be laid throughout a house in the manner of gas or water pipes. Into these tubes the wires for single, double, or three-wire systems can be drawn; the basis of the system is, therefore, an insulating tube. This is now made in three grades, the plain tube, the brass covered, and the iron armoured. The plain tube is waterproof and electrically fireproof, but in order to protect from external sources of fire, an extra mechanical covering of brass or iron is sometimes used. The insulating material of the tube consists of paper impregnated with a suitable compound which will render the tube incombustible and also gives it a sufficiently smooth surface, and strength and toughness enough for the work it has to do. In order to retain the tubular form the walls of the tube are built up spirally, and the complete tube, after a further cementing treatment and impregnation in and outside, with a waterproof compound, becomes almost homogeneous in texture. In some cases it has been found that the tube will stand being embedded in cement, but where caustic cements occur brass-covered tubes are usually used. It will be seen that in addition to the insulation of the wires themselves, the material of the tube assists the insulation resistance, giving much better results than with ordinary casing. These tubes are supplied in standard 10ft. lengths, with one end ready fitted with a coupling socket. They

Fig.



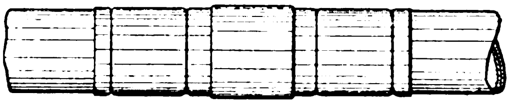


Fig. 2.

are made in standard sizes from ½in. to 2½in. diameter. Fig. 1 shows the ordinary form of coupling socket, and consists of a thin metal sleeve. The end of the tube to be joined on is first cut square with an ordinary hand saw, and then reamed inside and out with a suitable reaming tool. The end is then slightly warmed over a small flame so as to soften the outside waterproof compound, and, as this causes the tube to shrink, it may easily be slipped into the sleeve until it presses against and unites with the end of the other tube, thus making a sealed

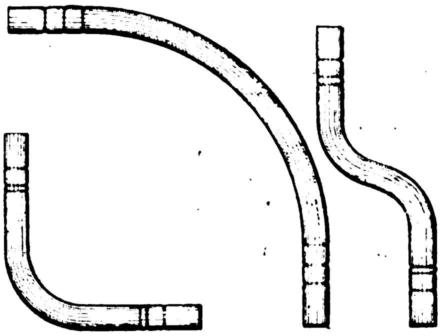


Fig. 3.

joint. This done, two rings in the soft metal sleeve are indented by means of a pair of clamping pliers, thus gripping the sleeve to the tube. For the brass-covered tubes the joint operation is practically the same, except that the brass has first of all to be cut back by means of a trimming tool. Fig. 2 shows a coupling for such a joint, and in this case the ends of the tubes are covered with an internal insulating sleeve at the point of abutment. It is stated that such joints may be made in less than half a minute. In order to meet the requirements

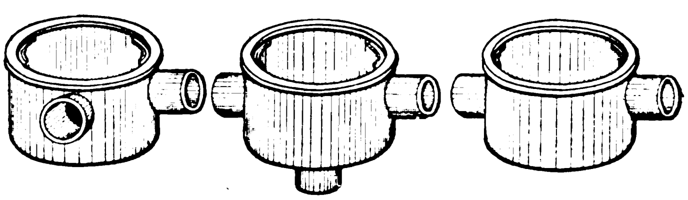


Fig. 4.

of practice a series of standard bends and elbows and junction boxes, or fishing boxes as they are called, are regularly manufactured. Fig. 3 shows some of these bends and elbows, and Fig. 4 a number of fishing boxes. If there are only three or four elbows on a length of conduit it is the custom to draw the branch wires right through, but when more than this number of bends occur a fishing box is inserted so as to form a convenient point from which the wires can be drawn out and redrawn

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into the next section. These boxes are also used in turning abrupt corners. Moreover, the box method would be favoured where the tubes are between floors or accessible on the surface, whilst the elbow method is followed where the work is to be completely plastered up. The fishing wire consists of a narrow band of steel fitted with brass ends, and by means of this device a long string or cord can be drawn through the system of tubes after erection and the wires for the different circuits drawn through and connected up. It is sometimes found advisable to assist the drawing-in process by blowing powdered soapstone through the conduits, the effect of this material being to reduce the friction and to diminish the chances of abrasion of the insulated wires. To secure the tubes in position wire or strip fasteners or pipe nails are used according to the local condition. Fig. 5 shows a method of wiring a bracket when the wires drop from the floors above, provision being made at the same time for the insertion of the controlling switch below the bracket. The usual method of arranging a conduit system is as follows: The work is laid out first of all in sections, or in the case of very large buildings in a number of sections. Each section should be fed by a vertical riser, which may pass through several floors. By this means any one floor is supplied with two or more independent risers, upon which cut-out bars from several centres of distribution are arranged. These distributing boards are, as a rule, placed in corridors, the fuses being generally bunched together; and it is claimed that this arrangement has the advantage of avoiding a multiplication of elbows and inter-section boxes. Fig. 6 is a diagram of one possible arrangement of the lines of a single branch circuit, and in this extreme case independent switches are supposed to be required at every lighting point. It will here be seen that although a separate tube is advocated for each of the main wires or risers, when the branch wires radiate from the cut-out board, with less than 10 to 12 amperes on them, it will be safe and practicable to draw them together into one tube, care being taken to protect each branch circuit by double-pole fuses. One of the advantages claimed for this system is that when any one wire fails it can be withdrawn from outlet to outlet and a new wire substituted without interfering with the walls or ceiling to which the tubes may be attached. In addition, its advocates maintain that the fact that a complete system of tubes can be laid throughout a building during its construction, after the manner of gas or water tubes, is of itself sufficient to justify such a system being adopted, even if it possessed no other merits. In conclusion, we may observe that the interior conduit wiring system is not new to Europe, but that four years ago the system was inaugurated in Germany. We understand that it is used in the palace of the Empress Frederick, and that it has been adopted by such firms as Messrs. Siemens and Halske, Schuckert, Peiper, Bréguet, Pitot, Maschinenfabrik-Oerlikon, and the Helios Company, so that the system appeals to the English market more strongly than a complete novelty would be able to do. Arrangements have now been completed for the introduction of this type of work into England under the auspices of the General Electric Company and Mr. F. Bathurst.

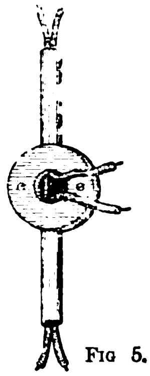

Fig 5.

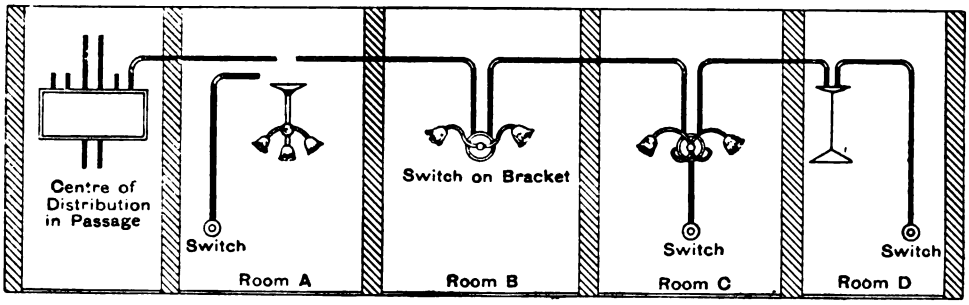

Fig. 6.

ELECTRIC LIGHTING TROLLEY.*

The first form of trolley used in connection with the system for lighting by electricity the cable cars on the New York and Brooklyn Bridge has been abandoned. This form was similar to the ordinary type of trolley with the length of pole reduced to about 2ft.

It was found that the wheel would not follow the wire, owing to the shortness of the pole and the thrust of the car at switches.

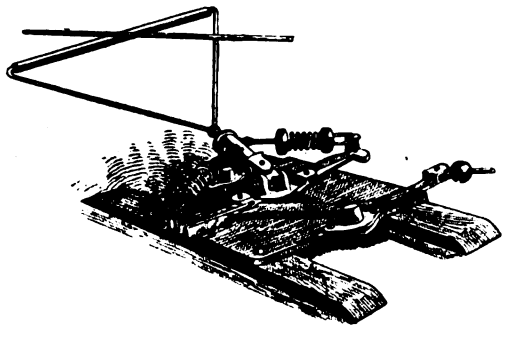

Fig. 1.—Trolley Used for the Electric Lighting of the New York and Brooklyn Bridge Cable Cars.

The form of trolley shown in Fig. 1 is now in use. It consists of a triangular wire frame, which is held in the pole socket of the trolley base. The upper part of the frame, which is pressed against the wire, carries a brass roller 18in. long. The contact thus effected, partly sliding and partly rolling, seems to meet all the requirements. The plan of reversing the trolley at the terminals at first consisted in merely raising the wire gradually until the trolley could stand upright, when it was thought it would reverse itself as the car changed its direction. In practice it has been found necessary to add the swinging stirrup shown in Fig. 2, which trips the trolley as it passes under it.

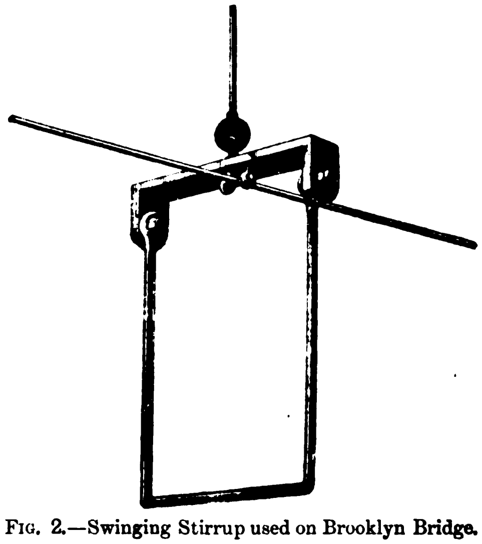

Fig. 2.—Swinging Stirrup used on Brooklyn Bridge.

* From the *Street Railway Gazette* of New York.

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PARLIAMENTARY INTELLIGENCE.

SELECT COMMITTEE ON THE TELEPHONE SERVICE.

The Telephone Committee held another sitting last Tuesday, the Postmaster-General being in the chair.

The first witness was the Hon. J. G. WARD, the Postmaster-General of New Zealand. In reply to the Chairman, he said he had been Postmaster-General for about five years, and during that time had had practical control of the telegraphs and telephones, both of which were in the hands of the State, the Colony having legislated to prevent anyone else from introducing a telephonic or telegraphic system. The telephonic system in New Zealand had worked very successfully, and its development over a sparsely-populated country had been very marked. At the starting of the system, 12 years ago, there were 116 subscribers ; now there were nearly 5,000, or about one subscriber per 120 inhabitants. Four-fifths of those subscribers would be urban, but the system was extended very widely from one end of the country to the other. The connecting trunk wires were used for both telegraphic and telephonic purposes. With one or two exceptions they used a single wire everywhere, and they changed from the one system to the other as the necessities of the public required. They charged a subscription of £5 per annum for business purposes if the subscriber was within half-a-mile of the exchange, and for private houses if within a mile of the exchange, but beyond those distances extra charges were made. Anyone requiring an exchange beyond a distance of five miles from an already existing exchange had to give a guarantee to keep the instrument for five years. In each town they had only one central exchange, but in addition to those exchanges they had bureaus, which are equivalent to the English call offices, at points all over the town. The total cost of the system from the beginning to the end of the last financial year was £104,500, and the total earnings £183,800. After allowing 5 per cent. for depreciation and 5 per cent. interest on capital, there was a net profit left of £54,000, which was handed over to the Consolidated Fund of the country. Every expense they had incurred was charged against the telephones, but where the exchange was situated in a Government building, the telephone accounts were not debited with rent. In New Zealand they were opposed to a system of centralisation, and at Wellington, where there had been a considerable increase in the number of subscribers during the last year or two, they were proposing to build an independent exchange a mile and a-half distant from the existing one, and to connect it with the trunk wire rather than have one very large exchange.

By Sir James Fergusson : The new works were partly paid for out of revenue. The greatest number of subscribers on any one exchange was returned as 872 on March 31, 1894, at Wellington, but that number had probably now risen to 1,200. Their longest line of trunk wire for telephoning purposes was about 100 miles, but they spoke over a distance of 150 or 180 miles. The service was an efficient one, and they had very few complaints, but he admitted that the single-wire system was not as good as a metallic circuit.

By Sir Charles Cameron : At the exchanges non-subscribers were charged 6d. for three minutes' conversation, if for less than six miles, and 1s. for over six miles ; and subscribers paid 6d. for six minutes. In Wellington there were 1,000 telephone users, and the population was 45,000 ; and in Auckland, with a population of 70,000, there were 726 subscribers. No reward or recognition was given to the telephone inventors when the State legislated to secure the monopoly. They had no difficulty whatever as to wayleaves, as that had been provided for by legislation. They worked on the pole system with overhead cables.

Mr. W. H. DICKINSON, Deputy Chairman of the London County Council, recalled, said that the County Council had sent out a circular to the subscribers of the National Telephone Company, numbering 7,359, calling their attention to the sittings of the Telephone Committee, and asking them to state whether the "existing service is sufficient and satisfactory ; if it is not satisfactory, in what respects is it unsatisfactory ; and what suggestions, if any, you would make for the improvement of the service." That circular was dated May 6th. The total number of replies received was 2,536 ; of those 555 expressed entire satisfaction, and 1,981 were not thoroughly satisfied. Of these 1,981, 1,305 expressed general dissatisfaction, 350 were undecided in opinion, but made no suggestion for the improvement, and 326 expressed themselves satisfied, but suggested improvements. About the same time the Company sent out a somewhat similar paper, and some of the replies were sent to the County Council instead of to the Company.

At the conclusion of his evidence, Mr. DICKINSON expressed his regret that Mr. Bennett, whom the Council had proposed to call, was very ill, and unable to attend ; but stated that he was quite prepared to put in the figures which had been prepared by that gentleman, showing the cost of various telephone systems, if the Committee desired it. The Chairman, however, declined to accept these figures, as they could not be cross-examined to.

Mr. JAMES STAATS FORBES, the President of the National Telephone Company, was the next witness. He said he would deal first with the document which the Company sent out to its subscribers on Friday, May 3rd. In that document they asked their subscribers to state whether they approved of the service being undertaken by the London County Council, and whether they were satisfied that the service supplied by the Company was reasonable ; 2,346 subscribers stated unconditionally their satisfaction with the service ; 266 stated their satisfaction, with qualifications ; 43 signed in favour of the London County Council, and 36 were returned as refusing to sign. So that, on the point of numbers the Company rather headed the County Council. Mr. Forbes then dealt with the history of telephony. He informed the Committee that Bell's Patent (4,765), which was dated December 9, 1876, expired on December 9, 1890 ; and that Edison's Patent (2,909), which was dated July 30, 1877, expired on July 30, 1891. On May 13, 1880, the Bell and Edison Companies amalgamated, and started business as the "United Company." On December 20th, in the same year, judgment was given in the Post Office action, declaring a telephone to be a telegraph, and therefore covered by the Post Office monopoly. In accordance with the statement of the Attorney-General (Sir Henry James), that the object of the Postmaster-General was not to prevent telephony, but to assert privileges, and that he would be willing that the Company should work on under a licence or agreement, a licence was granted to the United Company on April 11, 1881. That licence expired on December 1, 1884 ; and a second licence was granted to the Company on November 29, 1884. The first licence was over very restricted areas, namely, five miles round London, and one or two miles round a certain number of other centres. The result of the first licence was, to absolutely restrict and suppress telephony ; but under the second licence they got for the first time what was called an "all-country" licence, which extended over the whole of the United Kingdom. Then they began to find out what telephony really meant, and what it was capable of. Licences were also granted to the Lancashire and Cheshire, and a number of other companies ; 13 licences in all being granted. On May 1, 1889, the United, the Lancashire and Cheshire, and the National Companies amalgamated under the name of the National Company ; then the Northern District Telephone Company, and the South of England Company came in, in 1890, followed by the Western Counties and South Wales Telephone Company, the Sheffield Telephone Company, the Caledonian Telephone Company, and others in 1892 and 1893. At the time of the agreement entered into between the National and the United Company and the Post Office, the two companies between them had practically the control of all the licences, with the exception of the Irish one. On May 1, 1890, the subscription in Manchester, Liverpool, and Warrington was £20 ; that was reduced to £15, and then on January 1, 1891, there was a general reduction of rates to a uniform charge of £10, which involved an immediate loss of revenue of £55,000 per annum on the then number of subscribers. When the amalgamation took place in 1889, the National Company had 10,813 subscribers, the United 6,793, and the Lancashire and Cheshire 6,230, making a total of 23,836 ; and by subsequent amalgamations and extensions of business, the number of subscribers had been increased to 73,353 for the year ending April, 1895. The number of towns and places supplied up to the same date was 537, the number of exchanges opened 593, the number of subscribers' lines 75,216, the number of telephones in use 86,032, and the present ratio of effective calls per annum 139,639,032, which was equivalent to, at the least, 279,278,064 messages. The annual average payment per line was £9. 2s. 2s., which gave an average cost to the subscribers per message of 0·58d. As 400 words could be easily spoken in three minutes, he estimated that the minimum number of words per message would be 100. Now, taking the average annual payment at £9. 2s. 2d., that works out to an average of 3s. 6d. per week, or 6d. per day, Sundays included ; every subscriber could, therefore, at his discretion, have the use of the telephone all the day, and in most places throughout the night, for the price of a sixpenny telegram ; and whereas 100 words by telegraph would cost 4s. 2d., the average cost per message by telephone was only a little more than a halfpenny. The number of messages had been estimated on accurate observations or accounts kept from time to time. It would be, of course, a waste of time and labour and expense to keep a daily record of every operator's business, and therefore they had to depend upon an estimate ; but the figures he had given were very carefully arrived at. When one could send a message by telephone at a cost of less than a penny, what became of the outcry about the extravagance of telephony ? Then a comparison had been made between the Company's charges and the charges made in other European countries. The figures he had already given did not encourage the complaint that the charge in England was an extravagant one, but if it were high the Company was not to blame for it. As he had said, the average annual charge per line was £9. 2s. 2d. Now what would that charge be on the assumption that the Company were relieved from those direct and extraneous charges not pressing, or very slightly pressing, upon State telephones in Stockholm, Berlin, Switzerland, and several other of the model examples ? There were in this country such things as royalties, wayleaves, rates and taxes, and then there were the greater relative scales of salaries, wages, and rents of premises. In the year ending December 31, 1894, the working expenses of the National Company amounted to £456,809. 15s. 4d., or 62 per cent. of the telephone revenue. The charges for royalty, wayleaves, rates and taxes amounted to £147,938, and the charges for salaries, &c., amounted to £214,123. The cost of line and instrument repairs came to £93,537, of which 72·89 per cent. represented wages. Now the wages paid in Great Britain to the people employed in that category were 33 per cent. higher than abroad, or a difference against the Company of £22,719. Then the salaries of officers, head office expenses and rents came to £120,586, which was at least 30 per cent. higher than similar charges abroad. That represented another extra cost against the Company of £36,160. The working expenses averaged £6. 4s. 7d. per line ; but if they were relieved of the burdens he had alluded to, the expenses would be reduced to £3. 8s. 4d. ; they would, therefore be lessened by £2. 16s. 3d., and if that amount were taken off the average annual charge per line of £9. 2s. 2d. the latter would then become £6. 5s. 11d. London made less use of the telephones than any other city in the world, when the number of its inhabitants was taken into account. He did not think the cause was to be found entirely in the cost of telephony ; it was rather to be found in the difference of circumstances. According to the tables which had been published by the German Postmaster-General, in Sweden 30·7 telegrams were sent annually by every 100 inhabitants ; in Germany it was 55 per 100 ; whilst in Great Britain it was 177·1 ; therefore, the telegraph was a much more severe competition here than abroad. The number of towns and places supplied with telephones in Germany

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was 442, the number of telephones in use 91,458, the number of subscribers 84,129, and the number of messages 391,388,000. Then complaints had been made about the badness of the service, and the cost of establishing it. Well, they had had to train people to telephony just as in the early days of railways people had had to be trained to railway work. They had made mistakes, he admitted. He had no doubt that if they had all been wise—and it was easy to be wise after the event—they would probably have avoided the drawbacks of the single-wire system. It was an odd thing, however, that Berlin was absolutely single wire at the present moment. Unfortunately, in England they had started with the single wire, and no doubt that was the cause of a good deal of the discredit which attached to the Company. They were now doing their best to introduce the metallic circuit as rapidly as possible, although unfortunately the change could not be made without some disturbance and inconvenience to subscribers. The number of exchanges fitted or in process of fitting with complete metallic circuit wires and switchboards was 117, representing a total of 18,978 subscribers' lines. To show the increase in business, Witness mentioned that in Glasgow within the last five years the number of lines had increased from 2,652 to 5,292, in Edinburgh from 746 to 1,787, in Dundee from 837 to 1,309, and in Aberdeen from 584 to 1,063. Then as to the formal complaints which have been made by subscribers, the average number of complaints for the United Kingdom which have been received in the year 1894 was 0·73 per subscriber's line, the average number of exchange messages, local and trunk, per subscribers' line for the same year being 3,595. The average number of complaints in London was 0·94, in Manchester 1·56, in Liverpool 2·16, in Bradford 0·89, in Leeds 1·02, in Glasgow 3·79, in Edinburgh 0·09, in Dublin 1·30, in Belfast 0·47, and in Brighton 0·91. The witness then dealt with the foreign telephone tariffs. In Brussels the charge for a single wire was £10 within a radius of three kilometres of the exchange, £2 for each kilometre beyond this distance, and £1. 13s. 4d. for each extra kilometre; there was no royalty, and the number of subscribers was 2,400. In Amsterdam (which compared very well with London, because it was a financial, commercial, and social centre of great importance) the tariff was £9. 16s. 8d. for one kilometre; but in the suburbs the charge rose to £12. 10s., and in some cases £20. 16s. The free-speaking area in Amsterdam was about 30 square miles, and the number of subscribers 4,344. In Holland the telephone was in the hands of the State as a monopoly; the State erected the trunk wires, but they allowed the companies to work them, the companies handing over to the State 75 per cent. of the receipts for trunking. One peculiar thing about it was that although the State licensed the company to work, the company had also to obtain permission from the municipalities. The tariff for a three minutes' conversation in Amsterdam was a uniform charge of 10d., and the same sum was charged for every additional three minutes.

Mr. Forbes had not completed his evidence when the Committee rose. The Committee meet again to-day (Friday), when Mr. Forbes will be further examined.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *May 10, 1895.*

Trolley Accidents in Brooklyn.—As the result of the numerous fatal accidents on Brooklyn trolley roads—there have been 109 up to date—public opinion has at last forced the city authorities to take decisive action. The president of the largest trolley road is now on trial for manslaughter; but it is thought there is little probability of conviction, this extreme measure having been resorted to in order to quiet public clamour. An ordinance limiting the speed of cars is having an amusing effect, the public loudly denouncing the astonished companies for the inconvenience they now suffer from the slow speed of the cars. It is quite probable that the railway officials are rather inclined, from ulterior motives, to keep well within the limits of the speed designated (eight miles per hour), but the service is yet immeasurably superior to what it was a few years ago, before the adoption of electric traction. The moral is that the public must have rapid transit, and that the many deaths resulting from this necessity are an unavoidable sacrifice to the exigencies of modern progress.

The New York Underground Electric Railway.—The Governor has just approved a Bill raising to $55,000,000 the limit of money that may be expended on the proposed underground rapid-transit system for New York City. Unfortunately, however, the period when construction will begin is quite distant, and some complication may yet occur to nullify the scheme. Much time will be required for condemnation proceedings, which will in turn give rise to suits attacking the constitutionality of the rapid transit law that will have to be finally decided in the Court of Appeals before construction work can be commenced. The law requires that the system shall not be built by the city, but by the successful bidder for the operating use of the road during a long term of years, the bid to be made upon a percentage of the cost of construction, the funds for the latter purpose to be furnished by the city. Thus far, there has been no indication of any bidder appearing when the city is prepared to receive offers; but an effort is being made to interest one of the Vanderbilt railroads in the matter. To this end the bait is held out that during the night hours two of the four tracks in the heavy shipping part of the city might be used for the direct transfer of freight cars to and from the premises of large shippers. While it has been decided to use electricity for the motive power, nothing has as yet been decided in regard to details, these being very wisely left to be taken up after the road is nearing completion, when full advantage of the latest improvements may be taken.

LEGAL INTELLIGENCE.

North Metropolitan Tramways Company v. London County Council.

This action was heard before Mr. Justice Romer, in the High Court, in order to raise the question whether the London County Council could, under section 43 of the Tramways Act, 1870, compulsorily purchase so much of the plaintiff Company's tramways and works and undertaking as are within the County of London, and as were authorised by the Company's special Act of 1871 without purchasing the whole of the Company's lines and undertaking. The arguments in the case have previously been referred to in *The Electrician.*

Mr. Justice ROMER, in giving judgment, said that on the main question the London County Council were right in their contention. In construing section 43 of the general Act of 1870, it was clear that the word "undertaking" was limited by reference to the tramway previously mentioned in the section, and was, no doubt, used instead of the word "tramway." It was noticeable that what was to be paid for was only the value of the tramway, and the lands, buildings, works, materials, and plant of the promoters suitable to and used by them for the purposes of their undertaking within the district. That being the true construction of the section, he could not see that there was any difficulty when the section had to be applied in the present case. The general Act of 1870 was incorporated, and under the powers of section 43 the London County Council are now entitled (the Board of Trade approving) to require the plaintiffs to sell their 1871 tramways, and their undertaking so far as it relates to those tramways. He did not see that this section was rendered inoperative or affected by the fact that the plaintiffs had other tramways, some of which were authorised by the prior special Acts of 1869 and 1870 respectively, and others of which had been authorised by later special Acts, or by the fact that their general undertaking related to those other tramways as well as to the 1871 tramways, and had from time to time, as further tramways had been authorised, been recognised and defined by the various special Acts as extending to and including the further tramways. The contention of the plaintiffs, if adopted, would lead to great difficulties. With regard to the argument founded on the inconvenience of the plaintiffs being obliged to sell their 1871 tramways only, leaving on their hands their other tramways, some of which could not be well worked efficiently or profitably by themselves, he did not think this contention of much weight, as any purchase by the Local Authority was subject to the approval of the Board of Trade, who would, no doubt, refuse their approval in a proper case. The plaintiffs, when they took powers to construct small pieces of tramway, did so at their own risk, well knowing the provisions of the general Act. Moreover, section 43 of the general Act expressly contemplated a tramway company being liable to sell portions only of its tramway, for if the tramway was in more than one district a Local Authority was entitled to buy so much only of the tramway as was in its district. For these reasons the plaintiffs' contention failed. The declaration as to the right to take the tramway would be that under the Act the London County Council were entitled to take the 1871 tramways, and also the plaintiffs' undertaking so far as it relates to those tramways.

Wood v. Woodhouse and Rawson United (Limited).

In a debenture-holder's action an application was made to Mr. Justice Vaughan Williams in the High Court on behalf of the Official Receiver and Liquidator of Woodhouse and Rawson United (Limited) for liberty to take proceedings against Directors of the Company in respect of alleged misfeasances.

Mr. H. WRIGHT, in support of the application, said that the Official Receiver estimated that there would be a deficiency of not less than £150,000, and it was extremely doubtful if anyone but the debenture-holders would be benefited by the proceedings against the Directors if they were successful.

His LORDSHIP said that if the unbiassed judgment of the debenture-holders was obtained and was against the misfeasance proceedings, his Lordship thought he ought not to allow the proceedings to be taken. He therefore thought it would be better to call the debenture-holders together, so that their views on the subject might be ascertained.

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Mr. MACNAGHTEN, for the plaintiff, said that some disinterested person ought to be appointed to preside at the meeting, and he suggested that Mr. Leslie, of Coleman-street, E.C., the receiver in the action, should be appointed to preside.

His LORDSHIP said the Official Receiver must be appointed to preside. Although it might be thought improbable that anything would be obtained for the unsecured creditors, yet one could never be quite sure that this would be the result. If the debenture-holders arrived at a deliberate and honest conclusion that proceedings ought not to be taken, his Lordship would be very glad. But if their conclusion was based on the fact that they thought it a pity that there should be the scandal of subjecting respectable persons to proceedings, that ought not to be allowed to weigh much. Mr. Leslie must not suppose that because his Lordship had not appointed him to preside he had intended to cast the slightest reflection on him. His Lordship thought that under all the circumstances it would be better for the Official Receiver to preside. All the debenture-holders must be summoned to attend one meeting, but the voting must be arranged to take place in such a manner that it might be known how the persons belonging to the different classes of debentures had voted.

Bryson v. Cumming.

In the Court of Session, Edinburgh, before Lord Kyllachy, a settlement was announced in an action by Mr. W. A. Bryson, consulting electrical engineer, of Bothwell-street, Glasgow, against Sir William Gordon Cumming, of Altyre, Morayshire. Pursuer sued for £115. 18s. 5d. In March, 1892, he was consulted in connection with the fitting up of an installation of electric lighting at Altyre House, at an agreed commission of 4 per cent. on the cost of the installation, which was £3,063. Defender alleged that the pursuer had neglected his duties, and that he had been guilty of collusion with the contractors for the work.

By the settlement the defender has agreed to pay the pursuer £95 in full, and to withdraw all statements on record affecting the pursuer's professional character and reputation, each party to pay their own expenses.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices*:—

LABORATORY NOTES AND FORMS.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett. Strong portfolios can be had, price 1s. each. A full prospectus can be obtained post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s. —each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d. post free (abroad 11s.).

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"ELECTRO-CHEMISTRY."—This useful work, by Dr. G. Gore, is still on sale, the price being 2s., post free.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. nett, is now ready.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"THE ELECTRICIAN."—A special notice concerning certain changes in the price, &c., of this journal will be found on page 124.

TENDERS INVITED.—The Electric Lighting Committee of the Huddersfield Town Council invite tenders for cables, transformers, switches, fuses, and covers for their electric lighting works during the ensuing 12 months. Specifications and particulars can be obtained of Mr. A. B. Mountain, borough electrical engineer, St. Andrew's-road, Huddersfield, and tenders have to be sent in to Mr. Mountain not later than Saturday, June 1st. Some particulars are given in our advertisement columns.

——— By command of the Postmaster-General, tenders are invited for the purchase of about 35 tons of old copper (wire, plates, &c.) and quantities of other metals, india-rubber covered wire, mercury deposit, india-rubber, tin foil, &c. Forms of tender can be obtained of Mr. Charles E. Stuart, Controller of Stores, General Post Office, Telegraph-street, E.C., and tenders must be sent in not later than 10 a.m. on Monday, June 17th. Some further particulars are given in our advertisement columns.

——— The Secretary of State for War gives notice that purchases of electrical instruments (submarine mining), telegraph cable and wire, india-rubber goods, &c., will be made during the current year, and manufacturers desirous of tendering should apply to Mr. G. Lawson, Director of Army Contracts, War Office, Pall Mall, London, S.W.

——— *Extension of Time.*—The time for sending in tenders for the supply of electric light lamp pillars and copper canopies required by the Corporation of Brighton has been extended until 10 a.m. of Saturday, June 1st.

——— The Shoreditch Vestry invite tenders for the wiring of the Town Hall, and for supplying and fixing cables, wires, switches, &c., for the electric lighting of the building. Tenders must be sent in to the Vestry Clerk, Dr. H. Mansfield Robinson, by the 31st inst. Our advertisement columns contain some further particulars.

——— The Corporation of Hanley invite tenders for the supply, delivery, and erection complete of boilers and fittings, water tank and girders, arc lamps, of cables, street boxes, &c., transformers, switches, &c. Tenders have to be in to Mr. Joseph Lobley, borough engineer and surveyor, before Monday next.

——— *Daily Tenders and Contracts* states the municipal authorities of Santos (Brazil) are inviting tenders for the supply of the requisite plant for lighting the district by electricity. Water power, which is plentiful near the city, is to be utilised.

——— The Electric Light Committee of the Oldham Corporation invite tenders for two 200-H.P. steam engines and dynamos and steam pipes. Tenders to be in by Tuesday next.

——— Tenders are being invited until June 29th by the Municipal Authorities of Braila, Roumania, for the concession for the lighting of the public streets either by electricity or gas.

——— The Manchester Corporation invite tenders for laying a system of underground telephone pipes, with inspection pits, service boxes, &c., in various streets of the city. Tenders have to be in by the 31st inst.

——— The French War Department, Paris, is inviting tenders until the 30th inst. for the supply of optical telegraphic apparatus required by the military telegraph service from the years 1895 to 1897 inclusive.

TENDERS ACCEPTED.—The Coventry and District Tramways Company have accepted the tender of Mr. C. Haywood, jun., for the erection of an electric generating station, car-sheds, &c.

——— The tender of Messrs. Babcock and Wilcox has been accepted for the supply and fitting up of boilers for the electrical department of the new post office, Leeds.

——— The Chelsea Vestry have accepted the tender of Mr. C. L. Hacking for the supply of electric light fittings for the upper hall of the Town Hall for the sum of £48.

——— The Halifax Board of Guardians have accepted the tender of Messrs. J. Sunderland and Co. for supplying and fixing electric bells at the new Vagrant Wards.

TENDERS RECEIVED.—The following tenders were received by the Brighton Corporation for the supply of vulcanised rubber and lead-covered and armoured cables. The quotations are per mile:—

	Two-core cable.	Three-core cable.
Siemens Bros. and Co. (accepted)	£239	£289
British Insulated Wire Company	215	230
Callender's Company	255	290
W. T. Glover and Co.	240	298
Fowler-Waring Cables Company	268	328
Telegraph Manufacturing Company	281	335
W. T. Henley's Telegraph Works Company	279	337
India Rubber Company	297	396

The Lighting Committee of the Town Council originally accepted the lowest tender of the British Insulated Wire Company; but as this was made in error, and the Company asked to be allowed to

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withdraw, the offer of Messrs. Siemens Bros. and Co. has now been finally accepted.

Tenders Received.—The Brighton Corporation have also received the following tenders for the supply and erection of boilers at the Corporation electricity works :—

Babcock and Wilcox (Limited), London, accepted	£3,100
R. Taylor and Sons, Marsden	2,165
E. Danks, Oldbury	2,627
Fleming and Ferguson, Paisley	2,760
Spur, Inman and Co., Wakefield	2,870
J. Fraser and Son, Millwall	2,938
Tinkers (Limited), Hyde	3,060
R. Hornsby and Sons, Grantham	3,300
Fraser and Frazer, Bromley-by-Bow	3,486
Penman and Co., Glasgow	3,500
Davey, Paxman and Co., Colchester	3,644
J. Thompson, Wolverhampton	3,660
Hawkesly, Wild and Co., Sheffield	3,750
Yates and Thom, Blackburn	3,785
H. and T. Danks, Dudley	4,750

Sale by Auction.—On Wednesday next, at Wolverhampton, Messrs. T. J. Barnett and Sons will dispose of the extensive freehold property called Mitre Works, lately in the occupation of the Gospel Oak Iron Company (Limited), adjoining the Birmingham Canal, Bilston-road, Wolverhampton. The sale includes the freehold, covering an area of 3a. 1r. 1½p., with ranges of workshops, warehouses, stores, and offices, which have been specially arranged for the manufacture of galvanised wire, screws, &c. The plant and machinery, fixtures, tools, &c., are also to be disposed of.

Appointment.—The Electric Lighting Committee recommend that Mr. E. Sayer be appointed chief assistant electrical engineer to the Hampstead Vestry at a salary of £200 per annum.

Dissolution of Partnership.—Messrs. H. F. Jackson and T. A. Kerr, who have hitherto carried on business as electrical engineers, under the style of Whittaker and Co, at 85, Queen Victoria-street, London, E.C., have dissolved partnership. Debts by Mr. H. F. Jackson.

Bankruptcies.—The adjourned first meeting of creditors of J. Torr Todman, electrician, was held last week before Mr. A. H. Wildy, official receiver. There was no proposal before the meeting, but accounts had been filed showing gross liabilities £1,840. 10s. 2d., of which £725. 3s. 10d. was expected to rank, and assets £207. 7s. 2d. The debtor's solicitor stated that it was his client's intention to submit an offer of composition, and he applied for a further adjournment in order that an offer of at least 7s. 6d. in the £ might be made if the assistance which the debtor hoped for was forthcoming. Adjourned to June 14th, 11 a.m.

——— Messrs. L. P. Garrett and J. A. Rudd, Glasgow, and J. A. Buttery, Govan, have been appointed Commissioners in the sequestration of the estate of John Scott, sole partner in D. and G. Graham, electrical engineers, Glasgow. The examination of the bankrupt takes place at the County Buildings, Glasgow, on the 27th instant, at 11 a.m.

Liquidations.—A petition for the winding-up of the Madras Electric Tramways Company (Limited) has been presented by the Commercial and Land Mortgage Bank, and will be heard at the Royal Courts of Justice, Strand, London, W.C., on the 29th instant. Mr. Cyril Dodd, jun., 26, Bush-lane, London, E.C., is solicitor for the petitioners.

——— A petition for the winding-up of Ronald A. Scott (Limited) has been presented to the Middlesex County Court, at Brentford, by Messrs. Wells Bros., of Sandiacre, Nottingham, and will be heard on June 6th next. Messrs. Greene and Underhill, 31, Bedford-row, London, W.C., are solicitors for the petitioners.

——— It is probable that a meeting of debenture-holders in Woodhouse and Rawson United (Limited) will be called in a few days to discuss the question of the advisability of prosecuting the directors in respect of alleged misfeasance. The proceedings before Mr. Justice Vaughan Williams are briefly reported in another column.

——— A meeting is to be held at 9, Fenchurch-avenue, London, E.C., on June 19th, at 2 p.m., to receive an account of the winding-up of the European Sims-Edison Electrical Torpedo Company (Limited).

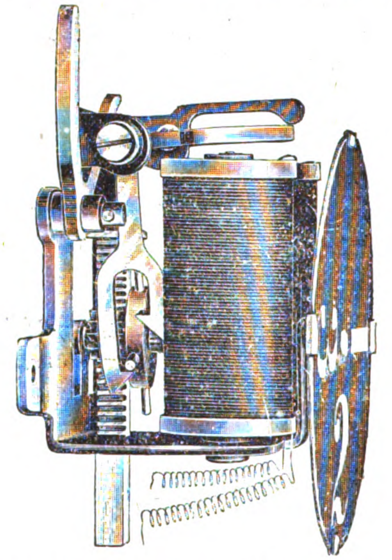
Mica Contract.—The Admiralty have placed with Mr. Archibald Campbell, of 28, Gray's Inn-road, London, W.C. (acting for Messrs. Baxters and Macdonald, of Dundee), a contract for mica.

Engineers' Tools.—Messrs. J. Carter, Sons and Co., of Salford, Manchester, have just issued a very complete catalogue of engineers', machinists', and general tools, consisting of lifting tackle, cranes, hoists, &c., and tools for engineers, machinists, &c., engine and boiler fittings, steam traps, pumps, injectors, &c. Nearly 90 large quarto pages are filled with illustrations and prices of an immense variety of engineering accessories.

Copyright in Designs.—Messrs. Sweet and Maxwell, of 3, Chancery-lane, London, W.C., send us a copy of "The Law of Copyright in Designs," by Lewis Edmonds, D.Sc., LL.B., Barrister-at-Law, assisted by Messrs. Stevens and Slade. The object of the authors is to present an exhaustive exposition of the English law of copyright in designs, which is a subject of great practical importance to manufacturing and industrial undertakings. It is pointed out that the number of designs annually registered is about 20,000. A very comprehensive "Table of Cases," and a simple index, making 21 pages, render the book of much service as a work of reference to those interested in the registration and copyright of designs.

"D.P." Batteries.—The D.P. Battery Company, Limited, of 66, Victoria-street, Westminster, S.W., have just issued Price List No. 1 of D.P. Batteries. The list is accompanied by testimonials from a number of users.

Triplex Movement.—The International Electric Company has recently patented and placed upon the market a new indicator movement, which allows of three signals being given with the same movement. It is constructed on the principle of this Company's universal bell, which was described in this journal some months back, and is intended to serve as a recording instrument where a pre-arranged code of signals provides for the using of the same bell to give different signals. The illustration gives some idea of



the arrangement of the triplex movement, and it is claimed that indicators fitted with this movement can be used with advantage on board ship, as it forms a perfect locking arrangement, only dropping when a current is past. An illustrated descriptive pamphlet can be obtained from the Company, 55, Redcross-street, London, E.C.

Electrical Heating and Cooking Apparatus.—The recent successful exhibition of electrical heating and cooking apparatus at the Portman Rooms, London, is a proof that the public are gradually according their appreciation to this branch of electrical industry. From Messrs. Crompton and Co.'s catalogue we take

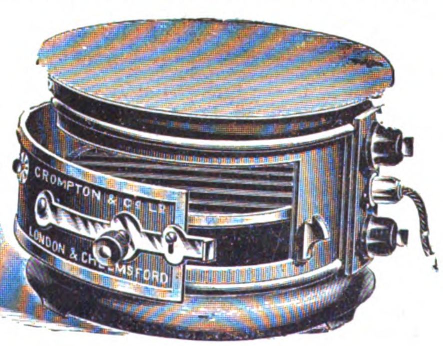


Fig. 1.

two of the most recent additions to the apparatus manufactured by that firm. Fig. 1 is a breakfast cooker, and combines an electric hot-plate and oven. Fig. 2 is an electric urn, and is used for heating water, milk, coffee, or tea. This article is made in a variety of shapes and patterns, and would be found of great service to restaurant keepers and others whose business premises are

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situate in the area of supply of any of the electric supply companies. At present gas heaters are used, and the fumes of the gas-heated water boiler are usually very objectionable. In addition, the heat of the gas speedily burns off the outer polish, and, in fact, prevents any ornate treatment of the apparatus. With the electrical urn ornamentation can be indulged in to any extent, and for counter purposes this is a feature not to be altogether ignored. A useful heating device is shown in Fig. 3. This is for use in lavatories, and is intended for both hot and cold water supply.

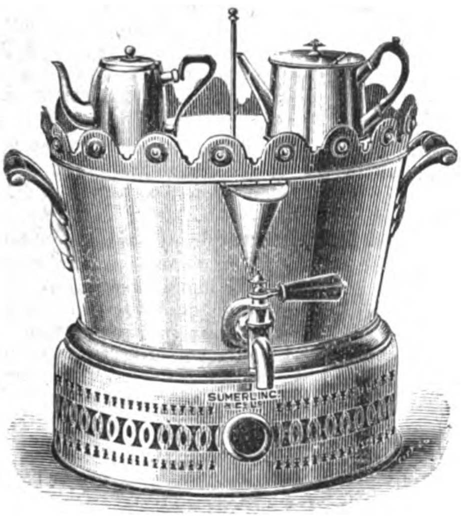

Fig. 2.

The cold water on entering the apparatus is electrically warmed in transit; the water can be heated to any temperature, and can be regulated by means of the dial shown on the right of the figure. If cold water is required, the pointer is turned from Z to K, and as the pointer is turned to the right so the water becomes hotter. The apparatus, which is manufactured by the Electrical Company (Limited), is claimed to be economical in use, and suitable for dealing with either large or small bodies of water.

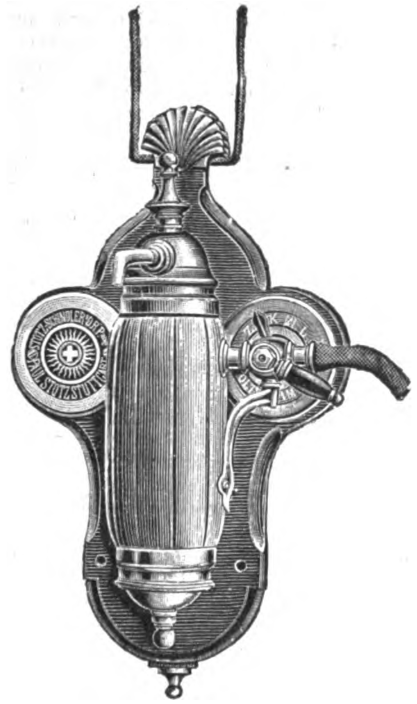

Fig. 3.

In purchasing electric heating and cooking apparatus it is most essential that the systems adopted by the makers for the actual heating arrangement should be carefully ascertained and examined. It is only by the adoption of a protective system, such as enamel or similar compound, that severe wear and tear of the conductors can be arrested. The pioneers in the manufacture of well-made electric cooking and heating apparatus may confidently look forward to reaping not only a full commercial reward for their exertions, but the thanks of a grateful public, for assuredly, if coal and gas cooking and heating can be satisfactorily and economically superseded by the more cleanly and easily-controlled electric method, the public will have reason to be grateful.

The Journal.—Part 117 of the *Journal* of the Institution of Electrical Engineers, containing Dr. N. S. Keith's Paper on "The Electrolysis of Gold," and the discussion thereupon, and also a Paper by Mr. W. E. Langdon "On the Employment of Electric Light for Railway Purposes," is now ready, price 4s.

Argentina.—It is stated the firm of Rufino Varela and Co. are drawing up the plans, &c., for lighting Bahia Blanca by electricity, and will shortly present a petition to the municipality asking for a concession for the public lighting.

Asylum Lighting.—The new Sunderland Borough Asylum at Ryhope, which was formally opened on the 16th inst., will be lighted throughout by electricity.

Birmingham.—It will be remembered that the contract for supplying electric light fittings and motive power for the Municipal Technical School, Birmingham, was some time ago awarded to Messrs. D. and G. Graham, of Glasgow. At the last meeting of the Town Council it was reported by the Technical School Committee that the trustee in the sequestration of the estate of D. and G. Graham (Mr. J. M. McLeod), in the exercise of the power conferred on him by his office, declined to fulfil the contract; consequently, the Committee recommended the acceptance of the tender of Messrs. B. Verity and Sons for the sum of £5,714. 11s. 11d., in place of that of Messrs. Graham. After a brief discussion the recommendation was adopted, a proposition to refer the matter back being lost. The amount of Messrs. Graham's tender was £5,515. 14s. 2d.

Bristol.—Mr. F. H. Tulloch, C.E., held a Local Government Board inquiry at the Council House, Bristol, yesterday (Thursday) respecting the application of the Corporation for sanction to borrow £10,000 for electric lighting extensions, and £32,048 for the erection of a refuse destructor, &c.——It is announced that the St. George and Kingswood Electric Tramway will be completed and running in July.

"Burglary."—The clerk Eve, who was charged with stealing £237. 10s. from the safe belonging to the Brush Electrical Engineering Company, was on Monday last sentenced to 18 months' hard labour. It was quite by chance that the prisoner was suspected, the robbery having been originally credited to burglars.

Cape Town and District Gas Light Company.—At a meeting of this Company last week, the Hon. H. Noel who presided, stated that although the electric light was established at Cape Town and the municipality was using it for street lighting in place of gas, as far as the gas company was concerned that would be a benefit to them rather than a loss, as the gas supplied for public lighting had been sold at cost price.

Cardiff.—The Corporation has been notified that the sanction of the Local Government Board to the application for powers to borrow £3,500, required for purchase of the site of the old brewery in Womanby-street, has been given. This is the site selected for an electric supply station.

Chiswick.—The lighting of this district, from reports to hand, leaves much to be desired. It is stated that those gas lamps which are not "out" give but a miserable glimmer of light, and this notwithstanding that the parish pays heavily under its lighting contract. The contract for electric lighting is in the hands of Messrs. Bourne and Grant, but the firm appears to experience much difficulty in its transactions with the District Council, whose latest order is that the erection of the shaft at the electric lighting station is to be stopped pending a satisfactory agreement being entered into with the Council. The prospect of an early turning on of the electric light, which we believe is much desired by the inhabitants, is likely to be considerably delayed, unless the authorities accept with a good grace the action of the previous District Council in handing over their Provisional Order to a company.

City Commission of Sewers.—At Tuesday's meeting of this body the Clerk presented an exhaustive report in connection with the circular-letter recently issued to telephone users. In all 3,456 circulars were issued and 1,085 replies received, which, seeing that the subject is supposed to be a burning one, does not appear a very complete return. This is, perhaps, accounted for by the fact that subscribers were somewhat embarassed by having no less than three separate circulars and three separate sets of questions to answer at the same time, and all in double-quick time. The opinion expressed in the majority of replies as to the inefficiency and costliness of the present service is stated to confirm the evidence given on behalf of the Commissioners to the Select Committee of the House of Commons now inquiring into the subject: 35 per cent. expressed satisfaction at the present service; 63·5 per cent. condemned the existing system as inefficient; 84 per cent. think the cost excessive; 10 per cent. do not object to the prevailing charges. The result of the canvass is to confirm

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the Commissioners in their contention that a £10 subscription is considered as the limit of charge for subscribers within the metropolitan area.

COVENTRY.—At the meeting of the Town Council on Tuesday, on the recommendation of the General Works Committee, it was resolved to consent to the substitution of the Westinghouse system for the Thomson-Houston system in the equipment of the Coventry and District Electric Tramways. The Electric Lighting Committee reported that they expected to be able to supply electric current in August next.

"DANGERS OF THE ELECTRIC LIGHT."—When in doubt—try the electric light. A small outbreak of fire occurred at the residence of Mr. J. Garnet, at Bromley Cross, last week. The house is lighted electrically. In giving an account of the fire the newspapers naïvely state that "as there were only two fires burning in the house at the time, it is thought that the fire must have been occasioned by fusion of the electric light wires." Gas journals please copy.

DOVER.—A sensible suggestion has been made that Snargate-street, one of the principal thoroughfares of the town, should be lighted electrically by means of arches thrown across the street. It is a narrow thoroughfare, and this method of lighting would prove most effective. The memorial that the street should be lighted electrically has been signed by the whole of the occupiers.

EDINBURGH.—Messrs. Smith and Co. (Limited), electrical engineers, of George-street, have just completed the installation of the electric light in the Assembly Hall, which is the first of the large halls in this city to be lighted electrically.

EXHIBITION.—On May 13th the Mayor of Newcastle inaugurated a General Trades' Exhibition at Newcastle, which is to remain open till June 8th. Amongst the exhibitors are Messrs. Bland Bros. (electric light fittings and plant, telephones, &c.), Ackroyd and Best (miners' safety lamps and electric plant). Rowland Barnett and Co. (electric lighting plant, &c.), Robert Bowran and Co. (Blackman electric fans, "Sunbeam" incandescent lamps, &c.)

"EXPANSION OF TELEGRAMS."—Further interesting matter has appeared in *The Times* and the *Daily Chronicle* during this week on the subject of the charge made by the former journal against the Central News Agency of unduly expanding telegrams relating to the war between China and Japan. Mr. John Moore, manager of the Central News, writes that the remarks of the *Kobe Chronicle* are a "tissue of fabrications," to which the *Daily Chronicle* replies that the journal in question is a British paper, published in a British settlement, where full justice can be claimed by the Central News Agency if it choses to take legal proceedings. But *The Times* offers a much simpler way out of the difficulty. It offers to afford space for the publication of the original telegram of 204 words (expanded by the News Agency into 655), and considers this offer (and the public will endorse this view) is one which will enable the News Agency to justify its action, if possible. Further, *The Times* of Wednesday contained a request "that the manager of the Central News will kindly authorise the Eastern Telegraph Company to send to *The Times* for publication the '204 words in reference to Wei-hai-wei' received by the Central News on February 7th, as stated by their manager in his letter of May 14, 1895." To this request no reply has been vouchsafed. The *Daily Chronicle*, in its issue of Friday last week, brings what many will consider a still more serious charge against the Central News—of having sent out on April 30th a telegram which, "fortunately, most of the responsible London papers put in the waste-paper basket." The *Chronicle* describes this telegram as "a message which might conceivably have wrought much mischief if it had been believed on the Continent." The present silence of the Central News Agency is, perhaps, preliminary to its publishing a complete history of the whole transaction.

GLASGOW.—The balance-sheet of the first year's working of the Corporation Tramways is just issued, and is interesting from the fact that the successful working of tramways by the Municipality is assured. The period of working is ten months. The accounts show a balance profit of £13,743. Of this sum £7,496 is to be handed over to the Common Good Fund, and the remainder is set aside for depreciation. Electric lighting of the cars during the period has cost £128. 6s. 5d., and £466 has been spent in electric lighting plant.

KINGSTON-ON-THAMES.—At the last meeting of the Board of Guardians a letter from the Town Clerk was read suggesting the desirability of introducing the electric light into the workhouse. The Chairman said they had already decided that there should be electric light in the new infirmary, and it was agreed to wait until that installation was completed before they considered any extensions.

KNITTING BY ELECTRICITY.—The *Textile Mercury* contains an account, from an American source, of a machine now in operation which appears to offer a great improvement in the knitting art. It is described as an electrical attachment to a knitting machine, and is said to have attained such perfection that any design, however complicated, can be produced in the knitted fabric without preparatory operation or alteration upon any of the ordinary types of knitting machines, either straight or circular, thereby saving the delays of weeks, and in some cases months, that arise in setting up a pattern on the weaving loom. A pointed stylus is used, electrically charged, which successively follows the design over the whole surface of the metallic cylinder upon which the design is fixed. Any sized machine up to 9ft. in diameter, making a fabric of 17ft. wide, can be employed, and any number of colours up to 18 can be introduced into the design, according to the size of the machine. The inventor is Imanuel Buxtorf, a French mechanic and electrician.

LEEDS.—The Parliamentary Committee of this week discussed a communication from the Yorkshire House-to-House Company with reference to the Town Council's Tramways Bill, now before Parliament. The object the Company seek to attain is the extension in respect to the tramways it is intended to construct on the powers which the Company now possess in respect to existing lines. The Committee agreed to accept the proposal of the Company subject to some slight alterations which, if accepted, leaves the Tramways Bill without further outside, opposition.

LIBRARY LIGHTING.—The 137th annual general meeting of the proprietors of the Library, Liverpool, was held on Wednesday, and the president, Dr. W. Irvine, after dealing with the accounts of the undertaking, which appears to be in a very satisfactory financial condition, referred to the installation of the electric light, which the Committee of the Library report "as a very great improvement."

LONDON CHAMBER OF COMMERCE.—The thirteenth annual report of the Council of this Chamber is now ready.

OSSETT.—The Gas and Electric Lighting Committee of the Town Council recently passed resolutions regarding the price and quality of gas in the district, and have decided to make inquiries from neighbouring towns as to lighting arrangements, at the same time obtaining particulars regarding electric lighting.

PACIFIC CABLE.—A telegram from Ottawa, dated May 22nd, states that Fanning Island has been definitely settled as the Pacific Cable Company's station, which insures the route of the cable being entirely British.

PENISTONE (YORKS.)—At the last meeting of the Board of Guardians it was resolved to accept the offer of Messrs. Pettitt and Hards to send in specification and scheme for the lighting of the workhouse by electricity.

PROVISIONAL ORDERS.—The Electric Lighting Orders promoted by the Town Council of Stirling and the Town Council of Motherwell were unopposed before the Committee of the House of Commons, and were duly passed. The opposition threatened by the Caledonian Railway Company to the Order of the Motherwell Council was withdrawn.

RAILWAY STATION LIGHTING.—Messrs. Drake and Gorham have secured the contract for the lighting by electricity of the South-Eastern Railway Company's station at Tunbridge Wells, for which work, we understand, a number of tenders were submitted.

SOUTH AFRICA.—The success of the electric light and power plant supplied by Messrs. Siemens and Halske for the Rand Electric Company appears to be established. The *South African Mining Journal* says that small electric motors for underground haulage are shortly to be introduced, and promise to supplant animal traction.

WAKEFIELD.—The Electric Lighting Committee of the City Council recently decided that it was desirable that the proposed electric lighting works for supplying the city with electric current should be continuous to or combined with the buildings for the proposed sewage works. The Committee also decided that tenders for carrying out electric lighting work, at a cost of over £20,000, be advertised for, and the Council have approved the Committee's recommendation.

WALKER (NEAR NEWCASTLE).—At a meeting of the Tramways Committee of the Newcastle Corporation last week an offer was received from a firm of contractors to work an electric tram line from City-road to Walker boundary and then through Walker. Further consideration is to be given to the matter at the next meeting of the Committee, provided the consent of the Walker Local Board is given to the proposed scheme.

WEST HAM.—The Highways and Parks Committee of the Town Council recently presented a report on the question of lighting the borough by electricity. It is recommended that estimates be invited from some of the leading electrical firms for the installation of the light in the compulsory area, viz., High-street, Stratford, The Broadway, The Grove, Barking-road, and Victoria Dock-road. The report is to be considered by the Council in committee.

ROWING.—On Wednesday evening the members of a newly-formed rowing club (consisting of the staffs of the Eastern and associated Telegraph Companies) opened the season with a four-oared race on the Thames.

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PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

April 18, 1895.

7,782. J. F. H. VOIGT and J. A. HAEFFNER. Liverpool. Improvements in electric resistances.

7,785. T. HARDEN. London. Improvements in connection with ventilating electric culverts, test-boxes, and other street-boxes.

7,788. W. R. RIDINGS, G. F. BULL, and L. B. CODD. London. Improvements relating to electric arc lamps.

7,795. VICOMTE G. DE S. DE DORMAEL. London. Improved construction of electrical accumulators.*

April 19, 1895.

7,829. W. J. S. BARBER-STARKEY. Manchester. Improvements in the method of and means for charging electric storage cells.

7,837. P. STOTZ and F. W. SCHINDLER-JENNY. London. An improved apparatus for electrically heating liquids.

7,888. E. ETEVE. London. Improvements in electric cells or batteries.

April 20 1895.

7,910. F. J. BORLAND. London. Improvements in and connected with apparatus for lighting up roundabouts and the like by electricity.

7,930. J. A. JECKELL. South Shields. Improvements in laying electric conductors underground.

April 22, 1895.

7,962. R. V. HOUSSART. London. An improved insulating compound.

7,966. W. E. DOW. London. Portable electric apparatus.

7,989. H. W. C. COX and GERSHON BOWMAR. London. Improvements in electrically-driven wool-shearing or hair-clipping machines.

7,990. F. H. W. HIGGINS. London. Improvements in telegraphy and apparatus therefor.

April 23, 1895.

8,011. G. HUBENER. Manchester. Improvements in the electrodes or plates of electric storage batteries.*

8,026. J. M. FAULKNER. London. Improvements in electric railway systems.*

8,037. A. MUIRHEAD. London. Improvements relating to electric telegraphs.

8,049. W. P. THOMPSON. Liverpool. Improvements in or relating to electric alarm clocks. (Rudolf Chillingworth, Germany.)*

8,072. E. WÜRL and A. NOWOTNY. London. Improvements in or relating to phonographs.

8,081. A. SCHANSCHIEFF. London. Improvements in the active material for secondary and primary batteries.

April 24, 1895.

8,135. F. HUGHES. London. An improved electric-light cask searcher and probe.

8,147. T. NEES. London. Combined trolley and accumulator system for driving electric cars.*

8,161. F. W. SCHINDLER. London. Improvements in electric igniting apparatus suitable for lighting tobacco pipes and cigars.

April 25, 1895.

8,167. A. LABRE and A. COUSSINET, Jun. Paris. System of electro-calorigen rheostatic chain.*

8,172. R. D. BAILEY. London. Belting for machine guns, dynamo, engine and other purposes.

8,186. A. HARVEY. Birmingham. Improvements in electric locks. (Samuel Bash: South America).

8,188. J. A. HIRST. London. Improvements in ceiling roses and lamp-holders for electric lighting.

8,195. O. HANKS. London. Improvements in cycle electric house table and other bells and gongs.

8,210. J. S. GISBORNE. London. A method of, and other means for, increasing the directive force of magnetic needles.

8,222. J. E. KINGSBURY. London. Improvements in telephonic systems and apparatus. (The Western Electric Company, United States.)

8,226. J. VON DE POPPENBURG. London. Improvements in and relating to electric batteries.

April 26, 1895.

8,253. T. COOPER. Walsall. Electric appliance to give signalmen control over drivers in foggy weather.

8,306. C. P. SHREWSBURY, F. L. MARSHALL, J. COOPER, and J. L. DOBELL. London. Improvements in or connected with electric batteries.

April 27, 1895.

8,373. W. S. RAWSON. London. Improvements in conductors for coupling cells of voltaic batteries.

8,392. M. MOSKOWITZ, L. D. ADLER, A. S. ADLER, and T. W. MYERS. London. An improved system of lighting and heating railway vehicles by electricity.*

8,393. M. MOSKOWITZ, L. D. ADLER, A. S. ADLER, and T. W. MYERS. London. Improvements in and relating to the electric lighting of railway vehicles.*

8,394. M. MOSKOWITZ, L. D. ADLER, A. S. ADLER, and T. W. MYERS. London. Improvements in means for equalising the electromotive force of dynamos.*

April 29, 1895.

8,398. A. S. F. ROBINSON. London. Improvements in the supporting and carrying of electric cables for conveying electricity over large areas, and to varying positions, whether for plough driving telegraphic, lighting, or other purposes.

8,421. R. FALSHAW. London. A new or improved automatic switch for electric welding and other purposes.

8,453. J. BROCKIE. London. Improvements in electrical switches, and means of actuating same.

April 30, 1895.

8,505. C. A. ALLISON. London. Improvements in the mode of and means for electrically transmitting articulate speech. (J. Absterdam, United States.)

8,507. J. A. JECKELL. South Shields. Improvements in disconnection fuse boxes.

8,537. A. J. BOULT. London. Improvements in insulating material. (The Virginia Phosphate and Paint Company, United States.)*

8,564. A. DUCEUX. London. Improvements in electric alarms.

8,573. W. S. SMITH and W. P. GRANVILLE. London. Improvements in electric cables and in their manufacture.

8,583. A. BERRY and J. LIPKOWSKI. London. Electro-automatic "block system" apparatus. [Date applied for under Patents, &c., Act, 1883, Sec. 103, October 30, 1894, being date of application in France.]

8,590. J. W. CARTER. London. Improvements in magnetic ore separators.

May 1, 1895.

8,603. H. REASON and G. W. GOLDRING. Brighton. Improvements in terminals for electrical conductors.

8,637. E. CLARK. London. Improvements in secondary batteries.

8,654. F. E. BEELTON. London. A rectifier for alternating electrical currents.

8,664. R. E. B. CROMPTON and E. A. N. POCHIN. London. Improvements in electric arc lamps.

May 2, 1895.

8,671. J. G. FIEGEHEN and E. G. FIEGEHEN. Bedford. Improvements in operating and controlling electrical and other cranes and hoisting machinery.

8,696. A. WRIGHT and R. C. QUIN. Brighton. Improvements in electric distribution and apparatus in connection therewith.

8,726. S. P. THOMPSON. London. Improvements in electric motors, generators, and current-converting apparatus.

8,727. SIEMENS BROTHERS AND CO. (LIMITED) and E. F. H. H. LAUCKERT, London. Improvements in switches for varying electrical resistance.

8,728. J. G. A. RHODIN. London. Improvements in plates for secondary voltaic batteries.

8,729. L. EPSTEIN. London. An improvement in secondary voltaic batteries.

8,731. J. BROCKIE. London. Improvements in electric arc lamps.

8,740. M. BAILEY and J. WARNER. London. Improvements in secondary batteries.

May 3, 1895.

8,764. A. WRIGHT. Brighton. Improvements in distribution of electricity.

8,810. SIEMENS BROTHERS AND CO. (LIMITED). London. Method of and apparatus for directly indicating the value of electrical resistances. (Messrs. Siemens and Halske, Germany).

8,834. O. LINDER and C. V. SWEEVELT. London. An improved system of electric traction.*

May 4, 1895.

8,884. H. J. HEINZE. London. Improvements in and relating to kinetographs, kinetoscopes, kineto-phonographs, kinetophones, and the like.

8,904. C. L. R. E. MENGES. London. Improvements in primary and secondary battery plates.

8,905. C. L. R. E. MENGES. London. Improvements in primary and secondary galvanic batteries.

8,914. A. R. DAVIS. London. Improvements in the preparation of chloride of lead for use in electrical storage batteries and for other purposes.

May 6, 1895.

8,966. H. A. ROWLAND. London. Improvements in meters for measuring currents of electricity, part of the invention being applicable to electric motors for driving astronomical clocks and other like apparatus.

8,967. A. GEUTZSCH and J. N. SCANAVI. London. Improved insulating material for cables and process of making same.*

8,972. W. LAWRENCE. New York. Improvements in electric railways.

8,994. W. JANDUS. London. Improvements in and connected with arc lamps.

May 7, 1895.

9,010. G. E. BAIRD. Manchester. Improvements in electric railways.

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9,050. E. Bailey, T. Cupper, A. L. Stobbs, W. A. Wilson, and J. W. Pollard. London. An improved process for the production of lead compounds or other metallic compounds by electrical means.
9,056. Siemens Bros. and Co. (Limited). London. Safety appliance for electrical circuits. (Messrs. Siemens and Halske, Germany.)*

May 8, 1895.

9,111. C. D. Jansen. London. Improvements in telephonic receivers. (A. Gerbert, France.)
9,112. C. D. Jansen. London. Improvements in the method of and means or apparatus for effecting multiple telephonic communications. (A. Gerbert, France.)
9,132. C. M. Dorman and R. A. Smith. Manchester. Improvements in electric ceiling and wall connectors.*
9,144. G. Binswanger and F. W. Ball. London. Electrical soldering apparatus.
9,146. H. Niewerth and R. Niewerth. London. Improvements in and connected with arc lamps.
9,158. G. F. Redfern. London. An electric light bath. (W. Gebhardt, Germany.)
9,167. J. A. L. Dearlove. London. Improvements relating to telegraphic working through cable lines.
9,176. W. B. Sayers, H. A. Mavor, W. A. Coulson, and S. Mavor. London. Improvements in armatures for dynamo electric machines.

May 9, 1895.

9,180. G. W. Lunn. Oldham. A hand-hoist for raising and lowering arc lamps.
9,184. J. Waddington, E. Waddington, and J. Waddington. Bury. An improved electric motor, called the "Leader" electric motor.
9,202. J. M. Huisman and H. C. Gomer. Glasgow. Improvements in holders for incandescent electric lamps.
9,206. H. W. Handcock and A. H. Dykes. London. An improvement in glow lamps.
9,237. H. Edmunds. London. Improvements in or connected with electric conductors for telephonic or other analogous purposes.

May 10, 1895.

9,257. J. Hargreaves. Farnworth-in-Widnes. Improvements in cells and diaphragms for use in electrolysis.
9,262. A. B. Mees and J. D. Pitt. Brettle-lane. Improvements in incandescent electric lamps.
9,273. J. Taylor. Warrington. Improvements in tubular electromagnets.
9,286. J. Hopkinson. London. Improvements in automatic electric switches and in their use for distribution of electricity, parts of which improvements are applicable to other automatic devices.
9,312. H. Edmunds. London. Improvements in electric conductors or cables.
9,314. H. Lepaute. London. Improvements in electric receivers or mechanism for actuating counting dials or the hands thereof.
,323. L. B. Miller. London. Heating, drying, and smoothing by electricity.

May 11, 1895.

,372. V. G. Middleton and G. Neale. London. An electric oven.
9,375. A. H. Brintnell. London. Improvements in the electric propulsion of cars.*
9,380. E. W. Lloyd (of the firm of Sir W. G. Armstrong, Mitchell and Co., Limited) and R. I. Brankston. London. Improvements in electrical-firing pistols for gun mountings.
9,388. R. E. B. Crompton. London. Improvements in regulating appliances for arc lamps.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

5,391. Aldred. Electric railways and tramways.
6,323. Mordey. Alternating-current indicating apparatus.
6,661. Rorke. Electric switches.
6,850. Ungley. Electric lamp protector.
7,132. Carbonnele. Microphones.
7,176. Carbonelle. Telephonic systems.
7,477. Edmunds. Vulcanising electric conductors.
7,530. Edison and Swan United Electric Light Company (Limited) and Moffatt. Electrical glow lamps.
7,726. Rollason and others. Storage batteries, steam generators, &c.
7,950. Guthrie. Electrolytical apparatus.
8,328. Threlfall (Threlfall). Electric condensers.
8,731. Froggatt. Electric batteries.
9,285. Kellner. Electrodes.
10,101. Binswanger and Gibson. Gripping tool for electric light, &c., fittings.
10,132. Edmondson. Electrical instruments.
10,425. Kingdon. Electrical transformers.
10,978. Goolden and Evershed. Electric measuring instruments.
11,059. Rowland. Varying the phases in polyphase electric currents, &c.
11,136. Wood. Regulating electric distribution systems.
11,225. Bevis and Hirst. Arc lamps.
11,323. Muirhead and Fraser. Telegraph lines and cables.
11,587. Hulin. Electrolytic decomposition of solutions, &c.
12,183. Parker. Electric railways.
12,283. Langen. Electric railways.
12,973. Hampel. Casting electric accumulator plates.
15,414. Warrell. Telephone systems.
15,455. Howes. Telegraphic transmitters.
20,596. Hammacher. Electric accumulators.
22,965. Thompson (Coffin). Electrically heating and welding metals.
22,986. Hubbell. Primary batteries.
23,858. Nalder and others. Measuring electric currents.
24,745. Richards. Electric light ceiling fittings.

1895.

358. Wershoven. Secondary battery electrodes.
1,546. Wright and Piper. Electric switch.
2,031. Siemens Brothers and Co., Limited (Siemens and Halske). Coupling for electromotors.
2,916. Devonshire (Steinmetz). Electric distribution.
2,917. Devonshire (Steinmetz). Electric distribution.
3,085. Jahnsson. Electric gas-lighting devices.
3,779. Albrecht. Arc lamps.
4,160. Lake (Thomson Electric Welding Company). Electric transformers.
4,245. Laura. Galvanic batteries.
4,255. Laura. Battery.
4,485. Langen. Electrically steering ships.
4,557. Pressley. Electric railway.
5,099. Kass. Electric gas lighter.
5,196. Cox. Thermo-electric generators.
5,693. Bergh and Tarbox. Electric railways and tramways.
5,742. Wright. Electric cars.

COMPANIES' MEETINGS AND REPORTS.

Western and Brazilian Telegraph Company (Limited).

The twenty-ninth ordinary general meeting of the Western and Brazilian Telegraph Company (Limited) was held yesterday (Thursday) at Winchester House, Old Broad-street, under the presidency of Mr. W. S. Andrews.

The SECRETARY (Mr. R. M. Cunningham) having read the notice calling the meeting and the minutes of the last meeting, which were approved by the present meeting and signed by the Chairman as correct, the report of the Directors was taken as read.

The CHAIRMAN: I see that we are honoured to-day by the presence of one of the gentler sex, so I must begin by saying—Lady and Gentlemen: The receipts last year amounted to £82,815, against £80,338, or an increase of £2,477. There is a small increase in the international words exchanged—words exchanged between Brazil and foreign countries—and there is a small decrease in the words exchanged within the territory of Brazil itself—that is, what we call internal words. The increase in the international words amounts to some 14 per cent., and the decrease in the internal words was something like 18 per cent.; but notwithstanding this decrease in the internal words exchanged, there is a small augmentation in the amount of the money derived from that traffic. That apparently contradictory, but, at the same time, satisfactory result, arises from the circumstance that the messages were conveyed on an average a greater distance than at the corresponding period, and therefore the product was a little more. There is nothing much to say with regard to the receipts beyond what I have stated. The expenses for last half-year were £36,403, against £35,592, or an increase of £811. As you know, we usually take abstract A and go through it item by item, but in this case two items cover more than the total increase—namely, wages abroad, £789, and maintenance, £353, which would land us already in upwards of £1,000 increase; but as against this increase there are items of decrease—namely, medical, rent, furniture and stationery, aggregating some £400, and therefore reducing the total increase to £995. Under abstract B—ships—there is an apparent total increase of £44; but the expenses under ships are rather larger than they would normally be owing to exceptional and, as we hope, non-recurrent causes. Of course, it would not be worth while to take up your time and practically waste it by talking about an increase of £44; but we take a strong interest in our shipping. We work at it always with the idea of reducing its expense as soon as we can, and therefore we are going to tell you one or two facts as regards the shipping which will no doubt be satisfactory. In truth, the permanent charges of the ships have undergone diminution. For instance, this half-year the ship was 564 more hours at sea, or an increase of 34 per cent. on the work which she had to do in her absence from port. Of course, this additional steaming and working involved a larger expenditure on account of coals, footing up some 873 solid

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sovereigns. Then, another circumstance came into play—namely, that we lost largely in our rebate upon insurance—in other words, if the ships remain in port for a considerable period, we get a rebate on the insurance money we pay. On this occasion, however, the ship was not in port. The ship was at sea, and consequently we found ourselves at sea in this respect—that we could not claim this rebate, and that makes another £441. Altogether, we hope that this increase together of about £1,314 may be exceptional, but we cannot say that it will be, as we may have another bad year. The increase on this occasion was of course owing to natural causes, and therefore causes which are non-controllable. Another incident arose which I must not go into too closely ; but owing to political circumstances we lost the services of an old captain, who was a very able and zealous, and at the same time a skilful officer, who rendered very good work to the Company over a large number of years. This landed us in certain compensation, travelling expenses, and other outlays, which we may deal with, atall events, as an absolutely non-recurrent item of over £700. Therefore, but for bad luck with respect to breaks and the other causes I have mentioned, we should not be £44 to the bad, insignificant as that sum is, but over £2,000 to the good, under abstract B. In other words, you see that our arrangements would have resulted in a further saving, which would have compared very favourably with the corresponding period, but for the facts I have just enumerated. Under abstract C there are four items of increase—rent, stationery, law charges, and so on, with respect to which, by-the-bye, some part will come back, as we have won the case in which they were mainly incurred. There is some increase in furniture, but there are five items of decrease, salaries and wages, office expenses, stationery, freight, and life insurance. The total increase under abstract C, allowing for the decreases, is £227, and I do not propose to labour that. There is one thing with respect to the ships which I desire to mention. We have not thought it wise to write down these ships or to interfere with them. They are laid up, as you know, at the smallest cost. One of them is ready for sea if we can get a charter for her at any moment. As our accounts have gone out to Brazil we thought that any alteration in them would really only complicate and disturb matters, and therefore it was better on all grounds to leave the ships exactly on the same basis as they would appear in what had already gone out to the Brazilian Government. In fact, it was important to preserve the *status quo*, and we think we were right in doing it as far as we could. The outcome of all the figures is that, after deducting debenture interest, £11,601, and placing £5,000 to the debenture redemption, there remains £40,059, from which £8,000 has been placed to the reserve, leaving £32,059 to be dealt with as the net profit of the six months. The Directors are enabled to recommend a dividend of 6s. per share, free of income-tax, which makes, with the dividend paid in November, 3 per cent. for the year. This compares with 2½ per cent. for the year 1893, and leaves a respectable balance of £2,846 to be carried forward to 1895. Considering the loss sustained on exchange by the Western and Brazilian Company and the Platino Company of £19,960 and £11,414—together no less than the very considerable sum of £31,374 for the half-year—we think this result is not unsatisfactory. The fact is, gentlemen, that, as you have been told before, this Company ought to be in a position to satisfy everyone who has invested in it. If only the exchange came right that would be the case. I need not go into the figure of that large sum of money, as you will see that it would give you a very satisfactory increase to your dividend. The one item of exchange, in fact, is the governing factor in your affairs. With a satisfactory exchange the Company would be enabled to give a very gratifying account of its operations. We can only hope that affairs in Brazil will become still more tranquil, and that the commercial activity of the country will increase, as well as its security generally, so that men can get about their work without disturbance. No doubt exchange would then improve, as well as all the surrounding circumstances, and whether we were bought up by the Government, or were not bought up, I should look at the future through not unsanguine spectacles. The next question I have to deal with is that of the action which we reluctantly had to bring against our friends the Brazilian Submarine Company with respect to our claim of some £6,000 a year, and with respect also to a question of considerably more importance than £6,000 a year to us—namely, the question of the control of the tariff, which the Brazilian Submarine Company at that time claimed That was fully gone into at the time. I gave you all the particulars about it, and I daresay you will not want to hear anything more about it, especially when I tell you that the whole of the questions raised have been decided in your favour, with costs. That removes a great source of trouble which we had with our friends, the Brazilian Submarine Company, because we are friends. We are closely allied. We could agree to differ without any display of temper, and the questions raised I have no doubt were raised on the other side conscientiously, and without any desire to take advantage of us in any way ; but, at all events, the result has proved that we were right. No doubt the shareholders remember that we undertook certain obligations—some shares and so on—to secure the establishment of a Pacific and European Telegraph Company. That Company gave us direct telegraphic access to the West Coast of America. Unless we had undertaken certain obligations we should not have succeeded in establishing that undertaking ; but it has now been established, the connection has been made between Buenos Ayres, and Valparaiso, and I am pleased to say that the traffic which this operation has brought to the Company's line has been satisfactory. It continues daily to develop, and wears a very encouraging appearance. You see by the accounts that we take credit for £5,000 as the revenue derived from this traffic during the period the line has been opened. That £5,000 is an estimated figure, and perhaps it is therefore necessary to say that, although it is an estimated figure, it cannot be reduced. The line was actually opened on March 18, 1894. At first the receipts were comparatively small, but the business went on increasing, and I have to congratulate you upon what I believe will turn out to be a decidedly valuable addition to the system of the Company. Now, up to this point, I have been dealing with the business of the concern upon the basis that it is a continuing one, but all of you know that the Government has given the Company notice to acquire the lines under the original concession. The matter was fully gone into at the last meeting, when I think that every explanation was given upon it that could be given, and the shareholders know practically as much as we do with respect to the position. There is, however, certainly a change in the position. At that time, if you remember, I dealt with the whole thing as a mere project. It was talked about, suggested,and there was an idea that an offer would be made,but the Government had no power, and it was a good deal in the clouds. It required to become law that the Government should be fully empowered to proceed further. In pursuance of the intentions of the Government, which evidently have been serious all the way through, application was made for the necessary authority to the legislature of the country, and the latter, after having given full consideration to the case, has passed an Act, which has been duly signed by the President, and it is now the law of the country. Therefore the scheme, or whatever it may be termed, has passed out of the region of projects, and the power to acquire the concern has become part of the law of the United States of Brazil. I did intend to read that paragraph in the report headed "Acts of the Legislative Power," but it is hardly worth while, because you have all had it, and know as much as I do about it. At all events, as you see, a step further, and a valuable step, has been taken, for the Government has actually acquired full authority from the legislature to purchase the undertaking, and, therefore, the negotiations and the arbitration will be in good time begun in Brazil, and we shall here have to await the outcome of that, whatever that outcome may be, with what patience we may. You know that as a rule governments do not move with lightning speed, even in the ordinary affairs which come before them. Matters are generally considered very deliberately, and are not hurried, and it is not likely, I think—this is a matter of personal opinion—that a question of this great magnitude will prove an exception to the rule. What we have done, of course, has been to take into counsel the best expert opinions we could get. We have had the case thoroughly examined. We have had reports from people competent to give them upon the value to be attached to the property, and indeed the case has been thoroughly and exhaustively examined from every point of view. We do hope and trust that these exertions of ours and others, and the careful examination that has been given to the case, may not prove unavailing when the time comes for consideration, discussion, and settlement. I do not think I need trouble this meeting any further, but after putting the motion for the adoption of the report I will await any observation which may be made. At the same time, if you will allow me, I would venture to suggest that we are still in the stage of negotiation—almost incipient negotiation—and remarks directed to the purchase question are, perhaps, a little to be deprecated. I now beg to move—

"That the report and accounts to December 31, 1894, be and are hereby approved and adopted, and that a dividend of 6s. per share, free of income-tax, making, with the interim dividend paid in November last, £3 per cent. for the year 1894, be and is hereby declared payable on the 24th inst."

Mr. C. W. EARLE seconded the motion.

The CHAIRMAN : The resolution has been moved and seconded, but before I put it to the meeting I will take my seat, in order to listen if you have any observation to make or question to put. After a pause, and no shareholder rising to speak, he continued : Gentlemen, I am very pleased to gather from the silence which prevails at the meeting that the Board have the confidence of the shareholders, and they have always tried steadily to gain it and to keep it. He then put the motion in the usual way, and, having declared it carried unanimously, said: It is now my duty to retire from this dignified position, and one of the Directors will take it for me.

Mr. EARLE then took the chair, and proposed the re-election as a Director of Mr. Andrews. The shareholders had, he remarked, so often heard Andrews' very clear and business-like statements at their meetings that he (the speaker) need not say a word respecting their Chairman's ability. When, too, it was remembered that Mr. Andrews was perhaps the most experienced gentleman in existence in the administration of telegraph companies, having been connected with them almost all his life with great success, he thought that there would be no opposition to the resolution.

Lord RICHARD H. BROWNE seconded the motion, which was carried unanimously.

The CHAIRMAN then resumed his former seat, and after thanking the shareholders for re-electing him, proposed the re-appointment of Mr. D. H. Goodsall.

Mr. JOHN COPPEN seconded the motion, which was carried unanimously.

A discussion then arose as to the re-appointment of auditors. For many years Messrs. Turquand, Youngs, Bishop and Clarke were the auditors to the Company. A short time back Messrs. Deloitte, Dever, Griffiths and Co. were appointed to act with Messrs Turquands. These firms jointly pointed out that the rate of remuneration for the Company's audit was inadequate, and Messrs. Deloitte offered to resign in favour of Messrs. Turquands, the original auditors for the Company. This offer was accepted, Messrs. Deloitte being thanked for their efficient services. Finally Messrs. Turquands were appointed auditors to the Company at a remuneration of 100 guineas per annum.

Major COTTON proposed a vote of thanks to the Chairman for his conduct in the chair, to the Directors, and to the Managing Director, Secretary, and staff for their services in the past half-year.

Mr. FROST seconded the motion, which was carried unanimously.

The CHAIRMAN returned thanks on behalf of the Directors and the officers, and the proceedings then terminated.

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West India and Panama Telegraph Company (Limited).

The thirty-sixth ordinary general meeting of the members of this Company was held at Winchester House, Old Broad-street, on Wednesday, Mr. C. W. Earle in the chair.

The SECRETARY (Mr. R. T. Brown) read the notice calling the meeting and the minutes of the last meeting, and the report of the Directors was taken as read.

The CHAIRMAN: I am sorry to say that the report is the least satisfactory in its results of any that we have had to make to you since 1882, and I do not know to which side of this table more sympathy is due —whether to us or you—to you for the long-continued self-denial displayed by you in restoring this Company to the position of credit it now enjoys, or to ourselves, who are disheartened by finding the poor dividend we have been in the habit of giving you vanishing, and that all the labour and all the thought that have been devoted to making this service a really good and substantial one have been almost fruitless as regards the ordinary shareholders. The only consolation that we have is that the causes of this unfortunate position of things are entirely beyond our control. At our last meeting I alluded to one or two of these causes—principally the decline of business in the West Indies and the decline in the value of sugar, which really seems to guide our receipts. When sugar goes up we get more traffic; when it goes down, as it has done persistently for a great many years now, there is a decline. The other day there was a little spurt in sugar, and you might have seen by the returns that there was at once an improvement in the traffic. Another influence which I referred to was the increase in the skill of using the codes by the merchants. That skill has gone on slightly increasing during the year 1894. In 1869, when this Company was first started, and obtained its Acts from the Colonial Governments, it was laid down in the rules for the tariffs that the minimum message should be 20 words, and it was only in deference to the growing custom among telegraph companies all over the world that we introduced the word rate some 18 years ago. By the introduction of that word rate the merchant, instead of having to send and pay for 20 words, now forwards an average message of about 7·25 words, showing what an immense advantage, in comparison with the original conceptions of this undertaking, the merchants in the West Indies are gaining. The decline in the traffic amounts, as the report states, to about £2,000, in comparison with that of the corresponding period of the previous year, and there has not been a single station cut off during the whole of the half-year under review. The whole of that loss was therefore attributable to the decline of business in the West Indies. Looking to our accounts, there is not, as usual, very much to remark on the expenditure side. There are slight variations in some of the items, but I hardly think it is worth while taking up your time by referring to them. They are very small. In abstract A there is an increase in the expenses, owing to the variations in some of the salaries, of £40; and in abstract B there is an increase of £45 from the same cause. The whole of the expenditure is £1,011 more than it was in the corresponding period of the previous year, of which £952 is due to the items under abstract C. These are influenced by circumstances over which we have not the slightest control. The winds and waves in the West India seas have not this half-year been very much "tempered to the shorn lamb" of our Company. Looking at the credit side of the revenue account, we have received £1,022 less than in the December half of 1893; and to sum up the result of all these variations, we find that, with £1,022 less receipts and £1,011 more expenses, we have less by £2,033 than in the corresponding period of the previous year. If we had had that £2,033 we should, of course, have been able to pay you a dividend of 6d. on the Ordinary shares. I daresay you would like to hear something about the prospects of the current half-year. Well, the traffics are slightly diminished, but very slightly. The expenditure on the cables will not, I hope, be very great. At the same time, as we announce in the report, we lose the £2,000 a year hitherto paid us by the Island of Guadeloupe. Our prospects, therefore, are not, on the whole, very bright. It is rather curious that while this diminution of revenue is going on, and the difficulties we are going through, are apparent to everyone, meetings are being held in the principal Colonies of the West Indies, who are passing resolutions calling on their Governors to put pressure on the Secretary to the Colonies to subsidise, at the cost of the English taxpayer, a single line of cable running to the middle of our system, and to reduce the rate to about 3s. per word to the West Indies. I do not know whether there is much chance of these proposals being adopted by the Secretary to the Colonies, or whether Parliament will grant him a subsidy to relieve the West India merchant from the expenses of his business; but when one remembers that our system was duplicated by the pressure, the entreaties—I might almost say the threats—of these West India Colonies, to give them a reliable system without interruption—which no single cable can give—it does seem to me rather hard that they should agitate now for a single cable. A single cable, as long as it is working, can work for much less than a duplicate system, because the capital, mile per mile, is only half, especially in a system like ours, where the traffic does not occupy the cables except for part of the day, they remaining idle for the rest of the 24 hours. I do not fear that this movement will have much effect here; but we must always be prepared for some surprise of this sort. One of the reasons advanced for this measure is to have cables passing through exclusively British possessions. It is supposed that in a great war these cables which only land on British Colonies will be free from the attacks of the Power we are at war with. It is only in the event of a great naval war that these tactical cables would be of any special use; but I say that directly we have a great war all cables will be torn up by the enemy. Is it likely, if we were at war with France—which heaven forbid!—France would allow us to have our cables working peacefully, when a harbour tug could go and pull them to pieces in a night? It would, therefore, be waste of the taxpayers' money to subsidise a tactical cable where you have our commercial cables doing the work already. If any of you have any questions to ask I shall be very happy to do my best to answer them. I now propose—

"That the Directors' report and accounts to December 31, 1894, submitted to this meeting be, and the same are hereby received and adopted, and that, as recommended by the Board, dividends of 6s. per share on the First Preference shares, and 6s. per share on the Second Preference shares be and the same are hereby declared."

Mr. WILLIAM ANDREWS seconded the motion.

Mr. DYETT asked whether there was any chance of any reduction in the expenses and in the Directors' fees, as he saw no other hope of the Ordinary shareholders receiving anything.

Mr. W. GRIFFITH said that they must agree that the report was not very exhilarating. Circumstances had been against them, and it was difficult to see what could be done in the future. A reduction of expenses would produce a little, but he thought that they had an equitable claim on the Governments of the Colonies, which the latter did not consider. The Company gave them a very useful service and provided them with news, for which they got only a wretched return. They might not be able to compete with foreign Governments, but at the same time it was possible that the cable of a private company did its business better than a cable which was under the control of the French Government. He agreed with the statement in the report that "the duty of maintaining an efficient service, and of fulfilling the unprecedented obligation of providing news to the Colonies is one that, in existing conditions, it is impossible to perform." The only thing they could do at the present moment was to rest on their oars. They ought not to be very prompt in spending money in making repairs or in providing news. If they could reduce their expenses in this way the Colonies would have to thank themselves for the less efficient service received by them. The Company had done their duty, but had not been paid for it, and the Colonies must put up with any inconvenience which might arise from a more dilatory service.

The CHAIRMAN said he did not see his way to reducing the expenses further, for they were already reduced to as low a point as possible. He would not say all that he knew might happen in connection with Mr. Griffith's recommendations. The first thing would be the stoppage of their subsidies, which would put them in a worse position than they were in at present. He did not think there was any other course but to go on maintaining the service. If they were not to repair their cables when they were broken they would be practically leaving the thing to be picked up by other people. He did not for his own part see that there was any solution of their difficulties in Mr. Griffith's advice. To refuse to spend any more money on the concern would be to destroy the foundation of the whole enterprise, and he did not think they would get anything out of it. With regard to the remarks about the Directors' fees, if any one would take his place he would be glad to give his successor his salary.

Mr. DYETT stated that in abstract A the item of salaries appeared as £1,040, while in abstract B there was an item of "salaries and wages" £6,154. These sums amounted to £7,000 odd, which was a good deal.

The CHAIRMAN stated that abstract A referred to London and abstract B to the 21 stations abroad; and having skilled operators in the tropics was expensive. He ventured to say that there was no telegraph company which so closely watched its expenditure as this Company did.

Mr. GRIFFITH desired to state that he had not proposed the extreme course of not repairing their cables at all; he had suggested that they should take their time about it. There were two steamers, and one was sufficient to effect all their repairs.

The CHAIRMAN remarked that that was fortunately the case last half-year.

Mr. GRIFFITH desired to know whether they could get rid of one steamer, by which, he said, a large amount would be saved.

The CHAIRMAN replied that the second steamer, "Duchess of Marlborough," cost the Company only about £400 a year, as she is lying up in dock in London, instead of about £7,000 a year when in commission. They had thought about this matter fully, and they must have a second steamer in port ready to proceed abroad on the return home of the other steamer. Unless they were in a position to repair their cables when they broke the subsidies would stop. In further reply to Mr. Douglas J. Patterson and Mr. Richardson, who also criticised the expenses, and suggested the retention of one steamer only, the Chairman stated that the main object of the reserve fund was to meet repairs and renewals. The reserve fund was calculated upon the basis of the "life" of a cable, which they estimated at 30 years; and if they dipped into this reserve now for their repairs they would leave themselves without a reserve at all when the cables had to be renewed throughout. He quite sympathised with the position of the Ordinary shareholders. The idea that they had a vessel which was kept as a pleasure yacht was an absolute delusion. The "Duchess of Marlborough" was available in case of any great disaster to their cables requiring the services of two ships, or whenever the other ship had to come home.

Mr. JOHN NEWTON agreed that the Ordinary shareholders' case was very much to be pitied, but it was the Ordinary shareholders' lot to have to bear the brunt of the misfortunes of a company. In the early days of this Company the shareholders were asked to provide Preference capital on certain conditions, and they did so. For the past 20 years the Directors had had the care of the Company, and they had brought it from a worse position than it was in now, for a sufficient reserve fund had been formed for preserving the *corpus* of the Company. Without the reserve fund the Ordinary shares would not be worth 1s. in the market, and the Preference shares would be quoted at a considerable discount also. He was convinced that the greatest economy had been practised by the Directors, and the Ordinary shareholders could not mend their position by reducing the

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remuneration of the Directors upon present circumstances. He also thought that the question of whether one or two cable repairing ships should be kept was purely one of administration; and the Directors must know best what was necessary for protecting the Company. They must protect their Debenture and Preference capital, or their undertaking would be nowhere.

Mr. PATTERSON: The debenture holders and the First and Second Preference shareholders are very well cared for.

Mr. NEWTON: That is exactly why they subscribed their money. Unless they had that protection they would not have subscribed at all.

Mr. CHAMBERLAIN said he would be very glad to have a dividend on his Ordinary shares, but he would be extremely sorry if the Directors were to tamper with the reserve fund in order to declare a dividend for a single year.

The CHAIRMAN repeated that the Directors had come to the decision that it was advisable for them to have a second ship, for the reasons he had already stated. If anything happened to the ship that was away and they had not a second ship to send out to replace her, they would have to charter a vessel so as to keep up the system and maintain their revenue. He then put the motion, and declared it carried with five dissentients. Resolutions were afterwards passed re-electing Mr. Henry Holmes to his seat at the Board and reappointing the auditors, Messrs. Deloitte, Dever, Griffiths and Co.

Mr. CHAMBERLAIN then proposed a vote of thanks to the Chairman and Directors. It was, he said, very unpleasant to have money invested and to receive no return on it, but it was extremely hard also for those who had the conduct of affairs—the Directors—to feel that things were beyond their control, and that it was perfectly impossible to get in a revenue which would enable them to declare a dividend.

Mr. JOHN NEWTON seconded the motion, and expressed his belief that the Directors had done all they could.

The resolution was agreed to.

The CHAIRMAN briefly acknowledged the vote, and the proceedings then terminated.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1895, pages *304-332, &c. &c.*]

HARRINGTON ELECTRIC LIGHT COMPANY (LIMITED).—This Company was registered on May 18th, with a capital of £3,000, in £1 shares, to carry into effect an agreement made between W. A. Whiteley and George Fletcher, of Long Eaton, Derbyshire, to carry on the business of an electric light company in all its branches, to construct, lay down, establish, fix cables, wires, lines, accumulators, lamps and works necessary for the same; and to carry on the business of electricians, mechanical and electrical engineers, suppliers of electricity for the purposes of light, heat, motive power, or otherwise, and manufacturers of and dealers in electrical apparatus of all descriptions. The first Directors are:—T. Pegg, W. Thurman, E. Dalby, G. Fletcher, and W. A. Whiteley.

BRITISH ELECTRIC LIGHT COMPANY (LIMITED).—The annual return of this Company to December 31st has been filed; 8,641 shares have been taken up out of a capital of £100,000, in £10 shares, and 1,145 have been issued as fully paid. The full amount has been called and paid on the remaining 7,496 shares.

BRITISH INSULATED WIRE COMPANY (LIMITED).—The annual return of this Company to March 27th has just been filed. The nominal capital is £110,000, divided into 300 Founders', 3,950 Preference, 9,450 Ordinary "A," and 8,300 Ordinary "B" shares of £5 each; 298 Founders', 3,720 Preference, 6,962 Ordinary "A" and 8,053 Ordinary "B" shares have been taken up, of which 219 Founders', 975 Preference, 575 Ordinary "A" and all the Ordinary "B" shares have been issued as fully paid. The full amount has been called on the remaining 79 Founders', 2,745 Preference, and 6,377 Ordinary "A" shares, and £46,270 has been paid.

CHAMBERLAIN AND HOOKHAM (LIMITED).—The annual return of this Company to April 17th has been filed; 1,000 "A" and 5,000 "B" shares have been taken up out of a capital of £100,000, in equal numbers of "A" and "B" shares of £10 each, and the "B" shares have been considered as fully paid; £3. 10s. per share has been paid on the "A" shares.

CHELSEA ELECTRICITY SUPPLY COMPANY (LIMITED).—The annual return of this Company, to March 19th, has been filed. The nominal capital is £100,500, divided into 14,000 Ordinary and 6,000 Preference shares of £5 each, and 500 Founders' shares of £1 each; 10,277 Ordinary, all the Preference, and all the Founders' shares have been taken up; 6,666 of the Ordinary and the Founders' shares have been issued as fully paid. The full amount has been called on the Preference and the remaining 3,611 Ordinary shares, resulting in the payment of £48,055.

COLLIER-MARR TELEPHONE AND ELECTRICAL MANUFACTURING COMPANY (LIMITED).—The annual return of this Company to January 17th has been filed. The nominal capital is £100,000, in £10 shares, and 4,592 of these have been issued as fully paid. In addition, 935 have been subscribed for and allotted, and the full amount has been called, resulting in the receipt of £9,155. £175 has been paid in respect of 88 forfeited shares.

CORLETT ELECTRICAL ENGINEERING COMPANY (LIMITED).—The annual return of this Company to May 13th has been filed. Out of a nominal capital of £10,000, in £10 shares, 620 have been taken up. 100 of these have been issued as fully paid, and the full amount has been called and paid on the remaining 520 shares.

CROMPTON ELECTRIC SUPPLY COMPANY OF AUSTRALIA (LIMITED).—The annual return of this Company to February 7th has been filed. The nominal capital of £50,000 is divided into 9,500 "A" and 500 "B" shares of £5 each; 3,115 "A" and all the "B" shares have been taken up, and the latter have been issued as fully paid. The full amount has been called on the "A" shares.

CROMPTON-HOWELL ELECTRICAL STORAGE COMPANY (LIMITED).—The annual return of this Company to May 10th has been filed. The nominal capital is £19,600, divided into 19,000 Ordinary shares of £1 each, and six Founders' shares of £100 each; 12,007 of the Ordinary and all the Founders' shares have been taken up and the latter have been issued as fully paid, while 8,000 Ordinary shares are considered as having 15s. per share paid; 16s. per share has been called on 4,007 Ordinary, and 1s. per share on 8,000 Ordinary, resulting in the receipt of £3,605.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The annual return of this Company to April 12th has been filed. The nominal capital is £95,000, divided into 13,000 Ordinary and 6,000 Preference shares of £5 each; 12,931 of the former and all of the latter have been subscribed for and allotted, and the full amount is called.

DOMINION ELECTRICAL COMPANY (LIMITED).—Mr. H. F. Jackson, electrician, who was the largest shareholder in this Company, has asked that the name of the concern may be struck off the register, as it is now doing no business.

CITY NOTES.

BLAKE AND KNOWLES STEAM PUMP WORKS (LIMITED).—Notice is given of the drawing of 100 debentures of £100 each of this Company, which will be repaid on or after July 1st next, together with interest up to that date, either at the offices of the Trustees, Executors, and Securities Insurance Corporation (Limited), Winchester House, Old Broad-street, E.C., or at the Company's head offices, 95, Liberty-street, New York.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended May 19th were £905, as against £907 in the corresponding period of 1894, being a decrease of £2. The total receipts for the half-year amount to £18,720, against £18,213 for the corresponding period of 1894, an increase of £507.

HASTINGS AND ST. LEONARDS-ON-SEA ELECTRIC LIGHT COMPANY (LIMITED).—The annual report of the Directors of the above Company is issued. Although the Directors are unable to declare a dividend, they consider the Company to be in a sound financial position, the amount earned during the past year being £6,641, against £5,390 in 1894. Considerable expense has been incurred in the purchase of additional premises and new machinery. Owing to the change of electric supply from the high-tension direct-current system to the alterating high-tension transformer system, considerable outlay had to be incurred in alterations of conductors, fittings, &c., and this outlay had to be charged to the revenue account. The Directors, finding that installation work was not remunerative, have abandoned it and sold the stock-in-trade, and for the future intend to devote their efforts to the supply of current only. It is announced that a large reduction in the cost of current will shortly be made to large consumers.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic returns of this railway for the week ended the 19th inst. amounted to £1,141. The amount for the corresponding week last year (Whit week) was £1,282.

REUTER'S TELEGRAM COMPANY (LIMITED).—The following is the report of the Directors of this Company for the year ended December 31st last, to be submitted to the thirty-first ordinary general meeting, to be held at 24, Old Jewry, London, E.C., on Wednesday, the 29th inst., at 12 o'clock:—"The net profits from the telegraphic business for the year ended December 31st last, after payment of current expenses and deducting rebate on unexpired subscriptions, amount to £4,485. 15s. 9d. After deducting the sum standing to the debit of profit and loss account from the previous year, there remains a credit balance of £1,718. 16s. 5d., which is carried forward. The results would have been much more satisfactory but for the heavy expenditure entailed by the war between Japan and China. Although the Directors are unable to declare a dividend, shareholders will see from the figures for last year that the business of the Company is sound. Baron de Reuter seeks re-election as Director, as do the auditors, Messrs. Welton, Jones and Co."

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have ordered the following securities to be quoted in the Official List:—89,261 "A" shares (Nos. 1 to 89,261) and £100,000 Four and a-Half per Cent. Debenture Stock of the Edison and Swan United Electric Light Company (Limited), in lieu of the shares of the Swan United Electric Light Company (Limited), now quoted; and 3,000 Seven per Cent. Preference Shares (Nos. 1 to 3,000) and £60,000 Four and a-Half per Cent. Mortgage Debenture Stock of W. T. Henley's Telegraph Works Company (Limited).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended May 17th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,584.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the half-month ended May 15th were £2,794, as compared with £2,510 in the corresponding period of 1894.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name.	Previous Week's Price, May 15.		Price Wednesday, May 22.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 22. Highest	Lowest
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	10/0	Anglo-American	47	49	46	48	4 3 4	Jan., Apr., July, Oct.	47½	46½
£2,993,560	Stock	20/0	Do. Preferred	85	86	84½	85½	4 14 2	,, ,,	85¾	84¾
£2,993,560	Stock	5/0	Do. Deferred	8½	9	8¼	8¾	..	,, ,,	8⅞	8⅝
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 17 1	January and July	..	–
130,000	£10	3/0	Brazilian Submarine	12½	13	12½	13	5 0 0	Mar., June, Oct., Dec.	13	12⅝
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 8 6	June and December	..	–
10,000,000	$100	7%	Commercial Cable Capital Stock	150	154	154	158	4 8 7	Jan., Apr., July, Oct.	..	–
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	,, ,,	..	–
12,931	5	2/0	Direct Spanish (fully paid)	3½	4½	3½	4½	4 8 11	April and October ..	..	–
6,000	5	10%	Do. Preference 10 per Cent.	9¼	10¼	9¾	10¼	4 7 7	,, ,,	–	–
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	105%	108%	105%	108%	4 3 4	..	–	–
60,710	20	2/0	Direct United States Cable, 1877	9¼	9¾	9¼	9¾	4 0 5	Jan., Apr., July, Oct.	9½	..
400,000	10	2/6	Eastern	16½	16½	16½	16½	3 18 9	,, ,,	16½	16¼
70,000	10	6%	Do. 6 per Cent. Preference	17¼	17¾	17¼	17¾	3 7 7	,, ,,	17½	17⅜
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	123	126	123	126	3 3 6	May and November	123	–
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	109	106	109	4 11 11	February & August	..	–
250,000	10	6/6	Eastern Extension	16⅞	17⅛	16⅞	17⅛	4 7 7	Jan., Apr., July, Oct.	17⅛	16⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	124	127	124	127	3 3 0	February & August	125¾	–
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	105	108	104	108	4 14 1	January and July ..	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	105	108	104	108	4 14 1	,, ,,	..	–
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	107	110	107	110	3 13 5	February & August	109½	107½
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	110%	114%	111%	114%	3 10 2	May and November	112½	–
180,227	10	2/3	Globe Telegraph and Trust	10	10¼	10	10¼	3 12 0	Jan., Apr., July, Oct.	10 3/16	10
180,042	10	6%	Do. 6 per Cent. Preference	16⅞	17⅛	16⅞	17⅛	3 10 0	,, ,,	17⅛	16⅞
150,000	10	7/2	Great Northern	21¾	22¼	21¾	22¼	3 15 7	Jan., April, and July	21⅞	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	..	–
17,000	25	37/6	Indo-European	47	49	44	47	5 6 5	May and November	–	..
37,548	10	2/6	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	–
£100,000	100	6%	* Do. 6 per Cent. Debentures	106	110	106	110	5 10 1	March & September	106½	–
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	106	109	106	109	3 14 9	..	..	–
11,839	8	4/0	Reuter's	3½	4½	3½	4½	..	April and October ..	..	–
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	123	128	123	128	4 13 9	,, ,,	..	–
15,609	10	5/0	West African Telegraph	4	5	4½	5½	..	January and July ..	..	–
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	102	105	102	105	4 16 2	March & September	..	–
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	1½	–
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	104	99	104	7 13 10	June and December	..	–
88,321	10	6d.	West India and Panama	⅞	1⅛	¾	1	..	..	1⅛	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	11	11½	10¾	11¼	5 6 8	May and November	11	10¾
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	9⅝	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110	113	110	113	4 10 1	June and December	112	110½
64,242	15	3/0	Western and Brazilian	10	10½	10½	11	4 15 7	May and November	10½	10
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	–	6 9/16	6 3/16
33,129	7½	4/6	Do. 5 per Cent. Deferred	4	4½	4¼	4¾	..	..	4½	4½
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	102	106	103	107	5 13 9	February & August	105	–
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	102	106	103	107	5 13 9	,, ,,	..	–
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	5 18 8	May and November	..	–
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	101	103	101	103	5 18 3	March & September	..	–
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	–	..	..	..
224,850	10/0	2⅔d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	–	May and November	..	–
171,504	£1	8·215d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	–	Yearly	..	–
484,597	5	2/6	National	5¼	5¾	5⅜	5⅝	4 8 11	June and December	5⅝	5⅜
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15½	16½	15½	16½	3 12 9	,, ,,	15 15/16	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½	15½	14½	15½	3 17 5	,, ,,	15⅝	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅞	6⅛	5⅞	6⅛	4 1 8	–	5⅞	..
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	104	106	3 6 0	January and July ..	105½	..
58,000	5	1/0	United River Plate	1	2	1	2	..	,, ,,	..	–
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	85	90	85	90	5 9 11	,, ,,	..	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	14½	15½	14	15	1 13 4	–	14¾	14 1/16
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15½	15¾	15½	16	3 15 0	..	15⅞	15 11/16
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	–	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	–		..		..	–	..	–
8,322	£5	..	House-to-House Electric	–		..		..	–	..	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	–		..		..	..	..	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July –	–	–
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7½	7¾	7½	7¾	..	–	..	–
111,000	5	..	London Electric Supply	–		..		..	–	..	–
49,900	£10	6/0	Metropolitan Electric Supply (fully paid) xd	10¼	10¾	10½	11	2 14 7	..	10 13/16	10⅝
£150,000	Stock	4½%	* Do. 4½% Debs.	118	120	118	120	3 16 3	June and December	..	–
6,452	£10	2/0	Notting Hill Electric	7½	8	7½	8	..	..	..	..
19,980	£5	4/6	St. James and Pall Mall	8¼	8¾	8¼	8¾	..	..	8 9/16	8½
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9¼	8¾	9¼	3 15 8	–	9⅛	..
59,900	5	5%	Westminster Electric Supply (fully paid)	7¾	8¼	7¾	8¼	3 2 6	–	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅜	2⅝	2⅜	2⅝	5 14 3	–	2½	2⅜
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2¼	2½	4 16 0	–	2½	2 7/16
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	113	116	113	116	3 18 7	March & September	..	–
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2½	3	2½	3	–	January and July –	..	–
12,139	5	–	Edison and Swan United	1⅝	1⅞	1¾	2	–	..	–	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	–		–		–	..	–	..
120,000	2	..	Electric Construction	½	¾	½	¾	–	..	..	–
12,845	2	2/9½	Do. 7 per Cent. Cumulative Pref.	1½	2	1½	2	–	..	1¾	..
91,195	2	10/0	Elmore's Patent Copper Depositing	⅞	1⅛	1	1¼	–	..	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	February & August	22	21⅝
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	101	103	101	103	4 8 0	March & September	..	–
15,995	£10	..	International Okonite Ordinary	..		..		..	–	..	..
16,000	£10	..	Do. 8 per Cent. Preference	..		–		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	–	⅛	–	⅛	..	..	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	40	42	41	43	5 11 7	March and July...	41	40½
£150,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4 11 9	January and July	..	..
37,514	£5	–	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,870	10	12/0	W. T. Henley's Telegraph Works Ordinary	9½	10½	10	11	5 8 1	..	10½	..
£30,000	10	..	Do. Preference	..		..		..	..	..	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1½%	City and South London Railway	45	47	45	47	2 13 2	May and November	–	..
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	..	–
£67,130	Stock	4%	Do. 4% Perpetual Debenture xd	131	133	131	133	3 0 2	May and November	..	..
37,500	£10	2%	Liverpool Overhead Railway	9	9½	9½	9¾	2 1 0	..	..	..
6,295	10	5%	Do. 5% Preference	14	14½	14¾	15¼	3 5 7	..	–	..
125,000	Stock	4%	Do. 4% Debenture	110	112	111	113	3 10 2	January and July –	–	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 889. [No. 5. Vol. XXXV.] FRIDAY, MAY 31, 1895. PRICE SIXPENCE.

NOTES.

A DISTINGUISHED diplomatist is stated to have given his valet strict orders never to disturb his diplomatic slumbers before 8 a.m. for anything short of a revolution. He was in consequence only once in his life up before eight. We are afraid it would fare exceedingly ill in this respect with any central station engineer or electric-light "undertaker" who should give orders never to be called before 8 a.m. for anything less than a new Board of Trade regulation. In another column we print the new rules for securing the safety of the public which have just been sent round to central station engineers and others for the purpose of eliciting any comments they may have to make. We trust the receivers of the latest official productions will tell the Board of Trade exactly what they think of them, and that both the Electrical Trades Section and the Council of the Institution of Electrical Engineers will do likewise. No good can come of futile grumbling. Much good might come of a round-table conference after the manner of that which brought about so many useful emendations to the original Board of Trade Electric Traction Rules. It is impossible that any official, however well qualified, should be able, without actual experience, to properly realise what is and what is not important, what is and what is not, humanly speaking, possible in the management and working of a modern electric lighting undertaking. Before the draft regulations become Board of Trade law, let the rulers and the ruled take friendly counsel together, and it will in all probability be found that the points of difference between them are neither so numerous nor so serious as was supposed.

THE Report of the Photometric Standards Committee, embodying the result of three years' careful investigation, has just been issued, and the recommendations they make with regard to a standard source of light may be confidently accepted as giving the best solution at present possible of this much-discussed problem. Their conclusions are in the direction in which general practice has been tending for some years past, namely, the adoption of a 10-candle standard produced by some form of flame. A portion of the luminous surface is all that is utilised, just as in the Methven standard, and the gas used in the burner is reduced to a constant luminiferous power by passing it, as in the Vernon Harcourt's standard, over the surface of liquid pentane before consumption in the burner. The height of the flame is adjusted to a fixed mark, although slight variations in this are not found to be important, owing to the fact that the area of the exposed part of the flame is quite constant. The form of instrument adopted is a 10-candle pentane argand burner designed by Mr. W. J. DIBDIN in 1886. The Committee have satisfied themselves that these burners can be reproduced in any quantities with sufficient agreement among themselves, and also that, as specified, the standard will give out light which is ten times the equivalent of the standard candle legally recognised for the last 35 years. One recommendation of special importance to the gas companies is that the illuminating power of coal gas shall be calculated, not as at present from the candle-power of a standard argand burner when burning the gas at a given rate, but from the rate of consuming gas when the burner is giving out a specified candle-power.

THE claims of an electrical standard of light have been considered and found wanting. The reasons are not stated, but probably the gradual change of the filament of a glow lamp with time formed the chief obstacle to its adoption. This alteration can be rendered small by under-running the lamp, but then the light given out is too red to be suitable as a standard. In any case the complication involved in the supply of electricity, adjusted, as it has to be, with the aid of a subsidiary electrical instrument, is almost enough to justify the recommendation of the Committee. The Dibdin standard is much more convenient, and is self-contained. It is possible to specify it completely, so that it can be exactly reproduced. With a glow lamp, on the other hand, the manufacture of the filament is not sufficiently under control, and its use as a primary standard appears impracticable, though it serves admirably as a secondary one.

MESSRS. HOUSTON and KENNELLY communicate this week a most useful contribution to the theory of permanent magnets. They show that there exists a factor of safety for magnets, by aid of which, in connection with the dimensions and quality of the steel, it is possible to state the degree of permanence of any particular magnet. They show how to calculate the demagnetising force due to the poles, and to compare it with the forward magnetising force, due to the induction density, determinable from the B-H curve for the particular steel of which the magnet is composed. The ratio of the latter force to the former they call the factor of safety, and experience shows that this should be at least 3 for

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really good permanent magnets, and which, for the magnets of the well-known Weston instruments, amounts to as much as 6.

As the authors were beyond the reach of "proofs", we have printed their article in all its symbolic splendour and nomenclatural novelty. Every individual is, of course, entitled to have his own opinion as to the relative merits of "block" and "black" letters; but the use of "block" letters having become well established in this country, where modern Magnetism took its growth, we may be pardoned for refusing to countenance any further this anarchic tendency of every new writer on magnetic subjects to employ whatever symbols and terms seem good in his own eyes. The strange names which Messrs. Houston and Kennelly employ for the numerous magnetic units they refer to are quite unnecessary additions to the jargon of science, already sufficiently irritating, and they possess neither the sanction of authoritative nor of international usage, notwithstanding their adoption by the American Institute of Electrical Engineers. The hasty introduction of superfluous names and terms cannot be too strongly deprecated, both in the interest of science and of sense.

The word "gauss" has already been used for several different units; but never before, we believe, has it been employed in the same Paper with two distinct meanings. The authors employ it for both the unit of **H** and the unit of **B**. We venture to regard these two quantities as being as distinct from one another as amperes are from volts. While **B** is, perhaps, the magnetic quantity which can most easily be measured under all circumstances, **H**, on the other hand, is, we venture to think, the magnetic quantity which never has been directly measured. It has been calculated from the magnetising current, and has been determined from the mechanical force exerted on magnets suspended in air, or from the density of lines of force produced in air; but when we have to deal with a solid magnetic medium, there is no means, direct or indirect, of determining **H** at any particular point. All that is possible is to measure the magnetising current, and to calculate, by means of assumptions, an average value of **H**. It is convenient to adopt as our unit of **H** that magnetic force which will produce unit induction density **B** in air; but we have no right to regard the units of **H** and **B** as the same on this account. We might as well regard the volt and the ampere as identical, because the former produces the latter through a wire of unit resistance.

Our English dynamo designers will probably require additional information before they will be prepared to recognise the utility of Prof. Ryan's formulæ as to the heating of armatures, which we publish in another column. When the rise of temperature of any part of a dynamo is discussed, it is usually understood to mean its final rise in continuous working, or after a run of at least six hours at full load. But when Prof. Ryan comes to apply his formulæ to standard Edison machines he works out the rise of temperature for a two-hours' run at full load. The temperature of a 175-kilowatt dynamo after so short a run possesses little interest, since even a 50-kilowatt machine will continue to store up heat for over six hours. But it is of interest to note that 75°C. or 135°F. is regarded as a normal rise for the two-pole drum armature; a table is even given in the complete Paper on the assumption that this rise is attained after a two-hours' run. Does the American variety of dynamo permit of such a rise with impunity, while the English consulting engineer in our more equable climate usually specifies a maximum of 70°F. after six hours in full work? Again, a standard peripheral speed of about 3,000ft. per minute is assumed, whereas our predilection for direct-coupled dynamos leads to a large number of cases in which the surface speed is much less. A really satisfactory basis on which to estimate the cooling surface of armatures of different design and to allow for different speeds of rotation is, in fact, still to seek. Finally, the amount of the eddy-current loss in the core and winding is summarily disposed of by Prof. Ryan with the statement that it produces a rise ranging from 20°C. to 40°C. in the armatures under consideration. Yet if the formulæ and the conclusions thence deduced are to be of general use and validity, the width of the conductors and the question of whether they are solid or stranded are factors of such importance that they must be taken into reckoning. The proportion which the hysteresis and eddy-current losses bear to the loss by copper resistance will vary greatly in large and small dynamos, and even in machines of the same output at different voltages.

But though the theoretical starting point of Prof. Ryan may be questioned, the practical outcome of his Paper may be followed with advantage. It is to advocate short multipolar armatures of large diameter, in which the end-connections act efficiently as fans to carry off the heat from the winding and body of the core. Such a design is the natural complement of any method by which the sparking limit is raised, and Prof. Ryan's Paper, of which we recently gave a reprint, shows the direction in which he finds a solution to this latter problem.

Cable Interruptions and Repairs.—There are no interruptions or repairs to submarine cables to report this week.

Obituary.—A Reuter telegram from Madrid, dated May 25th, states that Lieutenant Peral, of the Spanish Navy, and inventor of an electric submarine boat, has died in Berlin after an operation for cancer.

Birthday Honours.—Amongst the numerous recipients of "Birthday Honours" we note the name of the late Director-General of Indian Telegraphs, who will in future be known as Sir William Brooke, K.C.I.E.

The Alternate-Current Transformer.—Mr. Gisbert Kapp has arranged with Messrs. Whittaker and Co. for a translation from the German of his new work on "The Alternate Current Transformer." It will be published in the "Specialists' Series" in the autumn.

Royal Society.—At yesterday's meeting of the Royal Society Mr. W. E. Wilson was down for the following Paper: "On the Effect of Pressure of the Surrounding Gas on the Temperature of the Crater of an Electric Arc Light. Preliminary Notes of Observations made at Daramona."

Technical Education.—Prof. W. T. A. Emtage, Professor of Mathematics and Physics at University College, Nottingham, has been elected, subject to the approval of the Technical Education Board of the London County Council, Principal of the Technical Institute, Wandsworth.

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The Suez Canal and the Electric Light.—In the report of the Suez Canal Company for the year 1894 it is stated that 3,352 ships, of 8,039,175 tons, passed through the canal, conveying 165,980 passengers. Vessels to the number of 3,180 passed through at night by the aid of the electric light. The average time of transit was 19hr. 55min.

Electric Traction for the New York Elevated Railroad.—According to the Philadelphia correspondent of *The Times*, the Manhattan Elevated Railroad Company, which works the New York Elevated Railway, has decided to change its motive power to electricity, and is selling an issue of Manhattan Consolidated Bonds in London in order to provide funds.

A Statue to Lavoisier.—At the instance of the Académie des Sciences a Committee has been formed in Paris with the view of collecting subscriptions for a proposed statue in Paris in memory of Levoisier. It is intended to make the fund an international one as far as possible. Subscriptions are to be sent to M. Gauthier-Villars, 55, Quai des Grands-Augustins, Paris.

Argon.—The trustees of Columbia College, following the recommendation made by the National Academy of Sciences at their recent meeting, awarded the Barnard Medal to Lord Rayleigh for the discovery of argon. This gold medal is awarded every five years to the investigator who makes within the preceding five years the most valuable discovery in physics or astronomy, in accordance with the will of President F. A. P. Barnard, who died in 1889.

Institution of Electrical Engineers.—The following gentlemen were passed into the Institution at the last meeting:—Foreign members: Clarence L. Cory, Albert Petersen, John Kreuse, Charles Leblanc, Edward W. Mix, and F. W. Tischendœrfer. Member: Alfred Dickinson. Associates: F. Z. Maguire, Harold S. Adey, James T. Cornish, Charles Jefcoat, James E. Lea, B.Sc., Theodore J. Ridge, Arthur E. D. Saul, Philange Trackson, and Herbert Brandon White.

Lightning.—During a thunderstorm on Saturday last a flash of lightning struck the drying-house of a powder manufactory at Osenburg, near Halver, in Westphalia, causing an explosion. Considerable damage was done to the buildings, but no one was injured.——On Thursday, last week, three labourers were engaged in hoeing a field of wheat at Bardney Dairies, Lincolnshire, when the two outside ones were struck by lightning and killed. The centre man experienced not even the slightest shock.

The Berliner Patent in America.—In the suit brought by the United States Government against the American Bell Telephone Company, the owners of the Berliner telephone transmitter patent, with a view to having it declared void on account of illegal delay in its issue, the decision of the first Court, which was for the Government, has been reversed by the Court of Appeals. The patent was applied for on June 4, 1877, and was only issued on November 17, 1891. The Government has appealed to the Supreme Court.

Electrically Operated Bulkhead Doors.—A Reuter telegram from Washington states that since the disaster to the "Victoria" the officers of the United States navy have devoted much attention to the question of bulkheads. Chief Engineer Melville has now prepared several mechanical devices, which may be operated either by compressed air or by electricity, by means of which all the bulkhead doors of a vessel can be automatically closed at a moment's notice. The officer on deck or the man in the conning tower, on seeing the danger, can by simply pulling a lever close every door instantaneously, after first, by a prearranged whistle or bell signal, warning those below to hasten on deck or otherwise escape. The plan will be tested on board one of the new American warships.

Worcester.—With reference to the statements in local and gas newspapers, in regard to some mishap at the Worcester electric supply station, we are informed that the matter arose from "the failure of two new coils, which had been put into an armature," and that, "when the first coil went, two machines were in parallel, and the faulty machine was switched out before further damage was done. The coil in the second machine went before there had been time to parallel another machine." We are promised further particulars from the contractors as soon as the matter has been thoroughly investigated. The mishap occurred last Wednesday week.

The Series-Parallel Control.—An American patent of Dr. John Hopkinson, claiming the series-parallel coupling of electric tramcar motors, came into "interference" with a similar patent granted to one Rudolph M. Hunter, and the question has been adjudicated upon by the American Patent Office. "While awarding Dr. Hopkinson the claim to priority, the examiner," says the *Electrical Engineer* of New York, "draws attention to the fact that the patent for which Dr. Hopkinson applied in the United States was in public use upon the Lehigh Avenue Railway, in Philadelphia, in the month of May, 1890, and hence comes under the law forbidding the issuance of a patent for an invention in use two years prior to the date of application therefor. From the opinion of the Patent Office examiner it would seem that the 'series parallel' method of coupling street railway motors was public property."

The China-Burma Telegraph Line.—A copy of the convention between Great Britain and China respecting the junction of the Chinese and Burmese telegraph lines, signed at Tientsin on September 6, 1894, has just been issued as a Parliamentary paper in the Treaty series. The junction is to be effected, according to the convention, between the British station at Bhamo and the Chinese station at Tingyueh (Momein), at the latest on May 31st, this year, unless this should be prevented by accident or by *force majeure*, and in that case as soon as possible thereafter. Each of the contracting parties is to bear the expense of establishing, working, and maintaining in good condition the line of connection incurred on its own territory. The rules for the extra-European system laid down in the service regulations of the International Telegraph Convention are to observed with regard to the telegrams transmitted between Bhamo and Tingyueh, but in reckoning the number of words in telegrams between China or Hong-kong on the one side and Burma, India, or Ceylon on the other, the rules of the European system are to be observed. The detailed charges per word levied by the Indian and by the Chinese telegraph administrations respectively are given, and it is provided that these charges are not to be raised before January, 1897, though they may be reduced.

Imperial Postal and Telegraph Routes.—On Friday last a deputation from the Association of Chambers of Commerce of the United Kingdom waited upon the Prime Minister with the object of bringing under notice the following resolution passed at the autumn meeting of the Association at Huddersfield:—"That this Association expresses its hearty approval of the resolutions adopted by the Inter-Colonial Congress recently held at Ottawa in favour of inter-Imperial postal and telegraph routes between this country and the Colonies and between the Colonies themselves respectively without such routes passing through other countries." Sir Albert Rollitt introduced the deputation, and spoke on behalf of the resolution. Mr. Thompson, of the London Chamber of Commerce, commented on the difficulties which he thought would ensue from our present telegraphic position in case of war. He was of opinion that the simple way of counteracting this danger was lay a cable between Vancouver and Australia. The Prime Minister, in reply, said that an inter-departmental committee, consisting of representatives of the Treasury, Post Office, and the Colonial Office, had been appointed, and was now considering the concrete recommendations of the Ottawa Conference, and until this Committee reported it would be impossible for him to express any definite views on the subject brought to his notice by the deputation.

A Century of Science. The *Philosophical Transactions* of the Royal Society, extending over a period of well-nigh a century (1800—1895), have recently been indexed in a handy little Catalogue of some 100 pages. The indexing is by alphabetical arrangement of the authors' names, and each item is accompanied by the price at which the Paper is published by Messrs. Dulau and Co. Within the limits of this scarcely completed century, and on the pages of this little pamphlet, are names which stand out as landmarks of progress in science.

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Some of the items enumerated are quaintly interesting; and in those which are of electrical or engineering interest, the stages of development of these branches of technology are clearly defined. We may notice one or two of the early Papers. In 1801 "An Account of Some Galvanic Combinations, formed by the Arrangement of Single Metallic Plates and Fluids, analogous to the New Galvanic Apparatus of Mr. Volta," was contributed by Sir Humphrey Davy. In 1834 Sir Charles Wheatstone gave "An Account of Some Experiments to Measure the Velocity of Electricity, and the Duration of Electric Light." In 1865 Clerk Maxwell read the Paper on his famous "Dynamical Theory of the Electromagnetic Field," and two years later he gave his account of "The Dynamical Theory of Gases." The researches of Faraday occupy nearly two pages, and we find also in handy columns the Royal Society works of Thomson, Rankine, Joule, Cayley, and others, besides later scientists, such as Hopkinson, Ewing, Crookes, &c.

Institution of Civil Engineers.—The annual general meeting of this Institution was held in the Hall of the Royal United Service Institution, on Tuesday, the 28th inst, Sir Robert Rawlinson, K.C.B., President, in the chair. The Report of the Council commenced by referring to the change that had taken place in the roll of the Society during the past twelve months, during which 29 members, 286 associate members, and five associates had been elected. The net increase was 155, or at the rate of nearly 3 per cent. per annum. The numbers of all classes on the books at the end of the Institution year were: Honorary members 17, members 1,862, associate members 3,687, associates 355, making a total of 5,921. For the first time since the introduction of the higher qualifications of candidates for admission as students, the Council was able to report an effective increase in the roll, the numbers on March 31, 1895, being 816, or 25 more than at the same date last year. The statement of accounts showed that the receipts of the year had been altogether £30,318. The general expenditure amounted to £18,385. The completion was announced of the new Library Catalogue, comprised in three volumes, copies of which would be issued to public libraries and those of educational and scientific bodies in all parts of the world. The Council had given considerable attention to the question of enabling all entitled to vote at the annual election to exercise that privilege whether present at the meeting or not. The opinion of counsel was, however, that under the existing charters such votes could only be given personally.—The ballot for Council resulted in the election of Sir B. Baker, K.C.M.G., as President; of J. Wolfe Barry, C.B, W. H. Preece, C.B., Sir Douglas Fox and James Mansergh as Vice-Presidents; and of W. Anderson, Alex. R. Binnie, W. R. Galbraith J. H. Greathead, J. C. Hawkshaw, C. Hawkesley, Dr. John Hopkinson, Alex. B. W. Kennedy, Sir G. L. Molesworth, K.C.I.E., Sir Andrew Noble, K.C.B., Sir E. J. Reed, K.C.B., M.P., W. Shelford, F. W. Webb, Sir W. H. White, K.C.B., and Sir E. Leader Williams.

The County Council and Transformer Chambers.—At the weekly meeting of the London County Council last Tuesday, the Highways Committee reported on a difference that had arisen between the Council and the House-to-House Electric Light Supply Company, with reference to the construction of transformer chambers. Last February the Council, in giving sanction to certain works of the Company, expressly withheld sanction to the construction in Kensington High-street of a transformer chamber of the inside dimensions of 5ft. by 6ft. 6in, and between 6ft. and 7ft. deep. The Company gave notice on May 14th that, as its system of supply had received the provisional approval of the Board of Trade, it intended to proceed with the construction of the transformer chamber, and by their direction the Council's solicitor warned the Company that, as it had not appealed to the Board of Trade, it had no authority to proceed with the work. The Company had since intimated its intention to appeal; but had also, with the view of meeting the objection of the Council, offered to place the proposed chamber in Wynnstay-gardens, a position which was certainly less objectionable than that first proposed. The Council had consistently objected to the construction of large transformer chambers under the public thoroughfares, and the Committee did not see any reason for an exception being made in this case. They therefore recommended that the Company be informed that the Council was not prepared to depart from its previous decision, and that they left the matter for the decision of the Board of Trade upon appeal. This was agreed to. The Council also formally disapproved of applications from the County of London and Brush Provincial Electric Lighting Company to construct 42 transformer chambers in St. Luke's and 34 transformer chambers in the Wandsworth district.

Hong Kong Electric Supply Station.—The supply station at Hong Kong has now been in operation for four and a-half years, the public lighting having been started in December, 1890. The station is situated at the east end of the town of Victoria. It is built on the side of the hill, the ground having been arranged in two terraces, on the upper of which the engine room is built, and on the lower the boiler house, stores and offices. The engine room contains five horizontal compound engines, with jet condenser at back of low-pressure cylinder. The engines run at 100 revolutions per minute. The flywheel, which is between the high and low-pressure engine is 13ft. in diameter, with six grooves on the face for driving ropes 1¼in. diameter, leading direct to the countershaft for driving the dynamos. There are two feed-water heaters. The water supply for the condensers is obtained from a tank of about 30,000 cubic ft. capacity, dug out of the hill, and fed by a small stream. The boilers are supplied either from this tank or from the town supply. The boiler house contains three steel Lancashire boilers with Galloway tubes. The boilers are 26ft. 6in. long, and are worked at a pressure of 140lb. They are supplied with water by injectors and two donkey pumps. As a rule only one boiler is in use, but a second is kept under steam in case of accidents. Japanese coal is used, and although rather smoky gives very little trouble in keeping steam. The three arc light dynamos, which are fitted with automatic regulators, are each of 55 lights capacity, and are run off a countershaft by belts. Two horizontal and one vertical engine work on to the countershaft, and each pulley on the countershaft is controlled by a patent friction clutch so that any engine or dynamo can be changed while running without interrupting the lights. The alternators are 50 kilowatt Kapp type, running at 650 revolutions per minute, with 75 $\sim$, and giving 2,000 volts; and they are placed on slide rails. They are excited by Kapp dynamos, giving 50 amperes at 150 volts, driven by belts off the alternator shafts. Transformers transforming from 2,000 to 100 volts are used in the houses for private lighting. The switchboard, which is at the back of the engine room, is of teak, and is about 3ft. away from the wall, thus allowing access for connecting up the leads. Lightning arresters of the magnetic air-gap type are placed on each pole of every circuit. These were adapted in preference to the Brush type, which did not answer in the severe storms which Hong Kong is subject to, and it was no uncommon thing to have the arc circuits struck and short-circuited twenty or thirty times in an hour during a heavy storm. Sometimes it was impossible to keep the incandescent circuits going, as the fuses were blown as fast as they were replaced, owing to the lines being repeatedly struck. After the adoption of magnetic arresters and Wurtz arresters at intervals along the lines, there was seldom any mishap. The principal streets are lit by 80 double-clutch non-focussing Brockie-Pell arc lamps. These are fixed in carriers, with a reflecting hood, and placed on top of iron lattice poles 40ft. high, except in a few cases where shorter poles were found necessary. These posts carry wrought-iron brackets, on which are fixed insulators to carry the cables both for the arc lamps and incandescent circuits. Messrs. Johnson and Phillips' fluid insulators are used for carrying the stranded steel bearers. The cables, which are $\frac{7}{16}$in. stranded wire, are of high-insulation vulcanised rubber, and are suspended from the steel bearers. An earth wire connects all the poles and lamp posts together to guard against lightning. There are two incandescent and two arc-light circuits. In all about 10,000 lamps are in use in the official and private residences. The station and works were equipped throughout by Messrs. Johnson and Phillips, to the designs of Mr. J. W. Hart, and were erected under the personal superintendence of the present manager, Mr. W. H. Wickham,

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MOTIVE POWER AND GEARING.*

BY F. TREMLETT CARTER.

(*Continued from page 5.*)

Hornsby Horizontal Compound Engine.—At the Paddington station of the Metropolitan Electric Supply Company there are five Hornsby horizontal compound non-condensing per minute. Each dynamo has a normal output of 120 kilowatts; so that the normal effective power of each steam engine is about 190 B.H.P., and the total power about 210 to 220 I.H.P. Elevation and plan of one of these engines—all five are similar—are shown in Fig. 67, the plan also showing a section of the cylinders and valves. The stroke of each piston is 27in. The diameter of the high-pressure cylinder is 15in., and that of the low-pressure cylinder 24⅛in. The cranks are set at 90°, and there is a receiver between the

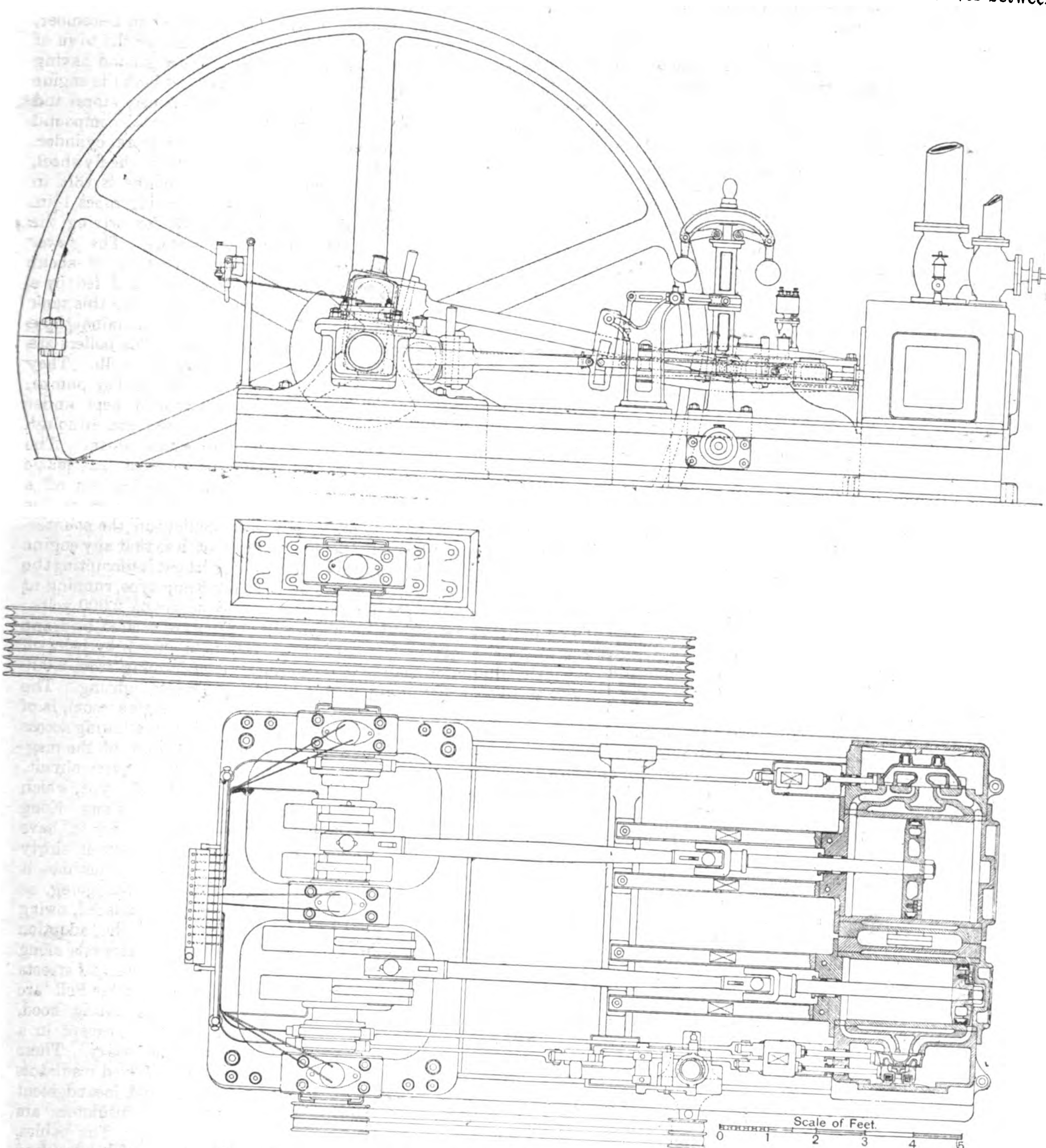

FIG. 67.—Side-by-Side Horizontal Compound Engine.—By R. Hornsby & Sons.

engines. Each of these engines is coupled to a separate alternator, by means of eight 1⅜in. ropes, the length of the drive being about 25ft. between centres. The engine fly-wheel is 14ft. in diameter, and runs at 100 revolutions per minute; the dynamo shaft is run at 600 revolutions

*From a forthcoming work to be published by *The Electrician* Printing and Publishing Company. All rights are reserved.

cylinders which is not shown in the drawings. The distribution of steam in the high-pressure cylinder is controlled by an automatic expansion valve, actuated by a governor through a vibrating link, after the manner of the Hartnell gear shown in Figs. 57 and 58 (see Vol. XXXIV. p. 698). The distribution of steam in the low-pressure cylinder is effected by a single Trick valve, and does not vary with the load. Both cylinders are

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steam jacketed, and the initial pressure of the steam admitted to the high pressure cylinder is 160lb. on the gauge. The governor is driven by two belts from a flanged pulley, and, to minimise hunting, is fitted with an oil cataract. The lubrication for all the working parts, with the exception of the governor and the cylinders, is effected by a system of pipes supplied from one oil reservoir at the front of the engine. Besides the separate cocks on the several cil pipes, there is one master cock by which the lubrication of the entire engine may be controlled. This lubricating apparatus is shown in under a jockey pulley; and the length of the drive is only 11ft. 4in. between centres. A side and an end elevation of one of these six similar engines are shown in Fig. 68, the latter view also showing a section through the cylinders and valves. The engine is designed to give 90 B.H.P. when supplied with steam at 120lb. on the gauge. It is coupled to a Ledward ejector condenser, shown in the side view (see also Fig. 45). The speed of the engine is designed to vary between 120 to 135 revolutions per minute, according to the load on the five-wire electric mains to which the engine supplies power.

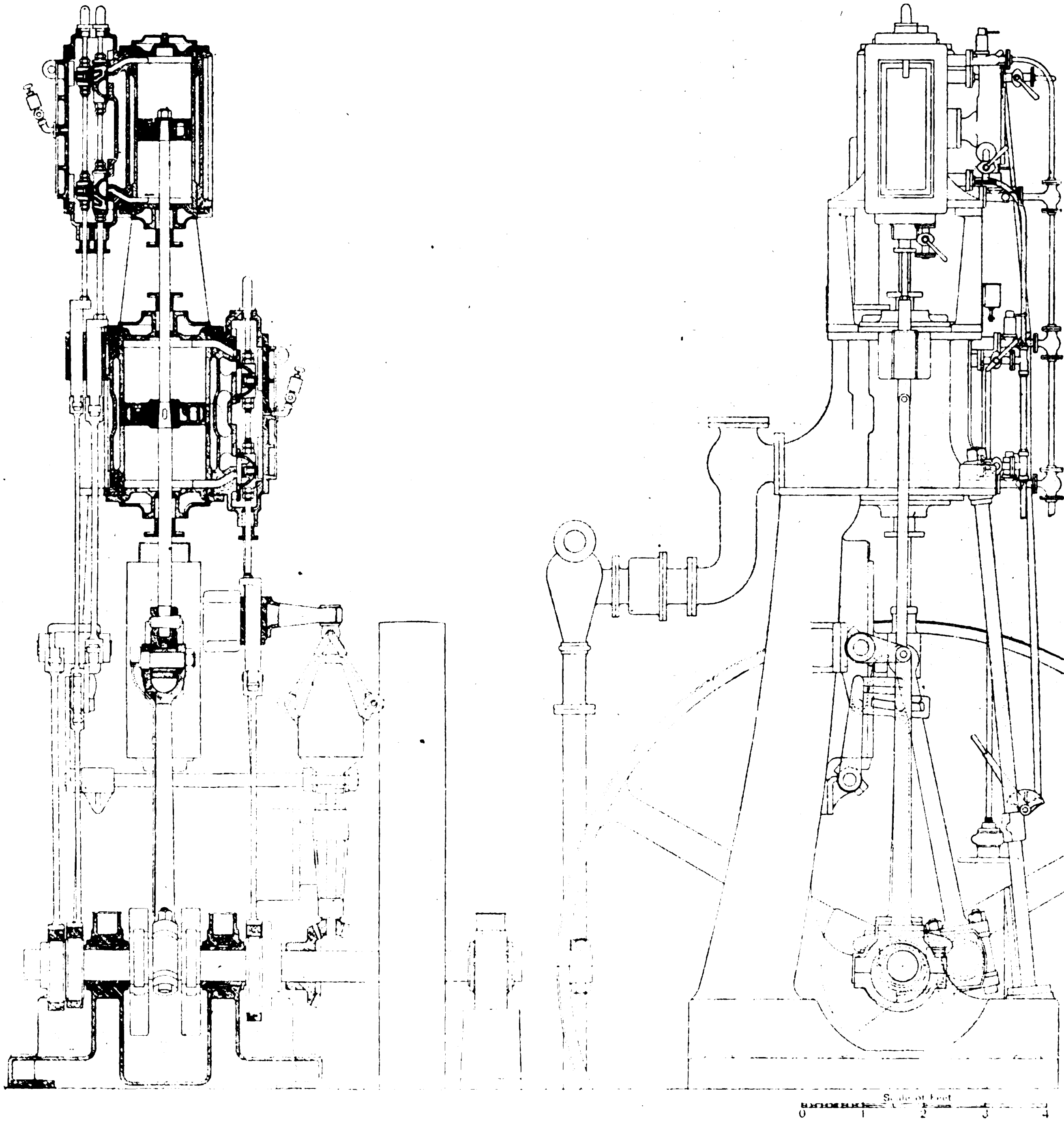

FIG. 68.—Vertical Tandem Compound Engine.—By R. Hornsby & Sons.

the drawings, at the extreme left of the bed-plate. These engines were built by Messrs. R. Hornsby & Sons (Limited), of Grantham.

Hornsby Vertical Compound Engine.—At the electric supply station of the Manchester Corporation there are, besides other engines, six vertical tandem compound condensing engines, built for this station by Messrs. R. Hornsby & Sons (Limited). Each of these engines drives a separate continuous-current dynamo, by means of link belting passing

This method of regulation is described on page 61 of Vol. XXXIV. The speed is varied by hand while the engine is running, by varying the weight on the dead-weight governer which actuates the cut-off in the high pressure cylinder. The governor controls the expansion valve by means of an efficient and special form of link motion, the details of which are shown in the drawings. The governor is of the Porter type, and is driven from the engine shaft by bevel gear, without belt or rope gear; it is therefore certain and steady in its action.

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The stroke of this engine is 24in. The diameter of the high-pressure cylinder is 10½in., and of the low-pressure

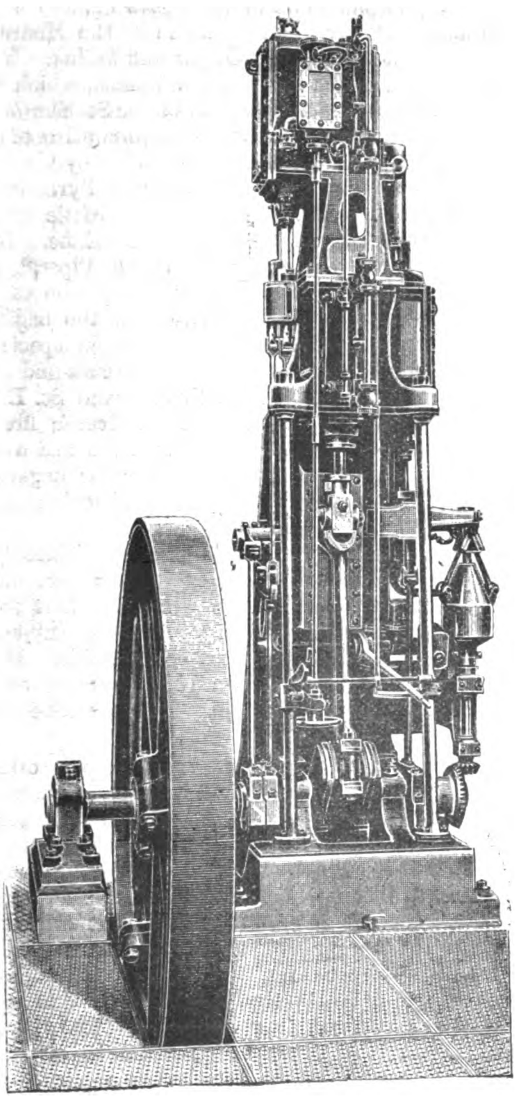

Fig. 69.—Vertical Tandem Compound Engine at the Manchester Electric Supply Station.—By R. Hornsby & Sons.

cylinder 16in. Both cylinders are steam jacketed. A perspective view of this engine, as erected at Manchester, is shown in Fig. 69.

(To be continued.)

ATMOSPHERIC ELECTRICITY.*

BY PROF. A. SCHUSTER, F.R.S.

(Concluded from 115).

Brief allusion must be made to some of the causes which alter to a marked extent the normal fall of potential. As the surface of the earth is negatively electrified, it follows that dust carried up by the wind must be electrified, and it is found, indeed, that in violent dust storms the laws of force near the surfaces are altogether distorted and reversed in direction. Werner Siemens† (*Pogg. Ann.*, CIX., 1860) could, while standing on the top of one of the pyramids during a strong wind, charge an improvised Leyden jar sufficiently to obtain strong sparks. A casual observation of Elster and Geitel,‡ may prove significant. On March 7, 1889, the temperature in Wolfenbüttel was rising from $-10°C$ to $+2°C$, a cirrus layer covering the sky. The fall of potential changed in the course of four hours from 1,302 volts per metre to $-1,200$ volts, that is, from a very exceptionally high fall to an equally strong gradient in the other direction. Although the atmospheric circumstances were anomalous, they seem not in themselves sufficient to account for the anomalous electrical effects, and the authors suggest that a possible explanation may be found in a violent dust storm which on the previous day was observed in Alexandria.

Fogs are generally found to increase the normal fall considerably, so that the drops of water must be taken as positively electrified.

Waterfalls considerably disturb the electric condition in their neighbourhood, the air surrounding the fall being found charged negatively sometimes to considerable distances.

Whether clouds in themselves are always electrified is very doubtful; they no doubt disturb and generally weaken the fall of potential at the earth's surface, but this may only be due to a displacement of the positively-electrified layer which balloon observations have shown to exist at a height of from 10,000ft. to 20,000ft. While a cloud discharges rain, the electrical effects in the neighbourhood of the place are the same as that in the neighbourhood of a waterfall. The explanation is probably the same in the two cases, and by means of experiments, alluded to further on, we may reproduce the negative electrification of air under similar circumstances.

Measurements of the electrification of falling rain or snow simple as they appear at first sight, are beset with very serious difficulty. We owe the most complete investigation on the point to Messrs. Elster and Geitel.* They find no regularity in the electrification, though positive signs slightly preponderate with snow and the negative signs with rain.

The approach of a thunderstorm announces itself by characteristic cumuli clouds, and the general atmospheric condition favourable to their formation is felt by many persons of nervous temperament. Many of us are accustomed to hear that "there is thunder in the air." Whatever the special feeling of "thunder" may be due to, it cannot be an electrical effect, for electrical instruments, delicate enough to detect a small fraction of the normal stress, give no indications of the approach of a thunderstorm, and it is only when the cloud has begun to discharge rain or hail that strong electrical effects are noticed. During the thunderstorm the electroscope is, of course, much disturbed, and there are frequent and violent reversals of its indications.† The fact that no effects are observed at the surface of the earth during the approach of a thunder cloud does not prove that there is no electrical separation, for we may imagine two oppositely electrified layers at different levels producing a strong electric field between them, but only weak effects outside. That some such thing may possibly occur is indicated by observations made in mountain districts, where violent electrical disturbances are observed previous to the formation of clouds.‡ The cumulus cloud, from which the lightning strikes out, is nearly always associated with a cirrus layer above it, and the flash occurs more frequently upwards or sidewards between the clouds than down to earth. Under such circumstances it is clear that instruments on the surface of the earth can only very partially indicate the nature and distribution of electrical stress in the neighbourhood of the cloud.

Thunderstorms seem always to be connected with a vortex motion, and meteorologists distinguish two kinds of thunderstorms. The first kind forms in the outlying portions of a large cyclonic system. The storms which occur chiefly in winter are of this nature, and the vortex necessary for its formation is of the nature of a secondary disturbance. The thunderstorm which forms in summer, on the other hand, makes its own vortex, and is of a much more local nature than that which is produced round a previously-established barometric depression. The summer storm is much influenced by the character of a district. There are certain configurations apparently favourable to its formation, as is clearly brought

* Friday Evening Discourse delivered before the Royal Institution.
† *Meteorologische Zeitschrift*, 1890, p. 252.
‡ Ziele und Methoden, p. 11.

* *Wiener Sitzungsberichte*, Vol. XCIX. (1890).
† Weber, *Elektrotechnische Zeitschrift*, Vol. X. Elster and Geitel, "Uber einige Ziele und Methoden Luftelektrischer Untersuchungen, Wolfenbüttel" (1891).
‡ Trabert, *Meteorologische Zeitschrift*, 1889, p. 342.

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out by the charts which have been made representing their frequency.

The route travelled over by the storm is affected by mountain ridges, and rivers also seem to offer a peculiar impediment. Many of them are brought to an end either along their whole front, or only part of it, when they reach the banks of a large river.*

Some curious problems are presented by the detailed structure of lightning flashes. Although these lie outside the range of the present lecture, reference must be made to the very beautiful photographs of lightning flashes taken both in this country and abroad. The ordinary forms which lightning takes are familiar to all; but a good deal of mystery still surrounds the so-called globular lightning. The manner in which this form appears is best described in the words of eye-witnesses.

Dr. A. Wartmann gives to the Physical Society of Geneva the following account of what he saw† :—"At half-past six o'clock in the evening I drove from Versoix to Genthod. On the Malagny-road, I heard the coachman say he did not know where he was. His eyes were so much fatigued by the frequent and intense lightning discharges, that he was blinded, and could not, even in the intervals, see the road, in spite of the good lanterns along it. I stepped on to the box and took the reins. We had barely passed the principal gate of the grounds of Dr. Marcet, when I became conscious of a bright and lasting luminosity behind me. Thinking it was a fire, I turned round, and saw, at a distance of, roughly, 300 metres, a ball of fire of about 40cm. diameter. It travelled in our direction with a velocity about equal to that of a bird of prey, and left no luminous trail behind. Just as the ball had overtaken us, about 24 metres to our right, it burst with a terrific noise, and it seemed to me as if lines of fire started from it. We felt a violent shaking, and remained blinded a few seconds. As soon as I regained power of distinguishing objects, I saw that the horses had turned at a right angle to the carriage, with their chests in the hedge, with drooping ears and all signs of great terror. I returned on the following day to the place where I had seen the ball explode, but could find no sign of any damage. At a distance of 100 metres I found that a group of three trees, bordering a wood, had their upper branches singed, but it is not possible to say whether this was due to the discharge which I had seen."

The following is a translation of an account given by Mr. H. W. Roth‡ :—"During the thunderstorm of May 19, 1888, at about 6 p.m., a flash of lightning took effect which seems to me remarkable from a physiological point of view. The dealer Werner, from Ellerbruch, and his son (16 years old), were at the time on the road which leads from here to the village of Ottensen, with a one-horse conveyance containing rags, about three miles away in a south-westerly direction. The father had been left behind a little, and the son was occupied in giving bread to the horses, when he found himself suddenly surrounded by light, and noticed a fiery ball, about the size of his fist, move towards him along the back of the horse. Then he lost consciousness. He felt no concussion. The father, approaching, still saw the horse's limbs contracting, and at first he thought his son was dead, but succeeded, after all possible efforts, in bringing him back to life in about three-quarters of an hour. The horse was dead."

Some curious statistics have been collected, especially in Germany, as to the damage done by lightning flashes. That damage seems to have increased to an enormous extent within the last 50 years, and although in cases of this kind statistics may easily be at fault, there seems no doubt about the reality of the fact, which may find an explanation in the partial cutting down of forests in those parts where thunderstorms chiefly occur. When lightning strikes into forests, it selects certain trees by preference. Thus, in the principality of Lippe, taking the percentage of beeches struck by lightning as unity, that for other trees is as follows:—Oak 48, pine 5, Scotch fir, 33.

* Bebber, "Meteorologie," p. 255. Bornstein, "Archiv. der Seewart, VIII." (1885).

† "Arch. des Sc. Phys. et Nat." (3), Vol. XXI. (1889). The above account is translated from the *Meteorologische Zeitschrift*, 1889,

‡ *Meteorologische Zeitschrift*, 1889, p. 231.

The St. Elmo's fire, a continuous discharge from points and sharp angles, is often observed on board ship and in mountain districts during a storm. Its appearance was considered a sign of the approaching end of the lightning, and was looked upon with favour by the ancient sailors in the Mediterranean Sea, who gave to it the name of Castor and Pollux. There was another appearance called Helena, a bad omen, which by many is believed to have been another form of the St. Elmo's fire, and the present name has been stated to be a corruption of the word Helena. Some support is given to this view by the fact that the Emperor Constantine built a castle in the Pyrennees, which he named after his mother, Helena, and this castle seems to be referred to occasionally as St. Elne or St. Elme. But it is much more probable, as argued by Dr. F. Piper,* that the word is derived from St. Erasmo, a bishop who came from Antiochia, and suffered a martyr's death at the beginning of the fourth century. He seems to have been specially considered the patron of Italian sailors. Churches and castles in Naples and Malta were called St. Erasmo and St. Ermo, and Ariosto describes St. Elmo's fires as St. Ermo's fires. The electric discharge which goes under this name has a different appearance according as it is the positive or negative electricity which escapes, and both kinds occur with about equal frequency.

Although we have not yet arrived at any satisfactory theory of atmospheric electricity, some progress has been made, and this account would not be complete without a short account of the views taken by men of science on the subject. The number of theories proposed is very considerable. Dr. Suchsland,† in a pamphlet published in 1886, gives an account of 24, to which he adds one—his own. The year 1884 alone has given birth to four theories.

We may group the theories according to the origin they assign to the source of energy which is involved in the formation of the electric field. All the work we can perform is either derived from the sun or from the earth's rotation. There is, as far as I know, only one theory—that of Edlund—which makes the earth's rotation in space responsible for the separation of electricities in the atmosphere. But Edlund's views are not tenable in theory, and, even granting his deductions, the normal fall of potential should, according to the views of the author, have a different sign in the polar and equatorial regions, which is contrary to the observed fact. This theory does not, however, exhaust the possibility of explaining atmospheric electricity as a phenomenon of electromagnetic induction, and it is not disproven that in some form or other the rotation of the earth's magnetic field may play a part in the origin of the electric field. The theories which take solar radiation as the source of the energy divide themselves into several groups. We may think of a direct thermo-electric or actinic action, but there is, so far, no experimental support to such views. One of the earliest and most natural suppositions is the belief in evaporation as a source of electrification. This was Volta's theory, and experiments have at various times been produced in its support; but, so far, no one has been able to invalidate Faraday's conclusion that whenever electrification seemed to appear as a consequence of evaporation, it was really due to secondary causes, such as the friction of the liquid spray against the sides of the containing vessel. Rejecting Volta's theory, there is nothing left but the belief in some form of contact or frictional separation either between drops of water and air, or water and ice, or any two of the various bodies present in the atmosphere. The possibility of contact electricity, between a solid or liquid, and a gas, is not quite easy to submit to the test of experiment. If we rub two solid bodies together we may, by separating them, investigate the electric field produced; but, supposing we have a drop of water surrounded on all sides by air, the water may be covered with an electric layer of, say, positive electricity, the air in contact with the water with the opposite kind, and it is not at all clear how we could experimentally demonstrate the difference of potential between the air and the drop which is thus produced. A current of air flowing past the

* F. Piper, *Pogg. Ann.*, Vol. LXXXII., p. 317.

† "Die Gemeinschaftliche Ursache der Elektrischen Meteore und des Hagels." (H. W. Schmidt, Halle-a.-S.)

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drop might carry away some of the negative layer, and in this way an electric field may be established while clouds are forming, but the conditions necessary for an experimental demonstration would be very difficult to realise. Two methods have been devised which practically demonstrate some form of contact electricity between gases and water.

Lenard, wishing to imitate the electric field observed in the neighbourhood of waterfalls, has established by careful experiment a number of important facts, which are all consistent with the following explanation. If we imagine two oppositely electrified layers at the surface of a drop of water such as has been referred to, and if the drop falls on to a layer of the same liquid, or if similar drops impinge on each other, the difference of potential produced by the fusion of the surface layers becomes greater than is consistent with equilibrium. For, taking the case of drops falling into a mass of water contained in a cylindrical vessel, the extent of surface between air and water is not increased by the falling drops, and we must imagine that surface to be already covered with a sufficient electrical sheet to establish the required difference of potential. The electrification of the drops is, therefore, not wanted, and a change in the distribution takes place. The natural supposition would be, that this equilibrium would be restored very quickly through the surface of the water, but a sufficient time seems to be required for the surplus electricity to be blown away by the strong current of air which in Lenard's experiments is brought down with the water drops. The air, passing out sideways, is negatively electified, and the water remains positive. More recent experiments of Lord Kelvin's, with air bubbing through water, point similarly to contact forces between gases and liquids, and in these experiments also it appears that a considerable time is required to establish electric equilibrium between a gas and a solid. Lenard finds very important differences caused by small impurities in the water, the water acting much more strongly when it is pure. If it contains as much salt as is contained in the sea, the effect is reversed, and the air becomes positively electrified. The explanation which is given above is practically that of Lenard, whose observations have been confirmed and further extended by Prof. J. J. Thomson. These experiments, no doubt, account for the behaviour of air in the neighbourhood of waterfalls, and they probably also explain the negative electrification of air in the neighbourhood of districts in which rain is falling. The strong positive electrification of mist may also be due to the same cause.

There seems to be no doubt that the formation of cloud is often accompanied by electrical effects. A few years ago, descending from Dent Blanche, I found myself, after sunset, at a height of about 12,000ft. A current of air was apparently blowing up the valley, which reaches from Evolena towards Ferpecle, and I could observe below me the formation of a cloud at a height a little below the snowline. As night came on, and we continued our descent over the glacier and down the valley, a series of electric discharges were noticed between the cloud, which was lying in a deep-cut valley, the sides of the mountain, and the blue sky overhead. Here the moist air was evidently flowing through the cloud, depositing its moisture in the form of drops, and it seemed the most natural explanation at the time that the air left the cloud in an electrified state. But while by means of experiments we have been able to produce some of the phenomena of atmospheric electricity, we have other important effects which cannot be accounted for in so simple a way. The electric discharges during a thunderstorm give evidence of electric fields, which could hardly be explained by contact electricity between drops of water and air alone. The fact that thunderstorms are nearly always connected with the formation of hail, and Faraday's experiments showing that water rubbing against ice becomes negatively electrified, is made use of in the theories of Sohnke and Luvini. It is quite likely that there is some truth in these theories. Their weak point lies in the difficulty of seeing how particles of ice and water can be first sufficiently mixed to allow of friction, and then become sufficiently separated to produce an electric field of such magnitude as we know must exist in a thunder cloud. It is to be remarked, however, that the laws of contact electricity must be applicable to gases as well as to solids, and that if water becomes positive when rubbing against air, and negative when rubbing against ice, there must be a strong contact difference between ice and air. In other words, it does not matter whether there is direct friction between ice and water, or whether the air forms an intermediate body. We may imagine air rising through a cloud containing drops of water becoming negatively electrified, and then passing through an ice cloud having its negative electricity increased, thus leaving the ice and water particles at a difference of potential which may, by a fusion of the drops, increase sufficiently to produce a lightning discharge. This seems to the writer the most plausible theory which, in the present state of our knowledge, can be formed. As regards the permanent negative charge of the earth's surface, the time has not yet arrived for forming a definite opinion. Because, although we know that the earth, once electrified, would gradually lose its charge into the atmosphere, yet we can express no opinion as to the rate at which the loss is going on. That loss may be exceedingly slow, and consequently equilibrium might be attained by a very small preponderance of negative electricity brought back to its surface through some cause or other. Rain, as has already been mentioned, is more frequently electrified negatively than positively in our own climate, and though we do not know how far this holds in the tropical belt, it is at any rate possible that the surface of the earth may in this way alone make up for the loss. We may also reasonably think that Lenard's observation on salt water may account for the permanent charge. Every wave that breaks into spray under the action of a strong wind would leave the water negatively electrified, the air carrying away the positive charge. It would be of great interest to possess observations on atmospheric electricity on board ship while waves are breaking in the neighbourhood. So far we have only Exner's observations to guide us, who found, while observing at Lavinia, in Ceylon, that the spray from breaking waves affected the indications of the electrometer, proving its positive electrification.*

But although the loss of electricity of the earth's surface may be very slow, it is equally possible that it is considerable. We shall not be able to treat this question satisfactorily until we have some clearer notion of the causes of the aurora. We know that the aurora implies electric currents, and the circuit of these currents may lie completely within the earth's atmosphere, and have nothing to do with the observed fall of potential near the ground. It is also possible that the body of the earth forms part of the electric circuit, and if that is the case, there must be across different parts of the surface an outward and inward flow of positive electricity. Such a discharge could not fail to affect profoundly the phenomena we have discussed, and it seems probable that we should have some evidence derived from observation if the aurora necessarily involved discharges through the earth's surface. Except in the polar regions, these auroræ do not seem to affect the normal fall of potential. There is a third view we may take as to the circulation of electric currents indicated by the aurora: the return current may take place in space outside the earth's atmosphere. A good deal might be said in favour of this view, and the rotation of the earth's magnetic field in space might be a sufficient cause for the production of these currents; but this is not the place to enter further into this question.

Calculations made from observation on the height of the aurora have generally resulted in an altitude of from 100 to 200 miles, except in the polar regions, where the aurora seems occasionally to descend to a much lower level. It has also been noticed that auroræ are associated with certain bands of cirrus clouds, and this seems to indicate that although the luminous phenomenon is sufficiently intense to be observed only at great heights, yet the electric phenomena may descend to the level of the cirrus.

As regards the connection between the aurora and the sunspot period, further observations in the polar regions are needed. On the one hand, we have Paulsen's† statement,

* *Wiener Akad. Sitzungsberichte*, Vol. XCVIII.

† Paulsen, "Danske Videnskal. Selskats Forhaud," 1889. (I have not seen the original memoir, but only an abstract in the "Jahrbuch der Astronomie und Geophysik, 1890.")

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derived from observations in Greenland, to the effect that the greatest number of auroræ are seen when sunspots are at their minimum, that is, at a time when in our own latitudes the number is smallest; and, on the other hand, we have Nordenskiöld's observations, which seem to point in the opposite direction. In a publication which contains much important matter on the geographical distribution and form of the aurora borealis, Nordenskiöld contrasts the appearances he has observed in the Vega during the winter of 1878-79, passed in the Behring Straits, with that previously observed in 1872-73 to the north of Spitzberg. According to this author, the aurora, during the minimum sunspot period in 1878-79, were "hardly worthy of his notice by the side of those observed in 1872-73." But, although only faintly luminous, the auroræ of 1879 were persistent and regular in shape. They did not affect the magnetic field, and seem to show a regular and continuous, though weak, electric discharge. The arc and streamers in 1872 were much more brilliant and much more irregular. Some objection may be raised against these observations, in so far as they refer to different places, and local circumstances may have affected the phenomenon; but in the face of the very careful description he gives us, we cannot as yet accept Paulsen's results without further confirmation.

The problem of atmospheric electricity, like that of terrestrial magnetism, presents special features in the arctic regions, and until we possess a greater number of observations in those little accessible parts of the earth's surface, many important problems cannot be satisfactorily solved. Arctic and Antarctic expeditions are of interest to scientific men, not because they care much whether we get a few miles nearer the pole, but because a well-conducted party collects invaluable information on its journey. Although much remains to be done in the regions surrounding the north magnetic pole, our knowledge in the southern hemisphere is almost disgracefully inadequate, and it is to be hoped that before long a well-equipped expedition may fill up to a certain extent the large gaps in our electrical and magnetical knowledge which at present stop so many of our researches.

But although investigations to be conducted in the Arctic regions are of primary importance, we may do much nearer home in extending and completing existing information. Instrumental appliances and methods of observations, originally put into a satisfactory state by Lord Kelvin, have been improved, especially by Mascart, Exner, Elster and Geitel. One of our most crying wants at present is a series of continuous observations by means of self-registering instruments in places where the neighbourhood of a town, or other local circumstances, do not interfere with the normal changes. The Greenwich Observatory, to whom we look for help in such matters, is placed in the difficulty that the daily variations there observed are markedly different from those in the majority of places, and it is probable that the nearness of London is fatal to any generally useful series of observations of atmospheric electricity being conducted in our national Observatory.

ON THE RECENT DEVELOPMENT OF THE SINGLE-ACTING HIGH-SPEED ENGINE FOR CENTRAL STATION WORK.*

BY MARK ROBINSON.

(*Concluded from page 122.*)

APPENDIX.

Description of the Willans Central-Valve Engine.—The engine is single-acting and on the "constant-thrust" principle—that is to say, the connecting rods are always in compression, never in tension. All the brasses are held close together, both upon the up-stroke and upon the down-stroke. The latter is the working or effective stroke; during the first portion of it the steam pressure in the pistons, of course, presses all parts against the cranks, and the crank shaft against the lower main-bearing brasses; in the later portion of the down-stroke the inertia of the parts, as they are brought to rest by the changing angle of the crank, also helps to keep them in compression. On the up-stroke, when no work is being done, and when the steam is being merely exhausted from the several cylinders, the inertia of the parts as they undergo acceleration by the crank also keeps them in compression for the earlier portion of the stroke; in the later portion they are cushioned by the arrangement to be afterwards described. The result is that in no part of the stroke, up or down, do the parts tend to separate; consequently there is total absence of "back

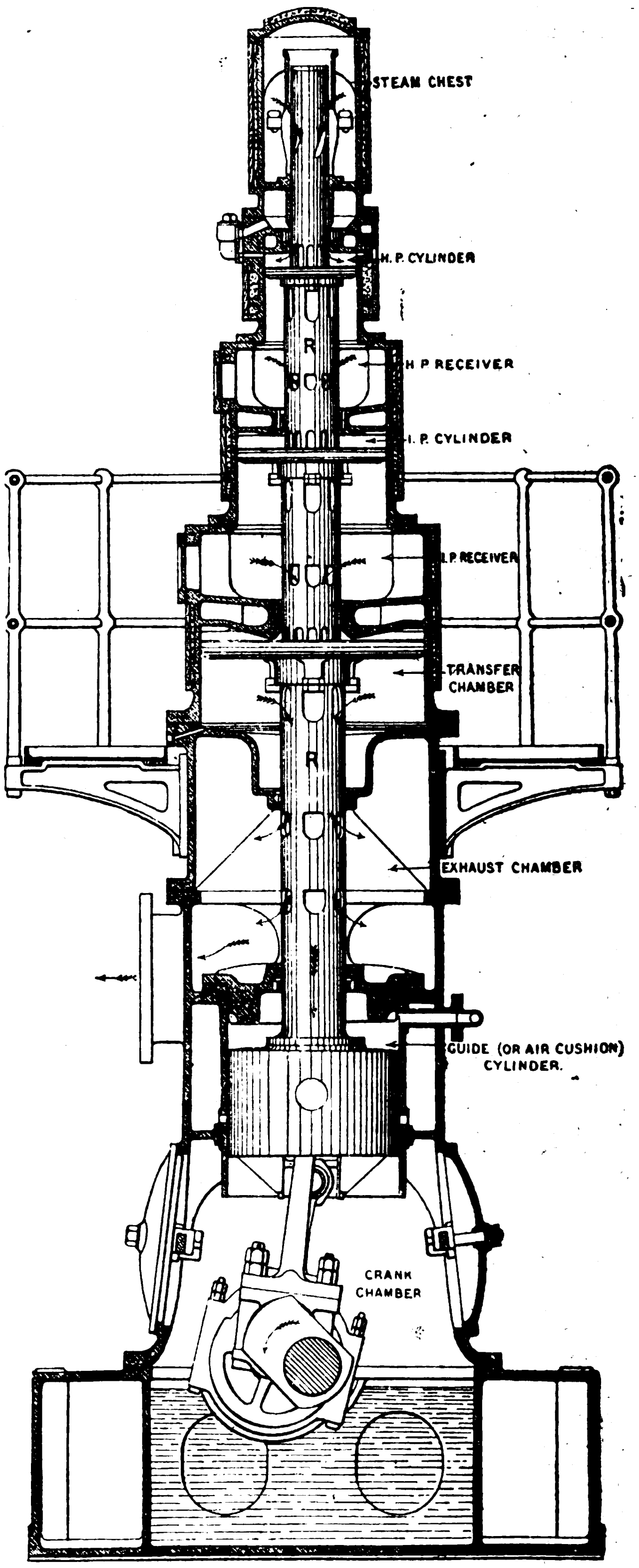

Fig. 15.

lash" or "lost motion," and "knock" cannot arise, as it would if the engine were double-acting, particularly in view of the high speed adopted.

Fig. 15 shows a triple-expansion condensing engine in section (through one line of cylinders). The steam is distributed throughout by the hollow piston-rod R (sometimes called the "trunk."). It enters from the steam chest by the oblique cut-off ports, shown

* Paper read before the Institution of Electrical Engineers

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near the top of the piston rod. By the movement of the line of piston valves, which works inside the piston rod (driven by the eccentric shown), the steam passes into the high-pressure cylinder, at the beginning of the stroke, by the holes or ports shown just above the high-pressure piston. It is important to remember that this ring of ports is the only inlet to and outlet from the cylinder, and that it moves up and down with the piston. The action of the valve inside is shown in detail in Fig. 1, which represents it in the exhaust position.

The valve gives just the same steam distribution as an ordinary slide valve, with a slow cut-off at about three-quarter stroke, or a little later. Cut-off is, however, actually effected by the oblique ports in the steam chest, which, at a point in the stroke either pre-arranged in the design of the engine or controlled by the governor, pass behind rings, or a sleeve, so disposed as to prevent the further supply of steam for that revolution. As the cut-off motion is the same as that of the pistons themselves, the cut-off is very prompt, and shows a sharp corner in the diagram.

After the steam has worked expansively in the high-pressure cylinder, the valve passes above the ports (*see* Fig. 1), and opens communication from the working end of the cylinder—*i e.*, the space above the piston—to the space below it, which is called the high-pressure receiver, but which is equally a steam chest for the intermediate pressure or intermediate cylinder. During the up-stroke the steam is simply transferred from one side of the piston to the other; the whole cylinder, including the "working end," at that time forms part of the receiver.

When the next down-stroke commences, the steam in the high-pressure receiver is passed into the intermediate-pressure cylinder. It enters the hollow piston rod again from the receiver by the ring of short square-headed holes shown, and passes from the piston rod to the cylinder by the ring of ports shown just above the intermediate-pressure piston. Cut-off in this case is given by the square-headed ports passing into the gland in the intermediate-pressure cylinder-cover, and so losing the supply of steam from the high-pressure receiver (=intermediate-pressure steam-chest). The cycle is exactly the same as already described for the high-pressure cylinder, and at the end of the *second* revolution the steam fills the intermediate-pressure receiver. Thence, in the *third* revolution, it passes into the low-pressure cylinder; and in the second, or exhaust, half of that revolution, it passes from the low-pressure cylinder—*i.e.*, from its upper end to the lower end, of course without material change of volume or pressure. It is only during the first half of the *fourth* revolution that it finally passes away from the "transfer chamber" to the "exhaust chamber," the latter being in permanent communication with the condenser.

The full cycle thus described is that of a *triple-expansion Cornish engine*. In each separate stage of the expansion the complete Cornish cycle can be traced, and it is evidenced by two separate diagrams from the upper and lower end of each cylinder. The diagram from each receiver, or from the "transfer chamber," represents (as in every Cornish engine) work done upon the up-stroke, but it indirectly contributes to the power of the engine, for on the up-stroke the piston is in equilibrio, while the removal of back pressure on the down-stroke is a virtual addition to the size of the diagram from the upper end of the cylinder. The advantage is that the total range of temperature due to each stage of expansion does not take effect in the working cylinder, but only part of it. Part of the temperature range acts in the receiver only, where it does little harm; the limitation of the temperature range in the working cylinder is, of course, a clear gain in the matter of initial condensation. The adoption of the Cornish cycle in this engine is fully considered in the Paper in paragraph 16, *et seq.*

The construction of the pistons, and of the rings, which are very distinctive, is shown in Figs. 1 and 2, and is fully described in paragraph 12.

A complete line of valves (from a compound engine) is shown in Fig. 3.

The arrangements for self drainage from the cylinders are of great importance in the economy of the engine; they are explained fully in paragraphs 14 and 15.

All these points—viz., the special piston (and valve and gland) rings; the special arrangement for drainage; and the use of the "Cornish cycle"—are of great importance, and, except the last, are peculiar to the Willans engine, while all are peculiar to single-acting engines. They are described at length, and their advantages are pointed out, in the Paper, from paragraph 11 onwards. (Steam-packed rings can be applied in double-acting engines, but only by providing two complete sets of piston rings, with follower, &c., for each piston.)

The special glands (taking the place of stuffing boxes) are described and illustrated in paragraph 12.

The cushioning arrangement, before referred to, is special to the Willans engine. The guides take the formed of bored cylinders, and the crossheads are pistons, without rings. The top of the guide cylinder is closed, and on the up-stroke the air in it is compressed to the extent necessary to cushion the pistons and other parts. The power stored in the air by compression on the up-stroke is given out again during the immediately succeeding down-stroke, without sensible loss.

In a compound engine there are but two cylinders in series, but the "cycle" in each is precisely the same; in a simple engine only one. Sometimes the final "transfer chamber" is omitted (*see* paragraph 18), and the steam exhausts directly from the working (upper) end of the low-pressure cylinder into the condenser or atmosphere—*i.e.*, the lower end of the cylinder is in permanent connection with the exhaust.

The line of valves is driven by an eccentric *on the crank pin.* It is necessary that the source of motion for the valves should itself move up and down with the pistons, since the ports which have to be opened and closed also move up and down. There is an eccentric rod, which takes on to a hardened pin in a valve guide-piston; the latter works in a bored guide, formed inside the main guide-piston.

There are two connecting rods to each line of pistons, one on each side of the eccentric; the eccentric rod plays between them.

The cranks and all working parts, except the cylinders and valves, are lubricated by the splash of the cranks in the crank-chamber, where the lubricant usually consists of a mixture of oil and water. The guides and the pins at the upper ends of the connecting rods and eccentric rods are readily reached by the splash.

The cut-off in the first or high-pressure cylinder is effected, as before stated, by the movement of the ports in that part of the hollow piston-rod which projects into the steam chest. Where the engine has an invariable expansion, the cut-off ports, as they are called, are of the same shape as those for the succeeding cylinders, and they lose their supply of steam by merely passing into the gland which separates the high-pressure cylinder from the steam chest. If early cut-off is desired, the gland itself is raised a little by packing pieces between it and the cylinder top. In that case the ports enter the gland earlier, and cut-off is earlier.

Where the expansion is to be made variable, either by hand or by the governor, inclined ports are used, and the upper end of the piston rod is surrounded by a sleeve, which also has inclined ports in it. The sleeve is capable of a certain amount of rotation, which causes the ports in the rod to be covered (by the solid part of the sleeve) earlier or later. In the later patterns the sleeve is suspended by a spindle which passes through a gland in the top of the steam-chest, and the spindle is rotated by suitable links, &c. These are moved by hand, or by a relay cylinder, the action of which is controlled by the governor. The nature of the gear is more fully described in paragraph 52 of the Paper.

It will be noticed, in Fig. 15, that there is a hollow space in the casting under the bottom of each receiver. This is supplied with steam, and acts as a jacket, passing heat into the upper part of the working cylinder, and serving to re-evaporate, in the receiver, the the water which may enter it from the preceding cylinder. The later engines are without this jacket arrangement. Like all attempts to improve the Willans engine by jacketing, it has been unsuccessful. It reduces the consumption of steam in the cylinders per indicated horse-power, but the weight of steam condensed in the jackets just equals that which is saved in the cylinders. Apparently, a high-speed engine, *with good natural drainage* and ample sub-division of the total range of temperature, suffers too little from initial condensation to be capable of improvement by jacketing.

Speakers who have returned their proofs revised have their remarks prefaced by an asterisk.

DISCUSSION.

*The PRESIDENT (Mr. R. E. Crompton), after proposing a vote of thanks to Mr. Robinson, said he need hardly call attention to the extreme and paramount importance of this question of the development of the high-speed engine to those who were electrical engineers and power generators on a large scale. He thought their great progress dated from the time when Mr. Willans began to pay such close attention to the high-speed engine, and that fact should be the warrant for the Paper that had been read that evening. He hoped, after Mr. Robinson had acted in such a self-denying manner by cutting his Paper down to a mere abstract, that the discussion would be worthy of the Paper, and that they would be able to spend the remainder of that meeting and the whole of another in the discussion of it.

*Mr. J. S. RAWORTH said they had had a very great treat that night, because they had heard a gentleman read to them a Paper on a mechanical subject who was evidently not only a good engineer, but also a master of the literary art. He quite agreed with the President, that the electrical industry owed a very great deal to Mr. Willans for this wonderful engine, because it enabled electric lighting to be introduced in its early stages under circumstances in which, perhaps, no other engine could have existed. He did not, however, quite agree with the President in suggesting that electricity would not have advanced so rapidly but for this engine, although it was quite possible that it would not have advanced so rapidly within the confines of the London postal district but for the work which Mr. Willans had done, and of which he had given them the

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benefit. While he (the speaker) did his work with other kinds of engines, he must say he was a great admirer of enclosed engines, and he did not think all the advantages claimed by Mr. Robinson for the Willans engine came from the fact that it was a single-acting engine, but accrued from the fact that it was an enclosed engine. They had at the top of the Paper the title, "The Recent Development of the Single-acting High-speed Engine for Central Station Work," and he rather imagined that when Mr. Robinson took that title he was going to give them a history of the development of the single-acting engine; but the Paper itself was confined, so far as he understood it, to the recent developments of the Willans engine, and the author had not thought fit to go back to the early history of the Willans engine, because there were many single-acting engines before the Willans engine, and even the Willans engine itself went as far back as 1874. He did not want to develop that point, but to direct attention to the second paragraph, in which Mr. Robinson said that a certain Paper stated that if they "had stuck to the builders of mill engines and marine engines, instead of trying to strike out a new line of steam engines for themselves, electric lighting would have been very much the gainer." He (the speaker) quite agreed that that was all nonsense. The author said, further down, that the total indicated horse-power installed in all the lighting stations in Great Britain was 101,390, and of this his firm had made 53,340. Well, the Brush Company had built 31,000, so there were only about 17,000 left. He did not know whether either of them was exaggerating, but he would take it for the moment that both were speaking the truth. This fact remained, they had not been greatly indebted to mill engineers. He would undertake to say that there was no one in that room engaged in this industry who had not at one time or another tried the effect of consulting one of those engine builders. His experience had been that they failed entirely to grasp the situation. They knew how to design a good mill engine, but it was quite another thing to turn out an engine to drive an electric dynamo, which responded to every touch and reproduced the fluctuations of the governor with absolute accuracy, and which had not got the steadying influence of 200 H.P. or 300 H.P. in mill shafting. He had no hesitation in saying that if the horizontal engine lasted 40 years the beam engine would last 80 years, and if corporations, desiring to save a few pence or pounds in repairs, did not mind spending a good many more pounds in interest on money and depreciation, by all means let them put in a beam engine instead of a horizontal, and get one to last to all eternity. Coming back to the Willans engine, he was, as he had said, a very great admirer of that contrivance; he thought it had extremely good points about it. He had used some with very great success. Mr. Robinson had put its features most admirably, giving them some idea as to its engineering construction and the theory followed out by its makers, of which some were entirely ignorant before. This ingenious engine had one difficulty, and engineers would look on it as a serious difficulty; that was that it was a Chinese puzzle, and they could not afford always to keep a Japanese on the premises to solve the problem. When he said it was a Chinese puzzle, he meant that they could not take out any one portion to see whether that part was in proper order or not. Now he wanted to take them for one moment to the question of high speed. Mr. Robinson seemed to think that the speed of revolution was a natural corollary from having the thrust entirely in one direction, and he found that a great many people were carried away by the same specious argument. He would ask them to consider that a Willans engine giving 360 I.H.P. had only a stroke of 9in. Now did anybody ever see a double-acting engine with anything like so small a stroke for that high power? In his experience there never was such an engine, and the reason was obvious. The double-acting engine if run for a few minutes might get an appreciable amount of wear and slack. They knew that a small amount of knock would make a large noise. A small drummer boy would awaken a whole village. He noticed with considerable satisfaction that Mr. Robinson admitted that for the extremest speeds they must use a double-acting engine. The reason was obvious, because on the back stroke they had to put velocity into the working parts out of the cranks and not out of the steam, and the strain would become excessive. Now they found the question of wear discussed, and he was sorry to say he could not quite agree with the author; in clause 7 he said, "It is evident that a single-acting engine in which there is absolutely no back-lash and no reversal of stresses, and which is otherwise rightly proportioned, will run freer from wear in its brasses than a double-acting engine at any but very moderate speeds." He was quite willing to admit that the Willans engine was pretty free from wear, but he did not attribute it to that cause. He had had large experience with bearings run with considerable weights acting entirely in one direction. The Mordey Victoria alternator had a magnet which weighed a considerable number of tons, and it was always a very great difficulty to get the bearings of that machine to run at all. At the high speed of the old belt-driven machines it was found difficult to get it to run unless they adopted forced lubrication. By changing over the strains when the engine piston passed the ends of the stroke a gap was made into which the oil could freely enter, and it gave them the opportunity of getting better lubrication than they could get with constant pressure in one direction. He asserted that any ordinary Tangye engine would give from 90 per cent. upwards in brake efficiency. When they came to the slow-running horizontal engines which were so much admired, he quite admitted they could not do it because they had to drag forwards and backwards on a long rail with no wheels a heavy piston only imperfectly lubricated. This it was that reduced the brake efficiency of the horizontal engine. He heartily agreed that electrical engineers were greatly indebted to Messrs. Willans and Robinson for the specially highly-developed machines which they had put in their hands for getting over the difficulties of many very awkward conditions.

Mr. H. G. BOOTH said there were one or two remarks he would like to make, and particularly one with reference to the Cornish cycle. The author referred in the Paper to the overlapping of the temperature ranges in the cylinders of an ordinary engine, stating that that was not the case with the Willans engine. He did not think that was altogether correct. He had a diagram in which the expansion curve was taken right forward. The exhaust line went backwards almost like the diagram Mr. Robinson had given them. If the low pressure of that engine were as he had pointed out, there was no overlapping of the range of temperature in an ordinary combined engine which was properly designed, and the valves of which were properly set. That was a point which ought rather to be insisted upon. He admitted the value of the Cornish cycle, but thought the ordinary compound engine got the same result.

* Mr. E. TREMLETT CARTER said that the initial cylinder condensation depended on the temperature ranges of any mass particle of the iron. What Mr. Robinson had shown was that in the Cornish cycle the fluctuation of the temperature of the steam in the cylinder was divided into two; but the fluctuation of the temperature of any particle of the cylinder liner was not divided into two, but was really continuous, as if the whole expansion took place in one stage. While one side of the piston underwent the fluctuation of temperature represented by the upper portion of Fig. 6, when it had passed over on to the other side of the piston, it became now the other side of the cylinder, and underwent the fluctuation of temperature represented by the lower part of the diagram. His point was that the two stages of the fluctuation of temperature did not take place in two separate cylinders with two separate surfaces, but in one cylinder and with one surface. Every particle of iron underwent two changes of temperature, and the variation of temperature of the liner caused the condensation of water on the surface just the same whether they had a Cornish cycle or whether they had an ordinary expansion in one stage and on only one side of the piston.

*Col. SALE spoke as to the relative cost of these methods of driving. Recently he had had occasion to call for tenders on the part of the Government for certain engines and dynamos to turn out 500 H.P., the dynamos to be direct driven. The question lay between slow-speed engines and flywheel armatures and a comparatively quick-speed engine driving a multipolar dynamo, and a high-speed engine driving a comparatively small dynamo with comparatively high speed. The low-speed engine ran at 80, and the speed of the dynamos was 120. The speed of the high-speed engine was not specified. It would be supposed that far and away the cheapest would be the high-speed engine and dynamo—both comparatively small—but that was not the case. The highest price, but not much the highest price, was that of the slow-speed engine and the flywheel armature. Next in order came the high-speed engine and the high-speed dynamo together. The lowest priced of all was the vertical engine and the multipolar dynamo, running at 120. This result was contrary to expectation.

THURSDAY, MAY 23RD.

*Mr. ALEXANDER SIEMENS said it was a singular coincidence that that day was the anniversary of Mr. Willans' death. He should not have risen to occupy their time if Mr. Robinson had not mentioned his Newcastle Paper. With regard to the figures given in that Paper he would remind them that they were not test figures for show-trials, but they were the results obtained in the regular working of their central station in Woolwich. As to the results obtained by the Belliss engine, he would specially observe that that engine was the very first of its kind made by Messrs. Belliss, and it was only natural that later engines should show better results than the one about which he reported at Newcastle.

*Mr. CHANDLER said there were one or two points in Mr. Robinson's Paper with which he could not quite agree. Firstly, he told them the valve rings were "not steam packed;" that was the slide valve rings. Now, if they were not steam packed what prevented them from collapsing during the transit past the portholes in the trunk? Then, again, they were told that steam was admitted to the space behind the piston rings, and this steam, assisted by the thin junk ring or follower, kept the rings in constant thrust downwards. But the same conditions were arrived at with an old-fashioned piston. He simply mentioned this to show that not only could the most modern engine accomplish these things, but also the most ancient.

*Mr. MORCOM said he was rather at a loss as to the manner of his reply to Mr. Robinson's Paper, as he had referred so extremely politely to the Belliss engine in three or four points, but it had, however, been pointed out to him that the whole tenor of the Paper was to condemn this engine quite as much as any of the other engines to which Mr. Robinson had been referring. Now, he might say at once they had proved certainly that in all the points to which Mr. Robinson had referred they had an engine at least as good as the Willans. He would prove his words further on; but it would be useful to deal with the matter historically in the same way as Mr. Robinson had done, and show why their engine was designed. They had been building high-speed engines running up to quite as high revolutions as the present electric lighting engine, 500 and thereabout, for all kinds of powers, for a matter of nearly 30 years, so they knew what a double-acting engine could do, and what it could not do. When they were brought face to face with the necessity of devising an engine that would run continuously for station work at the higher speed of revolution, they naturally looked to the single-acting engine as a possible means out of the difficulty. They were building then for the Navy, and their first view was naturally in that direction. The engines for electrical purposes in the Navy some years ago were nearly altogether single-acting engines; but the Admiralty, owing to the difficulties occurring with the single-acting engine, permitted double-acting engines to be employed at the same time, but would not permit them to run at much more than half the number of revolutions. Gradually representations were made as to most serious collapses of the Willans engine, lines of valves coming down, crank shafts breaking, and pistons smashing altogether. In consequence at

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the present time the Admiralty, and also a number of other Governments, would not have a single-acting engine for driving the electric light. Double-acting engines had been going through the same duties alongside of them, and had not shown the collapses and difficulties. The reason was easily seen by taking the single-acting engine as it stood as compared with the double-acting engine. There was always the fact that you had twice the area of the piston; that meant double the strain upon each rod, double the pressure on every bearing, and therefore, under ordinary circumstances, double the wear. In addition to this, the mode in which the pressure was taken, *i.e.*, the constant thrust which Mr. Robinson had referred to as being a favourable feature in the engine, was bad. This constant thrust had been a thing he had had some experience with in the oil-testing machinery at one of the dockyards, when the apparatus had to be converted from single to double acting to enable it to run at all. These facts helped them to go boldly into the design of a double-acting engine, knowing that they were going to get somewhere near if not up to the Willans engine. He would now take up the points Mr. Robinson had referred to one by one and see how they fared. First came the question of economy. He had there the results of a trial of one of a set of engines for St. Pancras, recently made under conditions very parallel with those obtained at Thames Ditton; in fact, they had copied their testing arrangements as exactly as they knew how to do. The tests were made in the presence of Prof. Robinson's assistants, and were carefully checked. There were, in fact, three engines of the sort, and a comparison between the three showed that the results were practically correct as they stood. They had there certainly as good an engine as they could make at the present time. It showed that with pressure of steam about 120lb. the water per electrical horse-power had come out to a mean of 19·89 for an average of six hours, running under full power. The power that they ran the engine at was about 10 per cent. higher than the maximum required at the station, an extra full power being required occasionally. As the slide valves were set for that, they preferred to run at that power to get the best possible result. That result was as good as the Willans engine could do with that pressure of steam. The efficiency of the engine came out at 92, the higher figure which Mr. Robinson had spoken about. There was no doubt about this fact: that there was not a halfpenny between the two engines so far as economy went, and they might take his word for it that there was at present no use paying any more for it. As far as durability went, Mr. Siemens had referred to the engine that was spoken about at Newcastle. That, of course, was one of their first engines; he wished, seeing the position it was in, that it was one of their last ones. He had seen that engine opened up, and after the two years' hard running there was no wear whatever on the brasses, and no necessity for adjustment. He could also refer to many other cases, where after long continuous running the forced system of lubrication had entirely prevented wear of the working parts. Mr. Robinson put his finger on the reason why their (Messrs. Belliss') engine showed up so much better on the lower loads, but that question of piston ring friction was a big question, and was going to be a bigger one by-and-by. At the present time superheating was largely in the air, and he thought he should be willing as an engineer to predict that in the next year or two superheating would be very largely in electric lighting stations. If superheating came in, the question of rings and the friction they might have would be a much more important thing than it was now. The necessity for lubrication would also be of more importance, and there would also be the necessity for keeping that lubrication out of the boilers. With condensing and superheating the Willans engine would therefore stand a still worse chance. As far as governing went, one would say off-hand that the double-acting engine ought, having two impulses in the revolution, to be better than the single-acting engine for governing. He had seen some single acting engines where it had been necessary to throw the governors out and govern the station by means of a man at the throttle. If Mr. A. H. Preece were here he could corroborate the fact of the excellent working of the new type of throttle governor he had seen on an engine at their works last week. With this the governing was practically isochronous, and the sudden run up when all the load was thrown off only averaged about 2 per cent.

Belliss-Crompton Combination for St. Pancras.—Result of Six Hours Water Consumption Trial.

Hour.	Steam pressure.	I.H.P.			Water per				E.H.P. / I.H.P. Efficiency.
		H.P. cylinder.	L.P. cylinder.	Total.	E.H.P.	I.H.P.	E.H.P.	Hour.	
1st......	123·3	85·78	115·89	201·67	178·6	18·0	20·35	3,635	88·5
2nd......	123	85·00	117·23	202·23	178·8	17·3	19·66	3,516	88·4
3rd......	121·75	86·93	114·98	201·9	179·1	17·5	19·8	3,550	88·7
4th......	121·5	85·8	116·77	202·57	177·2	17·5	19·8	3,539	67·47
5th......	120·5	85·57	115·77	201·34	178·8	17·48	19·69	3,521	88·8
6th......	120·5	86·97	113·58	200·55	177·6	17·7	19·98	3,550	88·5
Mean ...	121·75	86·00	115·7	201·71	178·35	17·58	19·89	3,551	88·395

*Mr. ARTHUR WRIGHT, who was called upon by the Chairman, said he was afraid his remarks would be uninteresting, as he had nothing but compliments to offer. He had had about 2,000 H.P. of these engines under his control and had had no bad experience whatever. The whole of that 2,000 H.P. was managed by two men and a boy. He had hardly ever seen the insides of the engines, and had had no bother with them of any kind. Results showed that, so far as economy was concerned, they at Brighton could achieve it as well as other people. He could not imagine a better engine.

*Mr. DRUITT HALPIN said at the last meeting they heard some very high figures indeed about brake efficiency. He had never had one of these single-acting enclosed engines on the brake and knew nothing at all about their efficiency. But they heard a good deal about the "common or garden" engines running into fabulous efficiency—91, 92, and 94 per cent. —and he certainly could not believe any figures of that kind unless he was given means of verifying the statements. Of course, they knew there was nothing that would lie more consistently than an indicator, except, of course, a voltmeter and an ammeter. It was also known that it was very usual to get wrong indications in the brake. The remarks of the last speaker about the oiling and the necessity of having reversal of stress at the end of the stroke, change of stress, to enable the engine to run, reminded him of a discussion he had with the late Director-General of the Belgian Railways. His view was that all railway travelling would be impossible merely from the point of view of lubrication if it were not for the slight tremors produced by the road allowing the lubrication to get in: else the whole thing would stop and no system of lubrication could be maintained. But he certainly could not agree with the last speaker that it was necessary to have this perfect reversal of stress to get lubrication in.

*Mr. GEIPEL said the Paper which Mr. Robinson had put before them bristled with information and points which were of the utmost interest. There were one or two points in the Paper, however, to which he would refer, with a view to obtaining even more information from the author than he had already given. In the first place, in speaking of the costliness of slow-speed direct-driven steam dynamos, he took it that Mr. Robinson referred only to first cost; otherwise, was it not somewhat previous to state that high-speed would last as long as slow-speed engines? They knew that there were slow-speed engines which had been at work for 42 years and upwards which were running at the present day; that the Willans or any other high-speed engine would do this had yet to be proved. If they would not last so long then it was necessary to take into consideration whether the earlier renewal of the one would balance the increased first cost of the other. Mr. Robinson referred to the difficulty of overcoming the vibration so far as concerned the one and two-crank engines, and recommended the three-crank double engine. This, of course, was not a question which greatly concerned the users of high-tension systems, who could generally put their engines in distant places where vibration was of little moment. But was not the method of overcoming the vibration advocated, namely the use of double engines each having 9 cylinder or 18 cylinders in all, a further argument in favour of the use of slow-speed for the day-load engines? For tramway work the author correctly emphasised the necessity of engines considerably larger than were required for the mean power, and, in paragraph 23, he referred to the higher mechanical efficiency of double-acting engines at light loads. He agreed with the author in that, and believed that for such work the double-acting engine was best, at least in that respect. The necessity of using powerful governors, and giving them next to nothing to do, mentioned in paragraph 49, could not be too strenuously dwelt on. The makers of throttle-valve governors were too prone to cut down the weight of the balls. There was no part in an electric light engine which was more important, and to which probably less attention had been paid hitherto, than the governor. He agreed with the author as to the desirability of using plenty of flywheel power to control the engine in the event of sudden variations in the load, though he did not believe that the flywheel had so much steadying effect on the governor as he stated. The great sensitiveness of shaft governors was, in his opinion, partly attributable to a continual variation in the strains on the parts controlled by the balls; anyhow, speaking from experience, he had found shaft governors, notwithstanding the heavy work entailed on the balls, to give closer governing than throttle-valve governors.

*Mr. J. N. SHOOLBRED said there were one or two points he would like to remark upon. There was one point in regard to which he was afraid he could not eulogise the engine in the same way that Mr. Wright had done. It seemed to him to be a blemish on the Willans engine—the use of the throttle valve. To use it economically it was necessary to keep it pretty fully loaded, and it had not the advantage of the other engine in respect to the expansion valve; and it seemed rather contrary to one's ordinary ideas, that the steam at a very high pressure should be demanded, only to be throttled down and made use of at a loss of 25 per cent., or perhaps even 75 per cent., of its pressure. That in itself seemed an anomaly. The Willans engine was spoken of as the engine of the future; he would rather look at it as the engine of the present. He thought as they got into larger powers the more would the double-acting engine be used, even more than the Willans.

*Mr. R. W. ALLEN said, as a designer of double-acting engines for some years, he would like to give Messrs. Willans and Robinson credit for setting them a lead, not only in the designs of double-acting engines, but also in the excellence of manufacture, which was a most important point. He would lay stress on the crank shaft, which was the basis of an engine. There were very few men who could really turn a crank shaft which was true; and unless the crank shaft pin was true, trouble would certainly take place. Moreover it is impossible to obtain the high efficiency which is shown in the paper unless the greatest care is taken in the manufacture of every part. With regard to what Mr. Morcom had said, no doubt when he designed his engine, like his firm themselves had done with theirs, he had had the section of a Willans engine in front of him, and had taken advantage of the 15 years' experience of Messrs. Willans and Robinson, which had not only helped them, but the world at large, the designers of small and large engines. No doubt what Mr. Morcom had said was true with regard to the engines in the Navy, but that was, of course, due to circumstances over which Messrs. Willans and Robinson had no control. He could give an instance of the way in which one of his firm's double-acting engines had been treated on a ship which had been lying up in port

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for a few days. Water had accumulated in the steam pipe, and the engines were working at full load; this was the night before sailing. The engineers turned on the wrong cock, and instead of the water going to the condenser it came right back to the engine, and the engines were doubled up. That would take place with a single-acting engine just the same as with a double-acting engine.

Mr. R. DUMAS said although he had had nothing to do with central station lighting, he had had a little to do with the Willans engines on board her Majesty's ships, and as far as his experience was concerned he did not see that the interchangeable system of manufacture pursued at the Willans' works was found to be a very great advantage. There were, however, some points to which he should like to call attention, and in regard to which he would ask for further information. With reference to the piston rings it was rather surprising to find that steam packing had been so successful, since it had been tried and abandoned by so many others; the only conclusion one could come to was that some essential point had been overlooked in previous designs. With the piston rings exposed to the varying pressure of steam in the cylinder it might be expected in cases where the lubrication was not efficient that the wear in the upper part of the cylinder would exceed the wear in the lower part. With regard to the piston valve packing it would be interesting to know if any experiments had been made with a view to ascertaining the steam pressure in the interior of the valve; probably it was not far from a mean between the initial and exhaust pressures. Assuming this to be the case it seemed evident that collapsing of the rings of the upper part of the valve must take place in consequence of the excess of the outside pressure, and this especially when the packing rings came opposite the ports. The lower rings, on the contrary, must be pressed somewhat severely against the valve trunk, as with them the inside pressure exceeded the outside. Probably, therefore, the wear in the lower part of the valve trunk was greater than in the upper part. Doubtless, Mr. Robinson's experience was sufficient to set this point at rest. He supposed the reason why no attempt had been made to subdivide the hollow valve was that the weight would be increased thereby, and this would increase the difficulties mentioned in the Paper in the case of throttling engines working on light loads. With regard to the internal drainage, the coning of the pistons was at once a simple and efficient way of overcoming the difficulty as far as the cylinders were concerned, and it was a most happy coincidence that the strength of the pistons was increased at the same time. With regard to the Cornish cycle, he was of opinion that that was a most important and beneficial feature in the engine. He was rather surprised to hear Mr. Tremlett Carter question its advantages. With regard to the air-cushioning arrangement, he understood that this was so designed as to keep the lines of parts (of course, excepting the line of valves) in constant thrust even when there was practically no pressure in the steam chest. This being so, it was clear that whatever effective pressure there was in the cylinders was added to the pressure due to the air cushion, and that the pressure on the crank pin must be very severe during some parts of the down stroke. Since there was so little clearance, and consequently compression, in a Willans engine, the valve trunk must for some parts of the up-stroke be in tension. He would like to know if there had been any trouble with breakages through the bottom row of ports. Doubtless the air-cushioning arrangement was very efficient and was more easily adjusted than the compression in a steam cylinder. In a double-acting engine the compression curve was often very deceptive, especially when the diagrams from the two ends of the cylinder were separated. Now that variable expansion had in some cases been adopted, and that the full pressure was available on the high-pressure piston for acceleration of the parts, there seemed to be no reason why an effort should not be made to get rid of the air-cushioning cylinder. This could be done by arranging for the valve itself to cut off about 0·6 of the stroke, release to take place at 0·9 and compression about 0·83. Naturally, the clearance volume and consequently surface would have to be increased; if it was objected that this would prejudicially affect the economy of the engine he would ask, what had been the effect of letting steam to the back of the piston rings, and thus considerably to increase the clearance surface? He was of opinion that the mechanical efficiency of the engine would be sensibly increased if the cushioning cylinder could be dispensed with. He was aware that this would not be possible if a late cut-off were required, as sufficient compression could not be obtained in the steam cylinder.

Mr. JEREMIAH HEAD said he had not had the opportunity of reading the Paper, and he was not a member of the Institution; but the President and Council had been kind enough to invite him to speak. The only point which had struck him in the exceedingly interesting discussion which had taken place was that raised by Mr. Morcom about the difference of the lubrication between a single acting and a double-acting engine. It might be of some slight interest to the meeting to know that a good many years ago he was so smitten with that beautiful piece of mechanism, the Brotherhood engine, that he determined to have one made that should be larger than any that had ever been made before. Accordingly he had one made for 20 H.P. to work with a pressure of 60lb. to the square inch above the atmosphere. This engine was put to drive a rolling mill, and it ran at 300 revolutions per minute; but he was sorry to say that it utterly failed in the end by the seizing of the crank pin. Very elaborate arrangements were made for oiling that crank pin; but the oil was not pumped in, it was merely allowed to run down the vertical piston rod and connecting rod with a considerable hydraulic head upon it. As he had said, it failed because the connecting rod ends continually seized the crank pin and pulled the engine out. That impressed him very strongly with the view that single-acting engines, which were always bearing on the journal in that way, were liable to fail unless some arrangement was made by which the oil could be pumped in at a pressure at least equal to that of the connecting rod on the crank pin. He thought that little bit of information might be considered to bear on the subject and be of interest to the meeting.

*The PRESIDENT said in bringing the discussion to a close he wished to say a few words, because he had had the honour and pleasure of being a very intimate friend of the late Mr. Willans. It was 19 years since he first bought a Willans engine, and he had been using Willans engines during the whole period of time which had since elapsed. After alluding to the attack which had been made by one technical journal, the President went on to say that he had had over 25 years' experience in direct charge of steam engines, and of the earlier part of that time he had very unpleasant recollections. He was then out in India, and had to put the brasses together himself very frequently, because native labour had to be taught; and he of all men could appreciate the difficulty of keeping double-acting engines in order, in eliminating troubles connected with the bearings, and in keeping the engines free from knocking and vibration. It was his strong feelings on that point which brought him in very early association, first with Mr. Brotherhood, whose name had not been sufficiently mentioned in this discussion, and subsequently with Mr. Willans. He was sure the firm of Willans and Robinson would be the first to acknowledge the great services which Mr. Brotherhood had rendered to the cause of high-speed engines. He would not touch those points in the discussion, which would be dealt with most completely by Mr. Robinson. He (the President) did not speak at all as an advocate of the Willans engine *quâ* Willans engine, but he did speak of it from the point of view of regarding it as a highly successful high-speed engine, and he did so because high-speed had been the making of electrical engineers, for if high-speed engines had not been introduced they would not have made such progress with their central station work as they had done. He thought Mr. Morcom and Mr. Chandler would agree with him in what he had said on that point: that the great trade that had been made and was likely yet to be made in high-speed engines owed a very great deal to the Thames Ditton firm. Mr. Raworth, in his very humorous speech, objected to the Willans engine because it was such a puzzle to put together. He (the President) must say that he did not understand this statement. He was in charge of a great many of these engines, and had always found that they were taken down and put together by labour much more unskilled than that usually employed in such cases, by men who were not fitters in the usual sense of the word, and who would not be trusted to fit together the brasses and other work of that kind in an ordinary double-acting engine. The reason was that in the Willans engine all they had to do was to take it to pieces and put it together again in just the same way, and if the parts were worn to put in others of the same kind. The work was perfectly simple and the men had only to obey orders. Mr. Raworth told them a most interesting story about a dynamo, a tramcar, and a horse. In his comparison between the complication of the motor of a tramcar and the inside of a horse he hit upon the real reason why many engineers, including himself, thought that Mr. Willans and other engineers who enclosed their engines had done the right thing. What mattered it that parts were complicated if it was found in practice that they were very effective and did not become deranged? The constructor of the horse was well aware of this: he knew the horse was as simple a machine as could be devised for the purpose, but knew also that people would object to see the working parts, and also knew that the lubrication and things of that sort were not nice things to be flying about in public, and therefore he encased them. He thought that was a sufficient justification for enclosing engines. They were flooded with leading articles in the technical journals to the effect that they (electrical engineers) ought to take lessons from the fountain-head, *i.e.*, the Lancashire mill engineer, in reference to engines. He had challenged all the fountain-head men to come there, and he could not get any of them to speak. Apparently they had nothing to say, or they would back up the articles that had been brought forward. But there could be no doubt that their outcry had influenced—and he regretted it very much—a number of the members of their profession, for engines were still being put in in a way which was really pandering to this outcry. This, he was sure, would be a cause of regret to the users of those engines when they compared their results with the results obtained by those who used high-speed engines in their central stations. He believed all the speakers that evening were in agreement on that point. He regretted that they had not some of the enemy present there that evening. No doubts were so frequently raised as those regarding the durability and the high cost of repairs of high-speed engines. Eight or nine years ago it was found that in central station work the cost of repairs was as little for high-speed engines as for low-speed, and in some cases it was even lower. They were getting rather tired of hearing these objections, and he would like to hear something fresh; he would like to hear upon what grounds those assertions were being made. He regetted to hear one gentleman speaking of sweeping up the interior of an engine in a dust-pan; he did not think that was a nice way of putting it. No doubt such things had been, and it was not to be wondered at, seeing the brutal way in which engines were treated in the Royal Navy, where they injected steam pipes full of water suddenly into the cylinders of the engine. It was far better that something should give way, and that a nasty accident should not take place. But there was very little doubt that such accidents did not occur now; any engineer who allowed them to occur in his station would not confess it, because he would know his experience was so abnormal that he would rather not be thought of as the extremely careless man he would prove himself to be by permitting such accidents. He did think they had every reason to be extremely proud of what the Thames Ditton firm, and of what Messrs. Belliss and Chandler, and other makers of high-speed engines, had done for them. They had enabled them to show figures—steam into electrical units—which were better than any other figures he had come across. The improvements in engine construction had been a very great movement in advance for the benefit of engineering generally, and for electrical engineering in particular, and for that reason he was extremely pleased that the last Paper of the session was upon so interesting a subject.

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Mr. ROBINSON, in replying, said Mr. Raworth rather suggested that he must have treated of other single-acting engines than the Willans. The answer to that was to be found in the title of the Paper, which was "*Recent* Developments in High-Speed Engines." He had confined himself to improvements in the Willans engine, carried out either shortly before or shortly after Mr. Willans' death. If he had dealt with no other engines it was because none had taken, so far as he knew, a prominent part in central station work. In America there was the Westinghouse, of course, but he had not thought it necessary to deal with that. He had tried to make the Paper as general as he could. It would be but affectation to ignore the fact that the single-acting engine was for the present the Willans engine, and in that fact lay the chief reason why he was speaking to them upon the subject. As regards the amount of the total horse-power, he knew how difficult it was to get such figures. He had taken a public list, which excluded a large unfinished station, probably knocking a great deal off the Brush figures, and he had also excluded many thousands of horse-power which did not in his judgment come under the head of central station work for public lighting. Mr. Raworth had said the engine was such a Chinese puzzle, and that it was all boxed in. He (the speaker) never could sufficiently admire the virtuous disapproval of many engineers of parts which were boxed in. He was afraid he had not been sufficiently clear about engines for high-speed continuous working and constant thrust. Constant thrust enabled them to run an engine with no knock and very little wear, even at high speeds. They had had some difficulty with bearings apparently quite lightly loaded, where the shafts had formed part of a magnetic circuit, and the conclusion they came to was that such a bearing might appear to be lightly loaded, and yet for some magnetic reason might be very heavily loaded. Mr. Raworth had given himself and his colleagues credit for recent improvements. But those improvements had either been planned by Mr. Willans, or based upon experiments which he planned and carried out, the only exception being the automatic expansion gear now used. Mr. Morcom had shifted the discussion very much into the nature of a duel between single-acting and double-acting engines, and that was fair enough, because the Paper was in praise of that principle. Mr. Morcom said his firm had made engines running at very high speeds for more than 30 years. He presumed that was for marine purposes. [Mr. MORCOM: The large majority have been marine engines, large yacht engines, pinnace engines, and so on.] He was afraid that he had caused some indignation at the Admiralty by telling them that the Willans engine was intended to be used as a steam engine and not as a hydraulic engine. Mr. Morcom said there must, of course, be a double area of piston and cooling surface, and double stresses on the pins in the single-acting in comparison with the double-acting engine. That, of course, was true if they were to run at the same speed. That was the crux of the whole question. They (his firm) said you could not run permanently and continuously at the same speed. That was a point to be threshed out between the two systems. Mr. Morcom thought constant thrust was no good. He attached importance to the play of the crank-pin in its brasses or the shaft in its brasses, letting oil in underneath. No doubt the double-acting engine had advantages in that respect; but they had turned out something like 100,000 H.P. of Willans engines, and had been almost absolutely free from trouble with their main bearings, which were most pressed down on the brasses. Mr. Morcom referred also to economy. The economy in the St. Pancras figures was very great, but he did not think it was quite correct to say they were the same as some of the figures that could be given for single-acting engines. Still, it was a very good economy and a very good efficiency. All he could say was that, through the uncertainty of measurements, and especially in commercial engine rooms, they were always a little shy of quoting extreme figures. The highest of the efficiencies given, he thought, just about corresponded with what had been occasionally obtained at Thames Ditton. With regard to governing, he would just remark that the double-acting engine with two cranks only was in the same position as a single-acting engine with two cranks as regards impulses per minute, because two were coming at the same time. Governing was of no importance in this connection. Mr. Geipel asked how long the engines would last; would they last 42 years? It would take nearly 30 years to answer that question. So far as the shells went he did not see why they should not. As to vibration, he had never advocated six-crank engines for lighting stations, or for tramway work, except where absolute absence of vibration was to be obtained. That subject was gone into purely for marine purposes, and it was satisfactory to know that they had found something to get over vibration so slight that most people would describe it as no vibration at all. Far more importance attached to the question of vibration on board ship than in a lighting station. If they worked at very light load they certainly had to throttle the load down lamentably low; but experiments show that if they got down to very low load indeed the throttled engine was absolutely more economical than the cut-off, and that at moderately light loads the difference between them was extremely small. Seeing what the throttle or valve-expansion engine would achieve at full load, the moral was that they should not work at light loads at all; but if they must do so, as little as possible. Mr. Dumas supposed steam-packing had been tried before, but he (the speaker) thought not on the single-acting engine; that was to say, steam-packed rings were not worked in any way under the same conditions as in the single-acting engines. Mr. Dumas also asked if there were more wear at the top than at the bottom. He did not think so; it was quite equal at both ends. Mr. Dumas said the trunk must be in tension sometimes. He could assure them it would come to grief if it were. He greatly lamented that they had not had the criticisms of some of the advocates of slow-running. He wished they would come forward and give it hot to the fast-running engines. Mr. Morcom he was obliged to look on more as an ally than as an opponent, for he was a high-speed man. He thanked them all very sincerely for the kind way in which they had received the Paper.

PHYSICAL SOCIETY.

At an ordinary meeting of this Society, held on May 24, 1895, Capt. W. de W. Abney (President) in the chair,

Mr. BURSTALL commenced the reading of a Paper

"On the Measurement of a Cyclically Varying Temperature."

The experiments were undertaken with a view of measuring the temperature inside the cylinder of a gas engine at different points of the stroke of the piston. A modified form of platinum thermometer is employed to measure the temperature, and since the variations in temperature are extremely rapid, the wire had to be very thin and unprotected by any covering such as is ordinarily employed. The leads of the thermometer pass through a slate plug fixed in a seamless steel tube, asbestos being used as a packing to prevent leakage. The resistance of the thermometer was measured by means of a Wheatstone's bridge. Since the temperature at a certain part only of the *working* stroke had to be measured, and the galvanometer circuit was broken in two places, one of these breaks was closed by means of a cam on the shaft of the engine at a given point of each revolution, while the other was closed when an explosion took place by means of a relay worked by the pointer of a steam-engine indicator attached to the cylinder of the engine. The remainder of the Paper was postponed till the next meeting.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, May 31st.

ROYAL INSTITUTION.

9 p.m. Friday Evening Discourse: "The Radiant Heat from the Moon during the Progress of an Eclipse," by the Earl of Rosse, F.R.S.

THURSDAY, June 6th.

ROYAL INSTITUTION

3 p.m. Afternoon Lecture: "The Instruments and Methods of Spectroscopic Astronomy," by William Huggins, F.R.S.

FRIDAY, June 7th.

ROYAL INSTITUTION.

9 p.m. Friday Evening Discourse: "Phénomènes Physique des Hautes Régions de l'Atmosphère," by Prof. Alfred Cornu, F.R.S.

Australasian Electric Light and Power Wire Regulations.—We have received from Sir Charles Todd, the Postmaster-General and Superintendent of Telegraphs for South Australia, a copy of the second report of the Committee appointed at the Postal and Telegraph Conference, held at Hobart in 1892, for the purpose of drawing up a set of regulations with regard to electric light and power circuits. The report is dated Melbourne, November 8, 1894, and is signed by Sir Charles Todd, Major P. Walker, and Messrs. G. Smibert, R. Henry, Oswald Haes, A. J. Arnot, and J. O. Callender. The report states that it is the opinion of the Committee that it is desirable that the laws and regulations relating to electric light and power wires should, as far as possible, be uniform throughout Australasia. The regulations suggested by the Committee are a faithful copy of the (latest pattern but one) Board of Trade regulations dealing with the same subject, the main point of difference being, perhaps, that lightning arresters are specified where no mention of them is made in our English rules. The much-discussed regulation with regard to the thickness of the insulation of overhead wires is adopted as it stands in the Board of Trade rules; a minimum section for overhead wires is also specified, and suspension from a bearer wire is not absolutely obligatory. There are also one or two regulations dealing with transformers attached to street poles. In the electric traction regulations the minimum height of the trolley wire above the ground is put at 18ft. and guard wires are specified. Whilst Board of Trade regulations require an uninsulated return to be connected to the rails at every 100ft., the suggested regulations in Australasia propose to connect at each length of rail. Major Cardew's much-discussed suggestion of testing leakage to pipes by interposing a battery of three Leclanché cells is adopted without alteration. The Board of Trade regulations with regard to maximum leakage current, minimum insulation of underground cables, &c., are also all incorporated in the suggested Australian rules.

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(The Oldest Electrical Journal, 1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

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SPECIAL NOTICE.

Owing to the growth of the electrical and allied industries the demands for space in "THE ELECTRICIAN" are, for the greater part of the year, so pressing that a permanent increase in the size of the journal has become necessary. To meet the increased cost involved by this step, and by other improvements, such as heavier paper and more numerous illustrations, the price of "THE ELECTRICIAN" has from May 3rd been advanced to 6d.

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SINGLE-ACTING HIGH-SPEED ENGINES FOR CENTRAL STATION WORK.

The Paper which Mr. MARK ROBINSON has just read before the Institution of Electrical Engineers came as a direct challenge from a member of the well-known Thames Ditton firm; it was a piece of able but modest pleading as to the excellence of the single-acting high-speed engine in general and of the Willans type in particular. When it is remembered, assuming that Mr. ROBINSON'S figures are correct, that out of 101,390 I.H.P. now installed in electric lighting stations in Great Britain, over one-half, or 53,340 I.H.P., has been supplied by his firm, we offer no apology for referring fully to the many points he so definitely raises. As the author pointed out, the question, though in reality a very wide one, was, in his Paper, narrowed down within very precise limits: are the reasons for the almost unprecedented success of this engine —the central valve engine—to be sought in the late Mr. WILLANS' principle, or are they due to other causes? In the mind of the author there is no doubt; but it may be worth while to examine a little more closely some of his main conclusions.

In this connection it is a matter of extreme regret that the discussion was confined almost entirely to the makers of high-speed engines; the mill-engine makers and advocates were conspicuous by their absence, and it certainly seems as though they had abandoned their claims to share in this work, and were ready to admit in Mr. RAWORTH'S words that

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they had entirely misunderstood the problem of dynamo driving. There can be no doubt that the question of speed is a most vital one, and a very simple one: Is high-speed in itself a desirable thing or not? And on this we must take side with the author; if the principle is abandoned we are face to face with two difficulties. Either belt or other gearing must be adopted, with all its serious practical disadvantages, its resultant additional complexities and chances of breakdown, not to mention the absolute certainty of a reduction in the efficiency of the plant as an energy transformer, or else the dynamo itself must be radically altered in design, and in a a way which commends itself to few English electrical engineers.

This question of speed being conceded, it remains to consider whether, as the author claims, there is anything in the single-acting engine which makes it certain that it will beat its double-acting rival within the limits of speed and power suitable for electric lighting stations, for that is all its advocate claims for it. Mr. Robinson lays great stress on the fact, and rightly for many reasons, that it is a constant thrust engine; hence, there being no lost motion, wear at the brasses must be small. He, however, in defence of his conclusions, makes certain statements with which we are unable to agree. No doubt the actual rubbing of a brass upon the journal when the lubrication is perfect is a matter of comparatively small moment, but is the lubrication likely to be very perfect with the pressure always upon one side of the brass? Certainly, common experience and the results obtained by the Committee of the Institution of Mechanical Engineers on journal friction do not seem to agree with the view that it can be. It will be remembered that in certain cases they found it almost impossible to introduce the oil between the bearing and the brass, and it seems very possible that the rather high frictional load of the Willans engine, when running light, as compared with the Belliss engine, may be due to the fact that these surfaces are not well lubricated. On the other hand, the beautiful system of lubrication adopted by Messrs. Belliss may suffice to introduce the oil satisfactorily at low loads, and yet perhaps fail to do so at higher ones, thus accounting for the apparent anomaly in Mr. A. Siemens' experiments.

There are two other points on which great stress was laid by the author, and rightly, to which we wish to briefly refer. One was that with the central valve system adopted in the Willans engine the drainage was perfect, and probably none of the ordinary horizontal or vertical engines could compare in this respect with the Willans type. Undoubtedly this is a most important factor in the possible economy of any engine; the late Mr. Willans' experiments, described during a discussion at the Institution of Civil Engineers, on the enormous effect produced by a small coil of pipe (through which live steam could be passed) at the bottom of a cylinder in preventing accumulation of water, were a striking proof of the serious harm comparatively small quantities of water will produce in a steam cylinder, and how it tends to accumulate during the working. The other point is the adoption of the Cornish cycle, or the transfer system in working compound. One at least of the speakers in the subsequent discussion asserted that this transfer stroke had less effect than was claimed, dwelling in his remarks almost entirely on the action of the liner. But this ignores the main difficulty in connection with initial condensation in engines; experimental results have proved conclusively that it is by the clearance surfaces the most serious harm is produced. A jacketed engine with large clearance surfaces unjacketed as is so often the case has, as a matter of fact, but little reduction of initial condensation when compared with a non-jacketed engine. The transfer system most ingeniously saves the clearance surfaces from the range of temperature that the liner walls undergo (though a portion of these even do not have the extreme range); hence it is clear, that the condensation on them, for the same piston velocity, and the same surface per pound of steam, will be greatly diminished. In our opinion this transfer stroke, combined with the practical abolition of all ports, is the secret of the undoubted success of this particular high-speed engine in the matter of steam economy, and for the small practical value of jacketing when applied to them.

It has been frequently urged by the advocates of the slow-speed engine that the high-speed engine is usually a very uneconomical engine in the matter of steam, and as it wears always very badly, no real criterion of the steam consumption in practice can be obtained from the works tests. In this connection, the figures given by Mr. G. M. Clark at the meeting of the Institution of Mechanical Engineers in April last, and quoted by the author of the Paper, are most striking. Careful measurements of the actual steam consumption of one of the Willans engines at a station of the Westminster Electric Supply Corporation, under very different load conditions, brought out the interesting result that the calculated feed deduced from the full-power and light load trials at the works corresponded exactly to the measured feed when the latter was corrected for steam-pipe condensation, &c. This result is a striking confirmation of the accuracy of the so-called Willans law, when applied to these engines, and it shows most conclusively that in this engine electrical engineers possess a motor, the duty of which under most variable conditions is rigorously known; in fact, it is calibrated as accurately for all practical purposes as any of the instruments he is daily using.

The point of importance to users of power in regard to the economy of the high-speed engine is, that though they cannot hope to rival the best performances of slow-speed engines at full power, yet under light and variable loads they do. In fact, the mere knowledge of the steam used by any particular engine at its full power is of little value to the user, unless he also knows well the law of change of consumption with variation of power developed. This is a point too often neglected by advocates of some particular system. The question of durability is, after all, very largely one of good work; if an engine has nothing but the highest class of work put into it, if reasonable care has been exercised in its design, and if it is properly looked after while at work, then probably there is not much to choose between different types of high-speed engines. The facts given by Mr. Robinson, and the testimony of others are clear enough proof, if any were needed, that these engines are not machines which will knock themselves to pieces. Mr. Geipel's statement, that we have no proof that they will last because they have been only such a short time in use, is beside the mark, although they are probably unlikely to last as long as the more costly slow speed rival. Into the question the of value these engines have over the slow-speed engine in allowing a number of convenient-sized units to be arranged for in every station we do not now enter. It is now an article of faith that if economy is to be obtained, our units must be worked at full power as much as possible, and that means extensive subdivision. We can only hope that the welcome which has been accorded to Mr. Robinson's Paper will induce the makers of other types of central station engines to come forward and state their views in an equally lucid and cogent manner, and if they do so, we venture to express the further hope that the user of engines, the central station engineer, will take a more prominent part in the discussion than was the case last week, when the voice of the maker of engines was almost the only one heard in the land.

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A CONTRIBUTION TO THE THEORY OF DEMAGNETISATION.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

It has long been known that in order to retain the magnetism in a permanent magnet of hard steel, certain relations must be maintained between the length and cross-section of the bar as compared with the dimensions of the air-gap between its poles. In other words, it has been known that a certain proportion of the reluctance of the magnetic circuit must exist in the air-gap for a given value in the retentivity or hysteretic coefficient in the steel employed, in order that the magnetism in the circuit should be permanent. Mr. Hookham states in the *Philosophical Magazine* for 1889, Vol. XXVII., pp. 187-189, that from his

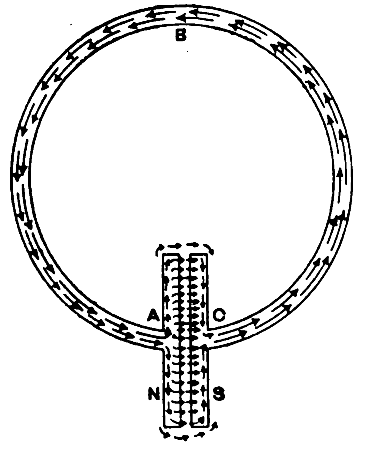

FIG. 1.

observations the ratio of length to cross-section in a magnet should not be less than 70 times the ratio of length to cross-section in its air-gap, in order to retain its magnetism indefinitely. So far as the authors are aware, the numerical theory of demagnetisations in permanent magnets has not been developed except in a few geometrical forms of magnets such as ellipsoids, which rarely present themselves in practice. It is here proposed to present this theory in a general form, and to show the relation existing between this theory and Mr. Hookham's empirical rule.

In Fig. 1, A B C represents a horse-shoe magnet of hard steel, $l$cm. in length, and of uniform cross-sectional area s sq. cms. Fig. 2 represents a portion of the descending

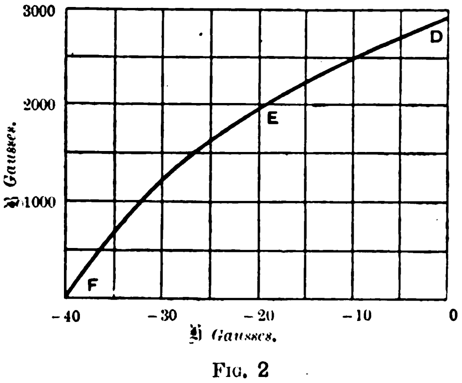

FIG. 2

curve in the hysteretic cycle of this steel. When the ring is magnetised by the application of an M.M.F. to an intensity of, say, 6,000 gausses,* and the M.M.F. is withdrawn, a certain residual intensity of $\mathfrak{B}$ gausses will exist in the bar, and the total residual flux will be $\Phi = \mathfrak{B}\, s$ webers. Of this residual flux a certain fraction Φ/n, or say ϕ, will pass through the air-gap, whose width is d cms., and active cross-section S sq. cms., producing in the air-gap an intensity of Φ/S gausses. The remainder of the flux, or $\Phi - \phi$ webers, will pass through leakage or air-paths outside the air-gap.

Just as in the electric circuit a current of i amperes passing through a resistance of r ohms produces a difference of potential of $e = ir$ volts, so a flux of ϕ webers passing through a reluctance $\mathfrak{R} = d/S$ oersteds in the air-gap will produce a difference of magnetic potential of $\mathfrak{M} = \Phi\mathfrak{R}\ \dfrac{\phi d}{d}$ gilberts. The mean difference of potential per centimetre length of the ring A B C will be $\mathfrak{H} = \dfrac{\mathfrak{M}}{l} = \dfrac{\phi d}{S\,l}$ gausses, and this will be the mean demagnetising force exerted through the bar. The effect of this magnetising force will be to reduce the flux through the bar until the residual intensity $\mathfrak{B} = \dfrac{n\phi}{s}$ is the intensity which corresponds in the descending branch of the hysteretic cycle to the demagnetising force $\mathfrak{H} = \dfrac{\phi d}{S\,l}$. As soon as the residual flux descends to this intensity, equilibrium will be reached. The equilibrium is, however, unstable, for any mechanical agitation or variation of temperature to which the bar may be subjected in the presence of this demagnetising force will cause a further demagnetisation to take place. In order, therefore, that a magnet should not be liable to variations in its intensity owing to slight accidental jars or variations of temperature, it is necessary that the demagnetising force $\mathfrak{H} = \dfrac{\phi d}{S\,l}$ should be considerably less than the value of $\mathfrak{H}$ which corresponds to the residual intensity $\mathfrak{B} = \dfrac{n\phi}{s}$ in the descending curve of the cyclic diagram for the quality of steel employed. The ratio of the cyclic value to the actual value of $\mathfrak{H}$ may be called the *factor of safety of demagnetisation.* According to the experiments of the authors, a reliable factor of safety is 3, and this factor of safety can usually be provided by proportioning the length and cross-section of the magnet and of the air-gap with reference to the hysteretic curve of the steel employed.

Suppose, for example, that an air-gap has to be provided 0·5cm. in width, and 10 sq. cms. in active cross-sectional area. Let the desired residual intensity in the steel be 1,500 gausses, and in the gap 600; also let the assumed value of the leakage factor $n = 1{\cdot}3$, and D E F (Fig. 2) be the descending curve of magnetisation for the steel employed. Then the flux $\phi = 1{,}500\ s = 600 \times 10 \times 1{\cdot}3$, or $s = 5{\cdot}2$, so that the cross-section of the magnet must be 5·2 sq. cms. The cyclic value of $\mathfrak{H}$ which corresponds to $\mathfrak{B} = 1{,}500$ is 26, so that with a factor of safety of 3 the value required is 8·7. The M.M.F. in the air-gap will be $600 \times 0{\cdot}5 = 300$ gausses, and the mean $\mathfrak{H} = \dfrac{300}{l} = 8{\cdot}7$, so that $l = 34{\cdot}4$. The length of the ring must, therefore, be 34·4cms.

With such a length provided, and with an intensity set up in the bar of, say, 6,000 gausses under the magnetising M.M.F., a powerful counter M.M.F. would tend to be set up on its withdrawal. If, for example, 6,000 gausses remained in the bar, the intensity in the gap would be 2,400, and the demagnetising force 34·8. Reference, however, to Fig. 2 shows that such a demagnetising force would reduce the residual intensity to about $\mathfrak{B} = 750$, at which the demagnetising force would only average 4·35 gausses. It is evident, therefore, that the intensity would fall along the line D.E.F. until equilibrium is reached between the intensity and demagnetising force. This would be met under the assumed conditions at $\mathfrak{B} = 2{,}250$ approximately. That is to say, if the magnet were allowed to assume its natural condition, the intensity in the steel would fall to about 2,250 gausses, and the demagnetising force rise to about 13 gausses, and this condition would be unstable, being probably followed by a slow and gradual decline in intensity under mechanical or thermal agitation. The process of seasoning a magnet consists, therefore, in designedly lowering its intensity below the natural intensity of equilibrium, so that the residual demagnetising force may then be too small to precipitate further demagnetisation, even when aided by considerable mechanical or thermal disturbance. Thus, if the magnet be

* [For the benefit of the uninitiated, we may remark that the names "gilbert," "weber," "oersted" and "gauss" were provisionally adopted by the American Institute of Electrical Engineers at its meeting of March 21, 1894, for the C.G.S. units of magnetomotive force, magnetic flux, reluctance, and flux-density.—ED. *E.*]

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boiled in water or oil, or its air-gap be momentarily widened, or if it be violently agitated, the intensity may be reduced to 1,500 gausses with a corresponding demagnetising force of 8·7, which is three times less than the cyclic force required to reduce the intensity still further.

If the magnet is not properly designed it will, after seasoning, be either unnecessarily heavy for the work it has to perform, or unduly weak in residual intensity.

Since $$\mathfrak{B} = \frac{n\phi}{s} \text{ and } \mathfrak{H} = \frac{\phi d}{S l}$$

$$\frac{1}{n} \cdot \frac{\mathfrak{B}}{\mathfrak{H}} = \frac{l}{s} \Big/ \frac{d}{S}.$$

So that if $\mathfrak{B}$, the remanent intensity, be given an assigned value, $\mathfrak{H}$, defined as being, say, one third of the cyclic value corresponding thereto, bears a fixed ratio to $\mathfrak{B}$, and $\frac{1}{n} \cdot \frac{\mathfrak{B}}{\mathfrak{H}}$ is for magnets of the same form and material a definite numerical quantity, which is the ratio of l/s in the steel to d/s in the air-gap.

According to Mr. Hookham's formula, this ratio is not less than 70. Assuming that the intensity in the steel he employed was 2,000, that it was powerfully magnetised at the outset, and that n was 1·3 in his magnetic circuit, then $\frac{1{,}000}{1{\cdot}3\,\mathfrak{H}} = 70$ or $\mathfrak{H} = 11$ approximately, while the cyclic value of $\mathfrak{H}$, corresponding to $\mathfrak{B} = 1{,}000$ is 33 gausses, giving a safety factor of 3.

In the well-known Weston permanent magnet ammeters and voltmeters, the accuracy of the instruments depends upon the permanence of the conditions existing in the magnetic circuits. The length of a particular Weston horse-shoe magnet is 27cms., its cross-sectional area 2·7 sq.cms. There are two air-gaps in series, each approximately 0·275cm. long and 11 sq. cms. in cross-section, offering, therefore, a total reluctance of approximately 0·05 oersted. The intensity in the steel is approximately 1,250 gausses, and the total useful flux through the air-gap 2,500 webers, making the total C.M.M.F. 2,500 × 0·05 = 125 gilberts, and the mean demagnetising force $\frac{125}{27}$, or nearly 5 gausses. For steel with a cyclic curve, as represented in Fig. 2, this would represent a factor of safety of 6, and the well-known satisfactory permanence in the magnetism of these instruments is no doubt owing to a large magnetic safety factor.

NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(Continued from page 126.)

40. Kennelly's Break Test.—It has long been observed in measuring through a break or fault making fairly good earth that the total resistance decreases as the testing current is increased, and the existence of some law governing the change of resistance was suspected and hinted at by several observers. The importance of knowing this law was evident to all who had to deal with the repair of cables, and some reference was made to the subject by Sir Henry Mance in the Paper above alluded to. It was left to Mr. A. E. Kennelly, who has developed the higher order of cable testing, to discover the law and its practical limitations, as the result of a long series of observations with different currents and areas of exposure. This law, which is known as "the law of inverse square roots," is briefly stated as follows:—The resistance of an exposed conductor varies inversely as the square root of the current sent through it. The subject was first made public in a Paper by Mr. Kennelly before the then Society of Telegraph Engineers and Electricians in March, 1887, on "The Resistance of Faults in Submarine Cables." The practical conditions and limitations may be stated as follows:—

(1) *Area of Exposure.*—The law is based upon gas development at the break, and has apparently its origin in this gas and its rate of discharge from the exposure. If the area of bare copper conductor exposed at the break is very small or is partially covered by the broken ends of the percha, the gas will not escape freely, but will cling to and accumulate on the obstructions, and when this is so the law does not hold good. Roughly, if the net area allowing free gaseous discharge is less than about half a square centimetre, the accumulation of gas forms a mechanical insulation which causes a less rapid fall in the resistance with a given increase of current, the variation being then more nearly as the inverse cube or fourth root of the current.

(2) *Strength of Battery Current.*—On account of the difficulty in measuring the true earth and polarisation currents active in the cable during the test, an error is introduced which makes the result somewhat too high. The deflection caused by these currents is read on the galvanometer as soon after breaking the testing current as possible, and the position on the scale treated as the false zero; but some seconds elapse before it can be observed, in consequence of the electrostatic discharge from the cable. And, as the E.M.F. of polarisation rapidly falls, the correct value to assign for false zero is not definitely determinable. The error, however, is almost inappreciable if the strength of current used in the test does not exceed 25 milliamperes.

On this point Mr. Kennelly says:—"A certain zero is assumed to start with as the false zero to work to; namely, the polarisation or cable current then existing. The battery key is then depressed and balance adjusted till this zero is maintained. The key is then released. Let O X represent

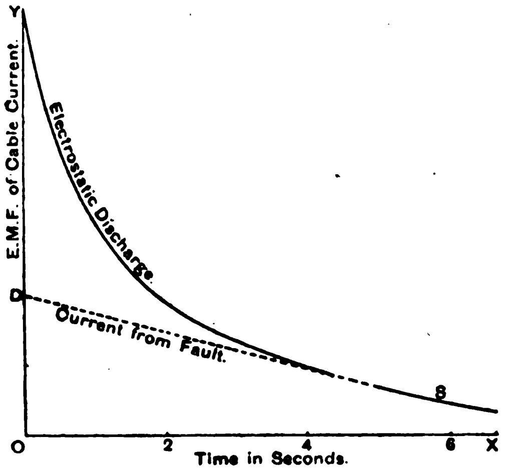

FIG. 110.

time, and O Y the observed discharge on the galvanometer (Fig. 110). Now, assuming the truth of the law, it can only be strictly applicable when the false zero is immediate—namely, when it is the first throw observed on releasing the battery key indicating less resistance. If there is no appreciable electrostatic or electromagnetic capacity in the cable or bridge to disturb the galvanometer on opening or closing the battery circuit, the rush of the spot in the first direction must be due to the polarisation electromotive force existing in the exposure circuit during the last moments of testing current flow, and consequently the correct position of the spot to select as zero is that position which in its first throw it endeavours to reach. Accordingly, in the experiments which established the law, the balancing resistance was reduced step by step until this first throw was so far diminished as to be no longer appreciable.

"If there were no electrostatic or electromagnetic capacity in the cable and bridge, the curve D S would represent the discharge due to depolarisation. It would then be possible to read to the first throw O D of the needle, or to 'immediate false zero;' but the electrostatic capacity discharge is superposed, and creates the discharge curve Y S. After a certain interval the electrostatic discharge is over, and the curves coincide. It is of no use to take any position of the spot as the false zero until that has taken place. All that can be done is to estimate by experience the point at which the electrostatic effect has disappeared, and to take that point as the false zero. It is

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neither theoretically nor practically correct, but the error for small currents (not exceeding 25 milliamperes) is generally small, except when the length of cable in circuit is under 50 or over 5,000 ohms. It is the best approximation that can be made.

"The balance is therefore made while the battery current is on, to that point taken as zero, determined as soon as possible after the battery is taken off. The period of time elapsing before fixing upon the false zero is much greater with a long than with a short cable. Fortunately the error produced is not great within the limits named."

(3) *Steadiness of Battery Current.*—The E.M.F. of the testing battery must be constant during the test. If it falls at all, the current through the break is reduced in proportion and affects the result. It is generally well to use plenty of battery power with resistance added to keep the current within the limit of 25 milliamperes, such as, say, 50 good Leclanché cells.

The periods of applying the battery for testing need not be long, and as the output does not exceed one quarter of an ampere, the E.M.F. should keep sufficiently constant. Any preliminary hard work in breaking down the resistance of the fault or cleaning it by a zinc current sustained for periods exceeding ten minutes should be done by a battery of Minotto cells.

(4) *Direction of Battery Current.*—Preliminary bridge tests taken when first communication is interrupted will show whether the fracture polarises with the zinc or copper current. Generally, of course, it polarises with the copper and breaks down with the zinc, signifying an exposure of copper at the break. It happens sometimes, however, that the bare conductor at the fracture is buried in mud, thus preventing the gas evolved by the zinc current from escaping and stopping any deposition of salts with the copper current. Under these circumstances the break is very variable, and sometimes polarises with a zinc and not with a copper current. The direction of current used in testing is always that which breaks down the resistance of a fault or fracture, or keeps it low and does not allow it to rise. This direction is almost always zinc to line; but if the break polarises with zinc as described (which, however, is a rare occurrence) the test can be taken with copper current, which, under these circumstances, gives the lowest results and follows the law with currents up to 25 milliamperes.

(5) *Distance of Break.*—Even with large exposures if they are a long way off the necessary range of current cannot be sent through them, partly because the testing E.M.F. is limited by the rules and partly on account of the intervening resistance of the cable. The battery power is generally limited to 50 volts. Under these circumstances, allowing, say, 200 ohms for battery and bridge, it will be seen that 25 milliamperes cannot be sent through the break if it is more than 1,800 ohms away. If it is further off, fairly reliable tests can be obtained with currents that can then be forced through, say up to 12 or 16 milliamperes; but if the break is 5,000 or more ohms distant the test cannot be applied owing to insufficient current reaching the break. It is not often, however, that breaks are more than 100 miles from shore.

In taking the test various strengths of currents must be used, but not exceeding 25 milliamperes. If A is the bridge reading with a current to line of c milliamperes and B that with c_1 milliamperes, x being required distance to break in ohms, we have—

$$\text{Resistance of break with current } c = A - x,$$
$$\text{,, \quad ,, \quad ,, \quad ,, } \quad c_1 = B - x.$$

And, by the law of inverse square roots, these resistances are inversely proportional to the square root of the currents; that is

$$\frac{A - x}{B - x} = \frac{\sqrt{c_1}}{\sqrt{c}},$$

whence
$$x = \frac{A\sqrt{c} - B\sqrt{c_1}}{\sqrt{c} - \sqrt{c_1}} \text{ ohms.}$$

It is convenient to use currents only in the proportion of 1 to 4. Then $c_1 = 4c$ and $\sqrt{c_1} = 2\sqrt{c}$, and the distance of break becomes

$$2\,B - A \text{ ohms,}$$

or in its more convenient form

$$B - (A - B) \text{ ohms.}$$

The explanation of this is that, by the law of inverse squares, the resistance of the break is halved when the current is four times the strength. The reading A gives distance to break, plus resistance of break, while the reading B gives distance to break, plus half the former resistance of break. The difference between the readings A and B is therefore equal to the resistance of the break when the B reading was taken. Therefore, subtracting the difference of any pair of readings (currents used for which are as one to four) from the lowest one of the pair gives the distance of break in ohms.

The following 12 currents give 6 pairs in the ratio of 1 to 4, viz.:—

1	2	3	4	5	6
4	8	12	16	20	24

If low resistance cells are used, of about one or two ohms per cell, the currents to line are sufficiently nearly proportional to the number of cells in series in the testing battery, and with equal ratios in the bridge arms the current to line in milliamperes is found by

$$\frac{E}{2\,b + a + A},$$

where E = volts of testing battery,
b = resistance of testing battery,
a = one bridge arm,
A = balancing resistance

with each variation of battery. Suppose a reading of 1,040 ohms is obtained (to false zero) with a battery of 7 volts and 5 ohms, and again another reading of 1,020 with battery of 28 volts and 20 ohms, ratio of bridge 1,000/1,000.

Neglecting earth current, the currents used were respectively,

$$\frac{7}{10 + 1{,}000 + 1{,}040} = 3{\cdot}4 \text{ milliamperes,}$$

and
$$\frac{28}{40 + 1{,}000 + 1{,}020} = 13{\cdot}6 \text{ milliamperes,}$$

or in the ratio of 1 to 4. Therefore, the distance of break is

$$1{,}020 - 20 = 1{,}000 \text{ ohms.}$$

The currents to line may also be varied and calculated by varying the amount of resistance in the battery circuit, the number of cells in the testing battery being constant.

With the bridge arms unequal, say a ohms on the cable side, and μa ohms on the coils side, as in Fig. 111, the equation for the current through the cable is—

$$\frac{E}{(\rho + b)\left(\frac{\mu + 1}{\mu}\right) + a + R} = \frac{n}{1{,}000},$$

where E = E.M.F. of battery,
b = resistance of battery,
ρ = added resistance to battery,
a = arm of bridge on cable side,
μa = arm of bridge on coils side,
R = resistance unplugged to balance,
n = number of milliamperes required,

From which we obtain an equation for the added resistance for any current of n milliamperes

$$\rho = \left(\frac{1{,}000\,E}{n} \times \frac{\mu}{\mu + 1}\right) - \frac{a\mu}{1 + \mu} - b - R\,\frac{\mu}{\mu + 1}.$$

With a bridge ratio of 1,000/1,000, μ is unity, and

$$\rho = \left(\frac{1{,}000\,E}{n} \times \frac{1}{2}\right) - \frac{1{,}000}{2} - b - \frac{R}{2}.$$

$$= 500\left(\frac{E}{n} - 1\right) - b - \frac{R}{2}$$

The first two terms can be calculated permanently for this bridge ratio, the third (the battery resistance) can be measured

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just before the test and deducted. A preliminary test with this resistance (calculated from the above three terms) added to battery is taken to get a value for R. Then the added resistance is reduced by half of R, and the test repeated, giving the required result A.

To obtain the result B, the value of n is made four times its former amount. The resistance to add is then worked out as before, and the balance obtained with this resistance in circuit.

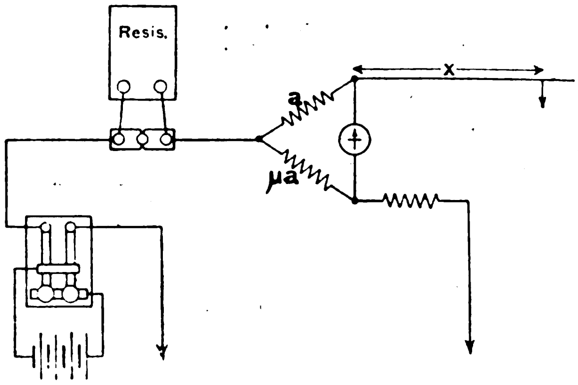

FIG. 111.—Kennelly's Test for Break.

It is convenient to work out tables for the different currents named and for different bridge ratios of the first two terms of the equation for added resistance. Thus, with a battery of 60 volts and 40 ohms, we can calculate the resistances as follows:—

Current to line in milliamperes.	For bridge ratios of		
	1000/1000	100/100	100/1000
1	29,460	29,910	54,414
2	14,460	14,910	27,142
Inter	mediate	values	
20	960	1,410	2,596
24	710	1,160	2,142

With the ratio 100/1000 $\mu = 10$, and the formula for added resistance becomes

$$\rho = \frac{10{,}000\,E}{11n} - \frac{1{,}000}{11} - b - \frac{10R}{11}\ \text{ohms.}$$

The resistances so calculated are further reduced during the progress of the tests, in the case of equal ratios by half the resistance unplugged to balance, and in the case of 100/1000 by $\frac{10}{11}$ of the resistance unplugged to balance; after which the balances obtained give the results required with the given currents.

These tests are all taken to false zero, and depend upon the earth current keeping fairly constant during a pair of readings. The effect of variation in the earth current is, however, reduced to a minimum by using a high E.M.F. in the testing battery. If there is no dead-beat galvanometer available, such as already described, the marine galvanometer must be used; but it is no easy matter to read to false zero with this galvanometer.

For these reasons the test with three readings to instrument zero, described in the last paragraph, is preferable, although somewhat more lengthy, because variations in the earth current are accounted for, and it is a null method, requiring no special galvanometer.

The instrument zero method has the further advantage of not being limited to 25 milliamperes, since it measures the true value of the polarisation current, which the false zero method can never do, in consequence of the interference of the electrostatic discharge. On the other hand, any errors due to deviation of the resistance of the break from the law of inverse squares, or to the variation of polarisation current, are less in the false zero than in the instrument zero method.

If a second galvanometer is available it may be used in the cable circuit to indicate the current passing into the cable. It must be shunted with a piece of wire, the size and length of which is adjusted to produce a convenient deflection when maximum current is passing. This saves calculation of resistances, the latter being simply adjusted until the deflection required is produced. The scale of such a galvanometer could be calibrated direct in milliamperes. A reflecting galvanometer for this purpose is rather too great a refinement on board ship, and few ships' testing tables are big enough for two galvanometers working at once. The author has suggested the use of a portable milliamperemeter for this purpose, and has devised a form whose indications are dead-beat and not affected mechanically or magnetically by the rolling of the ship. This instrument can be placed directly in the cable circuit, and reads directly in milliamperes; its use saves the time taken in calculations and trial tests to obtain the correct resistance for a definite current to line.

(To be continued.)

IMPROVEMENTS IN ARMATURE VENTILATION.*

BY PROF. HARRIS J. RYAN.

In the type of armature used in America during 1880-1890 the author states that the ventilation for an armature moving at a peripheral velocity of 3,000ft. per minute is 0·034 watts per sq. in. of surface per degree centigrade rise of temperature above that of the surrounding atmosphere. These two-pole armatures were rated at 75°C. rise of temperature, the hysteresis and eddy losses in the core usually causing a rise of 20°C., so that the $C^2 R$ losses in the conductors at full output caused an additional rise of 75 − 20° or 55°C. For a copper conductor 1in. long. and 1in. wide, mounted on this armature core, there will be the following relation between current in amperes and depth or thickness in inches for an increase of temperature of 55°C.

$$C^2 R = 0{\cdot}034 \times 55 = 1{\cdot}87 \text{ watts.}$$

Resistance of 1 mil ft. of copper at 95°C. = 12·5 ohms.

$$R = \frac{12{\cdot}5 \times \frac{1}{12}}{10^6 \times \frac{4}{\pi} \times D},$$

where D is the depth in inches.

$$C^2 R = C^2 \frac{12{\cdot}5 \times \frac{1}{12}}{10^6 \times \frac{4}{\pi} \times D} = 1{\cdot}87$$

$$C^2 = \frac{1{\cdot}87 \times \frac{4}{\pi} \times 10^6}{12{\cdot}5 \times \frac{1}{12}} D$$

(1) $C^2 = 2{\cdot}3 \times 10^6\,D$ and

(2) $R = 0{\cdot}83 \times 10^{-6} \frac{1}{D}$ is the relation between the resistance in ohms and the thickness in inches for such a copper conductor 1in. long and 1in. wide. Equation (1) teaches us that for a fixed allowable rise of temperature the square of the current output will vary as the depth of the copper.

Where T is the rise of temperature in degrees centigrade produced by $C^2 R$ heating in these armatures, we have this relation:—

$$T = \frac{R}{0{\cdot}034} C^2$$

differentiating, $$\frac{dT}{dC} = \frac{RC}{0{\cdot}017}. \qquad (3)$$

Equation (3) enables us to determine the rate at which T is increasing with respect to C.

The author concludes that there is a great need of improved facilities for armature ventilation. Since 1890 there has been a steady improvement in this respect. The demand for slow-speed electrical machinery has caused the development of the multipolar types with short hollow armatures of large diameters that are naturally much better venitlated than the two-pole types. In addition to this, ventilating flues in the laminated cores of "iron-clad" armatures are provided without weakening the structure. Through these modifications the ventilation has been increased very materially, the effect of which is to increase the radiation coefficient from 0·034 to 0·04 and probably 0·06 in some instances. The result is that makers have been able to deliver machines rated at a lower temperature increase, which will stand from 10 per cent. to 20 per cent. continued overload.

At present along orthodox lines of practice there is little incentive to modify designs so as to gain still further ventilation, owing to the fact that with the present methods machines may be loaded to the sparking limit without overheating. The sparking limit

* Abstract from the April number of the *Sibley Journal of Engineering.*

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may, however, be entirely removed by the use of a commutation lug and pole-face coils for balancing the armature reaction (see *The Electrician*, Vol. XXXIV., April 19th, p. 765) and regulating the induction at the commutation lug so as to be proportional to the output. To take full advantage of this improvement it is necessary to improve the armature ventilation to the greatest available extent without sacrifice. To do this Mr. M. E. Thompson adopts a short multipolar armature of large diameter, with windings whose cross connections are in the same cylindrical outline as the armature itself, and so disposed that they form a system of numerous flues through which great quantities of air are passed from moment to moment. Little dependence is placed on the ventilation from the smooth surfaces of the armature. The conductors are so short that a small difference of temperature suffices to carry the developed heat from the centre of the armature to the cross connections, where it is rapidly taken up by the radial air currents. Armatures recently built on this system and thoroughly tested show that ventilation is provided which is proportional to the depth of armature copper. Thus the maker is at liberty to select precisely those proportions of iron and copper and working induction and current densities that will give desired performances as to efficiency and durability at the lowest first cost.

DRAFT REGULATIONS AND CONDITIONS FOR SECURING THE SAFETY OF THE PUBLIC.

The following set of rules and regulations has recently been issued by the Board of Trade to central station engineers and others. Comments are invited. With a view of facilitating the work of comparison, we print below the proposed new rules in full. The portions in italics denote either considerable alteration as compared with previously issued rules or complete novelty:—

DEFINITION.

In the following regulations—

The expression "the Order" means the ——— Order.

The expression "the Undertakers" means the Undertakers for the purpose of the Order.

The expression "consumer's wires" means any electric lines on a consumer's premises which are connected with the service lines of the Undertakers at the consumer's terminals.

The expression "aerial line" means any electric line which is placed above ground and in the open air.

The expression "pressure" means the difference of electrical potential between any two conductors through which a supply of energy is given, or between any part of either conductor and the earth; pressure on any alternating-current system being taken to be the equivalent of pressure on a continuous-current system when it produces an equal heating effect if applied to the ends of a thin stretched wire or carbon filament; and—

(*a*) Where the conditions of the supply are such that the pressure cannot at any time exceed 300 volts, if continuous, or the equivalent of 150 volts, if alternating, the supply shall be deemed a low-pressure supply:

(*b*) Where the conditions of the supply are such that the pressure may exceed the limits of a low-pressure supply, but cannot exceed 3,000 volts, or the equivalent of 3,000 volts, whether continuous or alternating, the supply shall be deemed a high-pressure supply:

(*c*) Where the conditions of the supply are such that the pressure may on either system exceed 3,000 volts or the equivalent of 3,000 volts, the supply shall be deemed an extra high pressure supply.

Mains, service lines, and other conductors and apparatus are referred to as low-pressure, high-pressure, and extra high-pressure mains, &c., according to the conditions of the supply delivered through the same or particular portions thereof.

Where these regulations require any metallic body to be "efficiently connected with earth," it shall be connected with the general mass of earth in such manner as will ensure at all times an immediate and safe discharge of electrical energy.

Other expressions to which meanings are assigned in the Order or principal Act have the same respective meanings in these regulations.

A.—REGULATIONS AS TO SAFETY.

I. GENERAL.

Low-pressure supply to customers. 1. Save as hereinafter provided, the supply of energy delivered to the consumer's terminals shall be a low-pressure supply.

Limitations of high-pressure supply. 2. A high-pressure supply shall not be delivered to any consumer's terminals, except for special purposes, and with the approval of the Board of Trade on the joint application of the consumer and the Undertakers, and subject to such further regulations as the Board of Trade may from time to time prescribe. But a high-pressure supply may be given to distributing or converting stations, *or to transforming apparatus on a consumer's premises*, in accordance with the following regulations.

Limitations of extra high-pressure supply. 3. An extra high-pressure supply shall not be given except to distributing stations or other premises in the sole occupation of the Undertakers, and with the written consent of the Board of Trade, and subject to such regulations and conditions as the Board may prescribe.

Limit of power in high-pressure electric line. 4. *No high-pressure electric line shall be used for the transmission of more than 200,000 watts, or in the case of an aerial line 50,000 watts, except with the consent in writing of the Board of Trade, and efficient means shall be provided to prevent this limit being at any time exceeded.*

Quick-acting cut-off for high-pressure lines, &c. 5. *Every high-pressure electric line, conductor, or other apparatus shall be protected by a suitable automatic quick-acting cut-off.*

Transformers. 6. In every case where any transforming apparatus is used to convert a high-pressure supply into a low-pressure supply, some suitable automatic and quick-acting means shall be provided to protect the low-pressure system from any accidental contact with or leakage from the high-pressure system, either within or without the transforming apparatus.

Maximum current in conductors. 7. The maximum working current in any conductor shall not be sufficient to raise the temperature of the conductor or any part thereof to such an extent as to materially alter the physical condition or specific resistance of the insulating covering, if any, or in any case to raise such temperature to a greater extent than 30°Fahr.; and efficient automatic means shall be provided which will render it impossible for this maximum working current to exceed such limit to the extent of 50 per cent., even for short intervals of time: and special care shall be taken that the cross-sectional area and conductivity at joints are sufficient to avoid local heating, and that the joints are protected against corrosion.

Minimum size of conductors. 8. *The sectional area of the conductor in any electric line laid or erected in any street shall not be less than the area of a circle of one-tenth of an inch diameter, and when the conductor is formed of a strand of wires each separate wire shall be at least as large as No. 20 standard wire gauge.*

Insulation test of electric lines. 9. *Every electric line shall be tested for insulation after having been placed in position, the testing pressure being at least 200 volts, and the Undertakers shall duly record the results of the tests of each line or section of a line. No electric line shall be brought into use in which this test indicates an insulation resistance less than at the rate of 100,000 ohms per mile for every volt of pressure of the supply, unless it is connected with earth with the consent of the Board of Trade, in which case the insulation resistance of such electric line shall not be less than 10 megohms.*

Maintenance of insulation. 10. *The insulation of every complete circuit used for the supply of energy, including all machinery, apparatus, and devices forming part of, or in connection with, such circuit, shall be so maintained that the leakage current shall not under any conditions exceed one-thousandth part of the maximum supply current; and suitable means shall be provided for the immediate indication and localisation of faults of insulation. Every such fault shall be remedied without delay.*

Every such circuit shall be tested for insulation at least once in every week, and the Undertakers shall duly record the results of such testings.

Provided that where the Board of Trade have approved of any part of any electric circuit being connected with earth, the provisions of this regulation shall not apply to such circuit so long as such connection exists.

Specification of insulating material. 11. *All material used for insulating electric lines or apparatus shall be of the best quality, and thoroughly durable and efficient, having regard to the conditions of its use. Suitable provision shall be made for the protection of the insulating material against injury or removal.*

High-pressure conductors to be covered. 12. Every high-pressure conductor shall be continuously covered with insulating material to a thickness of not less than one-tenth part of an inch, and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulating material shall not be less in inches or parts of an inch than the number obtained by dividing the number expressing the volts by 20,000. If this protection be wholly or partly metallic, it shall be efficiently connected with earth.

Testing of insulation of all parts of any high-pressure circuit. 13. *No electric line, machine, device, or apparatus intended to form part of, or be connected with, a high-pressure circuit shall be brought into use unless the insulation thereof has withstood the continuous application during one hour of twice the pressure to which it is intended to be subjected in use.*

The Undertakers shall duly record the results of such test.

Protection from lightning. 14. Where any portion of any electric line or any support for an electric line is exposed in such a position as to be liable to injury from lightning, it shall be efficiently protected against such injury.

Accidents to be reported. 15. *Where any accident by fire or explosion, or any accident causing or likely to have caused personal injury, occurs at any part of any electric line or work to which these regulations apply, the Undertakers shall give immediate notice thereof to the Board of Trade.*

II. AERIAL LINES WHERE ERECTED WITH THE NECESSARY CONSENTS.

Maximum intervals between supports. 16. Every aerial line shall be attached to supports at intervals not exceeding 200ft. where the direction of the line is straight, or 150ft. where this direction is curved, or where the line makes a horizontal angle at the point of support.

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Supports, construction and erection of. 17. Every support of aerial lines shall be of a durable material, and properly stayed against forces due to wind pressure, change of direction of the lines, or unequal lengths of span. The factor of safety for the lines and suspending wires shall be at least 6, and for all other parts of the structure at least 12, taking the maximum possible wind pressure at 50lb. per square foot. No addition need be made for a possible accumulation of snow.

Every support, if of metal, shall be efficiently connected with earth.

Attachment of aerial lines. 18. Aerial lines* shall be attached to insulators, and shall be so guarded that they cannot fall away from the support. *Conductors covered with insulating material shall not be attached to the insulators by metal binders.*

Height from ground and distance from buildings, &c. 19. An aerial line shall not in any part thereof be at a less height from the ground than *18ft.*, or where it crosses a street, *30ft.*,† *or within 5ft. measured horizontally*, or 7ft. measured vertically, from any building or erection other than a support for the line, except where brought into a building for the purpose of supply.

Service lines from aerial lines. 20. Service lines from aerial lines shall be led as directly as possible to insulators firmly attached to some portion of the consumer's premises which is not accessible to any person without the use of a ladder or other special appliance, and from this point of attachment they shall be enclosed and protected in accordance with the regulations hereinafter contained as to service lines on the consumer's premises. *Every portion of any service line which is outside a building but is within 7ft. from such building shall be completely enclosed in stout india-rubber tubing.*

Angle of crossing thoroughfares. 21. Where an aerial line crosses a street, the angle between such line and the direction of the street at the place of such crossing shall not be less than 60deg., and the spans shall be as short as possible.

Crossing wires, &c. 22. *Where an aerial line crosses, or is in proximity to, any metallic substance, precautions shall be taken by the Undertakers against the possibility of their line coming into contact with such metallic substance, or of such metallic substance coming into contact with their line by breakage or otherwise.*

Suspending wires. 23. Every high-pressure aerial line shall be efficiently suspended by means of insulating ligaments to suspending wires, so that the weight of the line does not produce any sensible stress in the direction of its length. All suspending wires, if of iron or steel, shall be galvanised.

Discharge of pressure in case of fire. 24. *In the case of any aerial line exceeding one half-mile in total length, means shall be provided whereby the pressure may be discharged from any portion of such line erected over or alongside of any building or buildings without loss of time in case of fire or other emergency.*

Maintenance. 25. Every aerial line, including its supports and all the structural parts and electrical appliances and devices belonging to or connected with such line, shall be duly and efficiently supervised and maintained as regards both electrical and mechanical conditions.

Unused aerial lines to be removed. 26. An aerial line shall not be permitted to remain erected after it has ceased to be used for the supply of energy, unless the Undertakers intend within a reasonable time again to take it into use.

III.—Electric Lines other than Aerial Lines.

Conduits to be durable and strong. 27. All conduits, pipes, or casings used as receptacles for electric lines shall be constructed of durable material, and of ample strength to prevent damage from heavy traffic, and where they are laid in streets in which gas mains are also laid shall be so constructed as to prevent any influx of gas from the adjacent soil.

Crossing pipes, &c. 28. *Where any electric line crosses, or is in proximity to, any metallic substance, special precautions shall be taken by the Undertakers against the possibility of any electrical discharge to the metallic substance from their line or from any metal conduit pipe or casing enclosing their line.*

Electric continuity of metal conduits, pipes, or casing. 29. *All metal conduits, pipes, or casings containing any electric line shall be efficiently connected with earth; and shall be so jointed and connected across all street boxes and other openings as to make good electrical connection throughout their whole length.*

Precautions against charging of short lengths of pipe, &c. 30. *Where isolated lengths of metal conduit, pipe, or casing are used for the protection of any electric line at road crossings or similar positions, there shall be interposed between such electric line and the conduit, pipe, or casing such additional insulating material as will prevent the possibility of any electrical charging thereof.*

Precautions to be taken when bare conductors are used. 31. *Where the conductors of electric lines placed in any conduit are not continuously covered with insulating material, they shall be securely fixed in position, and no unfixed material of a conducting nature shall be contained in the conduit.*

Adequate precautions shall also be taken to ensure that no accumulation of water shall take place in any part of the conduit, and to prevent any access of moisture to the conductors or the insulators, and the latter shall be so disposed that they can be readily inspected.

* No mention of the "bearer" wires as in the old rules.—Ed. *E.*

† Note.—In the County of London, 35ft.

High-pressure lines laid above ground. 32. Any portions of any high-pressure electric lines placed above the surface of the ground, or in any subway, shall be completely enclosed either *in a highly-glazed porcelain tube* embedded in brickwork, masonry, or cement concrete, or in strong metal casing efficiently connected with earth, *and so protected and guarded as to prevent accidental contact with the casing.*

Treatment of high-pressure lines transmitting considerable power. 33. *Every high-pressure electric line transmitting more than 50,000 watts, or used for the supply of energy to transformers placed in street boxes, shall, except within the generating station, be entirely enclosed in strong metal casing efficiently connected with earth, and such casing shall not contain any low-pressure electric line.*

Ditto where the power transmitted is not more than 50,000 watts. 34. *High-pressure electric lines not intended to transmit more than 50,000 watts may be enclosed either as provided in the preceding regulation, or in glazed stoneware casings properly laid and jointed in cement at a depth of not less than 2ft. below the surface of the ground and sufficiently protected against breakage.*

IV.—Street Boxes.

Precautions with respect to street boxes. 35. *All street boxes which contain any vacant space shall be so constructed as to prevent any influx of gas or water either from the adjacent soil or by means of any pipes and ample provision shall be made by ventilation or otherwise for the immediate escape of any gas which may by accident have obtained access to the box and for the prevention of danger from sparking.*

Covers of street boxes. 36. *The covers of street boxes shall be properly secured, and shall, where the box contains high-pressure apparatus, be connected to strips of metal laid immediately underneath the adjacent roadway or pavement.*

Casing of high-pressure lines in street boxes. 37. *The casing of any high-pressure electric lines shall be continued within street boxes.*

V.—Converting Stations.

Converting stations. 38. All converting stations, or points in a system of distribution to which a high-pressure supply is given from generating stations, and from which a low-pressure supply is given to consumers, shall be established in suitable places, which are in the sole occupation and charge of the Undertakers.

VI.—Consumer's Premises.

Responsibility of Undertakers for their lines, &c., on consumer's premises. 39. The undertakers shall be responsible for all electric lines, fittings, and apparatus belonging to them, or under their control, which may be upon the consumer's premises being maintained in a safe condition and in all respects for supplying energy.

Fire risks. 40. In delivering the energy to the consumer's terminal the undertakers shall exercise all due precautions so as to avoid risk of causing fire on the premises.

Main fuses or disconnectors to be provided in a locked receptacle. 41. *A suitable safety fuse or other automatic disconnector shall be inserted in each service line as close as possible to the point of entry to any consumer's premises, and contained within a suitable locked receptacle of fireproof construction.*

Treatment of low-pressure lines and apparatus. 42. *All low-pressure electric lines and apparatus placed on any consumer's premises shall be highly insulated and thoroughly protected against injury to the insulation or access of moisture, and no metal forming part of the electric circuit shall be exposed so that it can be touched. All electric lines shall be so fixed and protected as to prevent the possibility of electrical discharge to any adjacent metallic substance.*

Transformers, &c., on consumers' premises. 43. *Where transformers are installed within buildings on consumers' premises, they shall be contained in a fireproof chamber securely locked, and the high-pressure service lines in highly glazed porcelain tubes bedded in chases cut in brickwork or masonry.*

Testing consumer's wires for leakage by Undertakers. 44. If the Undertakers are reasonably satisfied, after making all proper examination by testing or otherwise, that a connection with the earth exists at some part of a circuit of such resistance as to be a source of danger, and that such connection does not exist at any part of the circuit belonging to the Undertakers, then and in such case any officer of the Undertakers, duly authorised by them in writing, *or, if the Undertakers so require, an electric inspector*, may, for the purpose of discovering whether such connection with the earth exists at any part of a circuit within or upon any consumer's premises, at all reasonable times, after giving one hour's notice of his intention to do so, enter any such premises and disconnect the consumer's wires from the service lines, and may require the consumer to permit him to inspect and test the wires and fittings belonging to the consumer and forming part of the circuit.

In any case where the Undertakers require the services of an electric inspector under this regulation they shall pay him the prescribed fee.

Supply to be discontinued if leakage exceeds a certain limit. 45. If on such testing the officer or the electric inspector discovers that a connection exists between the consumer's wires and the earth, and that such connection has an electrical resistance not exceeding 5,000 ohms, or if the consumer does not give all due facilities for such inspection and testing, the Undertakers shall forthwith discontinue the supply of energy to the premises in question, giving immediate notice of such discontinuance to the consumer, and shall not recommence such

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supply until they are reasonably satisfied that such connection with the earth has been removed.

Provided that in cases where the maximum power taken by any consumer exceeds 25,000 watts, the consumer's wires may be divided for the purposes of this testing into separate circuits, the insulation resistance of each of which shall exceed 5,000 ohms.

Appeal to electric inspector. 46. If any consumer is dissatisfied with the action of the Undertakers either in discontinuing or in not recommencing the supply of energy to his premises, the wires and fittings of such consumer may, on his application and on payment of the prescribed fee, be tested for the existence of connection with the earth by an electric inspector.

This regulation shall be endorsed on every notice given under the provisions of the last preceding regulation.

VII.—Arc Lighting.

Arc lamps to be guarded. 47. *All arc lamps shall be so guarded as to prevent pieces of ignited carbon or broken glass falling from them, and shall not be used in situations where there is any danger of the presence of explosive dust or gas.*

Height from ground. 48. *Arc lamps used in any street shall be so fixed as not to be in any part at a less height than 10ft. from the ground.*

Cut-off switch. 49. *A cut-off switch, fixed in a suitable locked receptacle, shall be provided for every high-pressure arc lamp, and such switch shall be of such pattern and construction as will provide :—*

(a.) *That the lamp can by its means be entirely disconnected from the supply circuit;*

(b.) *That the switch itself can be safely operated in the dark by an inexperienced person and without special precautions ; and*

(c.) *That there shall be no danger of any injurious electrical arcing, sparking, or heating being caused by the operation of the switch.*

Penalties.

Penalties. 50. If the Undertakers make default in complying with any of the preceding regulations, they shall be liable to a penalty not exceeding £10 for every such default, and to a daily penalty not exceeding £10.

The imposition of any penalty under this regulation shall not affect the liability of the Undertakers to make compensation in respect of any damage or injury which may be caused by reason of such default.

B.—REGULATIONS AS TO SUPPLY.

Notice of intention to supply through mains. 1. One week at least before the Undertakers are ready to commence to supply energy through any feeding, charging, or distributing main, they shall serve a notice upon the local authority of their intention to commence such supply.

Undertakers to provide constant supply. 2. From and after the time when the Undertakers commence to supply energy through any distributing main, they shall maintain a supply of sufficient power for the use of all the consumers for the time being entitled to be supplied from such main ; and such supply shall, except so far as may be otherwise agreed upon from time to time between the local authority and the Undertakers, be constantly maintained. Provided that, for the purposes of testing, the authority by whom the electric inspector is appointed may give permission to the Undertakers to discontinue the supply at such intervals of time and for such periods as it may think expedient, and that for any other purposes connected with the efficient working of the undertaking, the Undertakers may, with the permission of the Board of Trade, discontinue the supply at such intervals of time and for such periods as the Board of Trade may think expedient. Where the supply is so discontinued, notice of such discontinuance, and of the probable duration thereof, shall be forthwith served upon the local authority.

Provisions as regards stoppage. 3. The system of distributing mains shall be so arranged that in case it becomes necessary to stop the supply through any portion of a main for more than one hour, for the purposes of repairs, or for any other reason, the stoppage of supply will in no case exceed in amount a maximum power of 200,000 watts, or extend to the premises of more than 80 consumers, and in the case of every stoppage for more than one hour reasonable notice shall be previously given by the Undertakers to every consumer affected thereby, except in cases of emergency.

Pressure in mains during supply. 4. During the whole of the period when a supply of energy is required to be maintained by the Undertakers in the distributing mains under the Order and these regulations, it shall be maintained at a constant pressure (in these regulations termed the "standard pressure"), to be fixed as hereinafter specified ; but such standard pressure may be different for different portions of the distributing mains. Provided that the Undertakers shall be deemed to have complied with the requirements of this regulation so long as the pressure does not at any point vary more than 3 per cent. from the corresponding standard pressure in the case of a general supply at low pressure, or 2 per cent. in the case of a general supply at high pressure, unless changes in pressure recur so frequently as to cause unsteadiness in the supply.

Fixing of standard pressure. 5. The standard pressure shall be fixed by the Undertakers for every pair of distributing mains, and notice of the amount of such standard pressure shall be given to the local authority before the Undertakers commence to supply energy to consumers through such mains, and such standard pressure shall not be altered except by permission of the local authority, and upon such terms and conditions as the local authority may impose, and after public notice has been given during a period of one month, in such manner as the local authority may require, of the intention of the Undertakers to apply for permission to alter the same. The Undertakers may appeal against any decision of the local authority under this regulation to the Board of Trade, whose decision shall be final.

Declared pressure at consumer's terminals. 6. Before commencing to give a supply of energy to any consumer, the Undertakers shall declare to such consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared at any pair of consumer's terminals shall not, except by agreement, be greater than *150* [115] volts or less than 45 volts if continuous, or the equivalents thereof respectively if alternating, and shall not at any time be altered or departed from except in consequence of any authorised alteration of the corresponding standard pressure. In distribution on the three-wire system, the central terminal shall for the purposes of this regulation be considered to form a pair with either of the outer terminals, and similarly for multiple-wire systems ; and, in the case of a transformation of energy on the consumer's premises, the Undertakers shall give the consumer the choice of a supply at either of two different pressures, one of which shall be approximately half the other, and in such case the pressure so chosen by the consumer shall be the declared constant pressure.

Variation of pressure at consumer's terminals. 7. The variation of pressure at any consumer's terminals shall not under any conditions of the supply which the consumer is entitled to receive, nor at any time, exceed 4 per cent. from the declared constant pressure, whether such variation be due to the resistance of the service lines or apparatus belonging to the Undertakers, or to any action or effect produced by such apparatus, for which the consumer cannot be shown to be responsible, or, partly to any variation of pressure in the distributing mains from which the supply is taken.

Penalty for default. 8. If the Undertakers make default in complying with any of these regulations as to supply, they shall, subject to the provisions of the Order, be liable to a penalty not exceeding £5 for every such default, and to a daily penalty not exceeding £5.

These regulations are made subject to the power of the Board of Trade to make such further or other regulations as they may think expedient ; and nothing in these regulations shall be construed to authorise the Undertakers to lay any electric line or work their undertaking otherwise than in accordance with the Order and the principal Act, or to supply energy otherwise than by a system for the time being approved of by the Board of Trade under the Order.

The following are some of the more important of the old rules not to be found in the new :—

Definition of earth. When any casing, support for conductors, conducting wire, or other metallic body is required to be efficiently connected to earth, it shall be deemed to be so connected when it is connected to metallic mains for water supply outside of buildings, or, where these are not available, to a mass of metal having a total surface of at least 4 sq. ft., buried to a depth of at least 3ft. in moist earth, by means of a conductor possessing a mechanical strength, and offering a passage to electrical discharges, equal to that of a strand of seven No. 16 galvanised iron wires.

High and low-pressure conductors laid in proximity. Where any high-pressure conductor is laid within a less distance than 18in. from any low-pressure conductor, or from the surface of the ground, or where any low-pressure conductor is laid within the above-mentioned distance from any previously laid high-pressure conductor, efficient means shall be taken to render it impossible that the low-pressure conductor or the surface of the ground shall become electrically charged by any leakage from or defect in the high-pressure conductor.

Precautions against sparking with high-pressure alternating-current mains. In the case of a high-pressure supply on any alternating-current system, where separately insulated conductors are laid in the same conduit or pass through the same boxes, precautions shall be taken against the discharge of electric sparks between the insulating covering of oppositely charged conductors, by providing a sufficient connection of a conducting nature from one covering to the other throughout.

Aerial Conductors.

Connection of support to earth. Every support, if of metal, shall be efficiently connected to earth, and if of wood or other non-conducting material shall be protected by a lightning conductor fastened to the support along its entire length, and projecting above the support to a height of a least 6in., such lightning conductor being efficiently connected to earth.

Specification of insulation. The material used for insulating any high-pressure aerial conductor shall be such as will not be liable to injurious change of physical structure or condition when exposed to any temperature between the limits of 0deg. and 150° Fahr., or to contact with the ordinary atmosphere of towns or manufacturing districts.

It only remains to point out that the much-discussed old Rule 33, dealing with the thickness of the insulation of high-pressure aerial conductors, although not to be found under *Aerial Conductors*, has not been dropped ; it has merely been transferred, and is now to be found under *General Rules* as Rule 12, where it covers a wider ground.

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THE ELECTRICAL TRADE SECTION.

A meeting of the Electrical Trade Section of the London Chamber of Commerce was held on Tuesday, at Botolph House, Eastcheap, Mr. E. Garcké in the chair.

The SECRETARY (Mr. Kenric B. Murray) having read the minutes of the last meeting,

The CHAIRMAN remarked that the principal matter which they had met to discuss was to consider the revised Board of Trade regulations in connection with the supply of electrical energy. He suggested that they should dispose first of the other matters on the agenda. With respect to the Telephone Agreement, he had to report that the Special Committee which been appointed sat on several occasions, and considered many of the suggestions that were submitted to the Section at the last meeting. The Committee was a very representative one, embracing all interests. Needless to say, it was very difficult for the Committee to come to any definite conclusion, and all their decisions were more or less in the nature of a compromise. Sir E. Carbutt and Major Flood Page were requested by the Council to give evidence before the Committee, and had done so.

Mr. SYDNEY MORSE said that, personally, he felt great regret that some gentleman representing purely commercial interests was not sent to give evidence on behalf of the Chamber before the Select Committee. The tendency of the evidence given to the Committee seemed to be very much in favour of the National Telephone Company for what they had done rather than for what they might do ; but if it were not too late, he felt that it would be well for simple commercial evidence to be given.

The CHAIRMAN stated that the point to which Mr. Morse had drawn attention was fully taken into consideration. He himself was not able to attend the Council meeting at which it was discussed, but Mr. Murray informed him that the views expressed by Mr. Morse were strongly put before the Council. He feared it was too late now to submit further evidence, for he believed that the Committee had taken all the evidence. With respect to the question of Light Railways, a Bill had been brought into Parliament by the Government, but he thought from present indications there was very little hope of the Bill passing this Session. Should there be any prospect of that, however, a special meeting of the Joint Committee would be called to consider the position. He did not think that the Bill adequately dealt with the matter. In answer to a question, the Chairman added that the Bill referred to was the outcome of the committee that was appointed, but it was not in conformity with the views expressed by a very large minority of that committee. It might be said to be in accordance with the views expressed by the majority, but a large minority were in favour of legislation on much broader lines. The next matter was that of electric rating, respecting which letters had been received from the Crystal Palace Direct Electric Supply Company (Limited). He had often expressed his views on this subject, but he did not know what they could do in the absence of general legislation. It was rather a large subject for their Section to initiate. The question affected all interests alike, and it was rather hard that the Electrical Section should be left to take the initiative.

Mr. MORSE observed that as electrical companies were in the exceptional position of having only 42 years' tenure, it seemed very hard that they should be subject to the same heavy rating as gas and water companies, which had practically a freehold. It was a large question, but unless some one moved, matters would go on as at present. He hoped that the fact that their section was moving would have some bearing on the question. It would be brought before the Council of the Chamber, who would appoint a committee of all the sections to go into the matter. The rating was not done now on any system, or with the simple idea of doing justice between ratepayers in a particular parish. There was a rating committee composed of interested ratepayers, who did not mind putting up the rating of an electric lighting company. He did not mean to say that they did anything dishonourable, but at the same time it was against all principles of justice that interested parties sh[ould] judge. What he thought the Chamber of Commerce might do was to advocate a central authority for the whole of London, as had been suggested, and with aproper appeal to the High Court of Justice, so that the matter might be dealt with in an impartial manner. Until that was done there would be unsatisfactory rating. The tramway companies, it is true, were on the same lines as themselves, having a limited tenure ; but they had never raised the question as to whether they ought to be put on a different basis from that of gas and water companies. He felt that a central rating authority would be beneficial to the electric lighting companies.

The CHAIRMAN suggested that they should pass another resolution asking the Council of the Chamber to take up the question in a general way, and point out to them the manner in which this matter prejudicially affected the electric light industry.

This was agreed to.

The CHAIRMAN said the next business was to consider a letter which had been received on the subject of electric traction from the National Traction Engine Owners' and Users' Association. After reading the letter, he stated that the point raised had been dealt with in a very competent way, and there was a definite promise from the Home Secretary. On the suggestion of Mr. Morse, it was decided to invite Major Flood Page to meet the Association.

The subject of merchandise marks was afterwards discussed, and Mr. SELLON undertook to act for the Section on the new general Committee, representing all interests of the Chamber, which Mr. MURRAY said it had been decided to appoint.

Mr. MORSE stated that under the Electric Lighting Act of 1888 the Board of Trade inserted in Provisional Orders a power in favour of Local Authorities to purchase electric lighting undertakings at the end of 42 years from the date of the Order. The Board of Trade, however, had this year, as regarded London, inserted 42 years from 1889, which was reducing the period to 35 or 36 years only. The powers of purchase given by the Act of 1888 were not favourable to an electric lighting company, but were favourable to the Local Authority, and it was a compromise by which, when the Act was passed, the Local Authority was given very good terms in return for the right to purchase being exercised at the end of 42 years. This seemed to him a matter in which their industry was very largely interested, and he did not think that the period of 42 years should be reduced without the consent of the company interested. It was quite right that local undertakings should agree with the Local Authority, and that the latter should have the power to purchase at less than 42 years, generally on terms, but where no consent was given by the company it seemed unfair that the Board of Trade should put forward this point, and insist on it. The object of the Board of Trade was to give the Local Authority, whoever that might be, power to purchase all their undertakings at the same date. There was no doubt some good reasons in favour of this, but if so the Board of Trade ought to say that it should only come into operation in respect to companies whose Orders were now being granted on other terms than the terms of the Act of 1888. He did not know how the Chamber felt in the matter, but he thought that a resolution should go to the Board of Trade saying what the electrical industry felt on the subject, and stating that these clauses ought not to go in.

Mr. ERSKINE asked whether the present Orders, apart from those granted this year, were dated from London.

Mr. MORSE replied that every Order granted by the Board of Trade since 1889 included the power of purchase at the end of 42 years from 1889.

It was finally decided that a letter should be addressed to the Board of Trade upon their action in the matter.

The meeting then proceeded to consider the revised Board of Trade regulations.

Mr. ERSKINE said it was very difficult to see by the regulations whether they referred to high or low tension, or both ; and taking the form of "regulations" generally, they seemed to be very badly worded.

The CHAIRMAN said he thought that the matter ought to be considered in detail, and that they should forward a circular to all supply companies asking them to send to the Section their suggestions with a view to their deputing some member of the Section to see the officers of the Board of Trade with a view to getting certain vague points in the regulations cleared up. They might send out these communications at once, and have another meeting next week, when they could go through the various suggestions which they might receive.

Mr. MORSE said he thought they ought to write a letter to the Board of Trade at once, if this course were adopted, and inform the Board what they were doing, and ask them to keep the matter open.

Mr. SELLON, acting on a suggestion from Mr. Morse, undertook to mark the clauses in the regulations which were difficult to understand, and, at the instance of the Chairman, further agreed to make a comparsion between the present and the old form of regulations.

The CHAIRMAN said that they would only regret it hereafter if they did not try now and get the amendments which were necessary.

Mr. MORSE stated that the electric traction protection clauses recommended by the Select Committee of 1893 were not always inserted in private Bills, and he thought it advisable that they should write a letter to the Chairman of the House of Lords, calling attention to the matter. He received a letter a few days ago from a Parliamentary agent, stating that in the South Shields Corporation Bill electric traction was asked for, and that the gas and water companies were opposing it in order to get clauses for their protection. It was sought to make the Corporation answerable "for all accidents, damages, and injuries happening by reason or in consequence of the construction, maintenance, or user of any tramway work, and shall save harmless the Company (that was the South Shields Gas Company), their officers and servants from all damages and costs in respect of such accidents, damages, and injuries." The object of this clause was to make the electrical authority responsible for gas explosions which had occurred and which might occur again. In consequence of this clause he looked into the Bill, when he found that the Telephone Company had a clause which was not in accordance with the clauses of the Joint Committee of the two Houses ; and, further, that the clauses of the Joint Committee were not inserted in the Bill. He afterwards proposed a resolution to the effect that the attention of the authorities should be called to the fact that the traction protection clauses were not always inserted in private Bills giving power for electric traction.

Mr. SHARP seconded the motion, which was adopted, and the proceedings then terminated.

BOOKS RECEIVED.

"The Law of Copyright in Designs." By Lewis Edmunds, D.Sc. (London : Street and Maxwell, Limited.)

"Petroleum." By R. Nelson Boyd. (London : Whittaker and Co.) Price 2s.

"Die Lehre von der Elektrizität." By H. Schwartze. (Leipzig: J. J. Weber.)

Journal of the Institution of Electrical Engineers. Vol. XXIV. No. 117. Edited by F. H. Webb. (London : E. and F. N. Spon.) Price 4s.

"The First Book of Electricity and Magnetism." By W. Perren Maycock, M.I.E.E. Second edition. (London : Whittaker and Co.) Price 2s. 6d.

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PARLIAMENTARY INTELLIGENCE.

SELECT COMMITTEE ON THE TELEPHONE SERVICE.

Upon the resumption, on Friday last, by the Committee of the House of Commons, presided over by the Postmaster-General, of their inquiry into the telephone service of the United Kingdom,

Mr. JAMES STAATS FORBES, Chairman of the National Telephone Company, continuing his evidence, produced further statistics with a view of testing the reasonableness and truth of the assertions which had been made as to the dearness and want of efficiency of the service afforded by his Company. With a view of disposing of the accusation that the service in Scotland was intolerable, and that the people there could not make use of it, he stated that on one day, namely, April 3rd last, the number of local messages, exclusive of trunk messages, passing through the Glasgow exchanges was 59,020, in the case of which the time occupied in placing subscribers into effective communication was under half a minute; under one minute, 4,590; under a minute and a-half, 974; under two minutes, 698; under two minutes and a-half, 260; under three minutes, 572; under three minutes and a-half, 54; under four minutes, 326; under four minutes and a-half, 218; and five minutes and over, 2,694. The number of messages passing through the Aberdeen exchanges on the same day in which less than half a minute was occupied in placing subscribers in effective communication was 14,050; under a minute 490; under a minute and a-half, 394; under three minutes, 66; and under five minutes, 54. Through the Edinburgh exchanges there passed on the same day 12,130 messages, in the case of which the time occupied in placing the subscribers in effective communication was under half a minute; under a minute, 1,956; under a minute and a-half, 1,298; under two minutes, 1,428; under two minutes and a-half, 628; under three minutes, 1,018; under three and a-half minutes, 110; under four minutes, 250; under four and a-half minutes 34; and five minutes and over, 750. The reasons for delay in making connections were subscribers not answering quickly, others being engaged and junction lines being occupied. Witness also called the attention of the Committee to the fact that on the same day the number of messages dealt with at the Queen Victoria-street exchange in London by one operator in charge of 50 subscribers, during the seven hours from 10 a.m. to 5 p.m., was 176, in which the time occupied in placing the subscribers in effective communication was unedr half a minute; under 1min., 146; under 1½min., 116; under 2min., 20; under 2½min., 34; under 3min., 4; under 3½min., 8; under 4min., 2; and under 5min., 2. Perhaps he ought to explain that each subscriber's call was counted as two messages—the question and the reply.

The CHAIRMAN: Can you give us the number of subscribers at Glasgow, Aberdeen, and Edinburgh?

WITNESS: Glasgow, 5,221; Edinburgh, 1,741; Aberdeen, 1,029; and London, 10,848.

Examination continued: In order to give an idea of the number of local messages passing over the National Telephone Company's system, he would take a few of the more important exchanges:—

Table A.

Exchange.	Number of subscribers.	Total No. of messages per day.	Messages per subscriber.	Cost per message.
				d.
Aberdeen (Central).........	866	11,966	14	0·37
Belfast (High-street)......	932	16,334	18	0·39
Birmingham (Central) ...	1,388	16,463	12	0·53
Blackburn (Central)	558	6,194	11	0·51
Bradford (Swan-arcade)...	1,378	19,685	14	0·44
Brighton (West-street) ...	809	7,062	9	0·70
Bristol (High-street)	681	10,157	15	0·42
Dublin (Dame-street).....	973	8,392	8	0·66
Dundee (Central)	784	15,199	19	0·27
Edinburgh (George-st.)...	407	4,811	12	0·51
Glasgow (Royal)	3,169	39,957	13	0·54
Greenock (Town Hall) ...	402	2,974	7	0·72
Halifax (Central)	312	4,526	15	0·42
Huddersfield (Central) ...	330	7,850	24	0·26
Hull (Central)...............	742	8,870	11	0·51
Leeds (Park-place)	1,574	40,789	26	0·23
Leicester (Central)	539	6,400	12	0·52
Liverpool (Royal)	3,938	96,644	25	0·25
London (Lime-street)......	2,135	22,625	11	1·04
Manchester (Royal).........	2,962	70,952	24	0·27
Newcastle (Quay Side)...	853	6,518	8	0·78
Nottingham (Central) ...	731	10,096	14	0·43
Oldham (Central)	340	3,956	11	0·53
Plymouth (Millbrook) ...	305	3,860	13	0·41
Reading (Central)	327	2,969	9	0·59
Sheffield (Commercial-st.)	2,152	20,652	10	0·48
Sunderland (Arcade)	725	9,096	13	0·47

The WITNESS desired to emphasise the extraordinary user in particular places, such as Leeds, Liverpool and Manchester, which, taken in connection with the efficiency of the call and the price, hardly bore out the swamping assertions which had been made as to dearness and want of efficiency.

The CHAIRMAN: How do you account for the fact that the cost to subscribers per message is so much higher in London than in other places?—Because the telephone is so much less used in London, and is not so essential as in Manchester, for instance.

The CHAIRMAN: Is it also due to the fact that in the City the annual charge is higher?—No doubt.

Mr. BENN: Are we to understand that the greater the business done the less the charge?—That is the direction in which the figures point. The greater the user for a fixed time the less the cost per user.

The CHAIRMAN: In the case of two subscribers paying the same amount, if one uses the telephone more frequently than the other he pays less per message?—Yes.

The CHAIRMAN: May the instances which you have given be taken as fair average specimens of the general state of circumstances throughout the country?—Yes, as nearly as we can ascertain the facts.

Examination continued: As bearing upon the possible effect upon the use of the telephone of a more or less perfect telegraphic service, Witness proceeded to give the following figures in regard to the telegraphic service of certain European countries, together with the ratio per head of the population:—

Table B.

Country.	Population.	Total number of telegrams.	Telegrams per head.
Austria	23,895,413	12,068,064	0·505
Belgium............	6,069,321	5,414,864	0·892
Denmark	2,172,380	1,817,718	0·836
England (United Kingdom)	38,520,116	73,299,237	1·902
France	38,343,192	47,017,117	1·226
Germany	49,428,470	33,172,116	0·671
Holland	4,732,911	4,429,771	0·935
Hungary	17,349,398	6,522,302	0·375
Italy	30,347,291	9,681,912	0·319
Norway	2,001,000	1,740,180	0·869
Roumania	5,040,000	1,649,294	0·327
Russia	120,000,000	13,193,257	0·109
Sweden	4,824,150	2,101,850	0·435
Switzerland	2,917,819	3,838,323	1·3150

The CHAIRMAN: I understand you to suggest that the larger user of the telegraphs probably indicates a more effective telegraphic service, and consequently a less demand for telephonic service?—That is the inference to be drawn.

In the course of his further examination, Mr. FORBES gave statistics showing the number of telephone lines and the population at various centres on December 31st last, from which it appeared that at 73 centres in England and Wales having a total population of 16,632,254, the number of telephone lines was 57,358, giving a population of 290 per line. In 17 centres in Scotland, with a population of 1,607,775, the number of lines was 12,661, and the population per line 127. In five centres in Ireland, having a population of 810,469, the number of lines was 3,319, showing a population per line of 244—making a grand total for the United Kingdom of 73,338 telephone lines and 19,050,498 population; that is to say, 260 per line. With all the drawbacks to the development of the telephone in this country, we had not made so slight an advance as was sometimes asserted. The conclusion at which he had arrived was that in places of commerce, shipping, and manufactures the service of the National Company compared very favourably with the telephone service at similar places in America. Having laid stress upon the extreme moderation of the initial charges, Witness, dealing next with the the metropolitan local exchanges, mentioned that there were on the Croydon local service, which includes free speaking between Sydenham, Bromley, Redhill, Epsom, and Streatham, 61 subscribers at £10 per annum and 250 subscribers havi[illegible] full metropolitan service; on the Kensington local service there were t[illegible]e subscribers at £10 per annum and 342 subscribers having full metropolitan service; at Kingston, including Richmond and Wimbledon, there were two £10 subscribers to the local service and 36 subscribers having full metropolitan service; on the Battersea local exchange there were one £10 subscriber and 67 subscribers having full metropolitan service; and in the case of the Eastern local exchange there were three £10 subscribers and 279 subscribers having full metropolitan service. The number of private houses connected in the metropolis was 492. Battersea was supposed to be the paradise of the working man, but the figures which he had just given went far to explode the theory that working men desired to use the telephones. As a matter of fact, he did not believe that one working man in a hundred thousand would use the telephone. As to small tradesmen and shop-keepers, although such persons might perhaps have to make use of the telegraph once a-day in connection with their business, they would certainly not subscribe to the telephones. Criticising the estimates put in on behalf of the London County Council for the establishment of a municipal system of telephones, Mr. Forbes pointed out that apparently nothing was allowed for the extraordinary wastage which went on in consequence of people going in for telephones, and then giving them up in a year or two. It was true that the salvage of the instrument and the wire might be left to the Telephone Company, but the cost and labour involved in fitting up the instrument and the wire would be gone, and that might be set down at a waste of from 50 to 75 per cent. This waste had to be paid for, whether out of capital or interest. The Witness next made an elaborate statistical comparison of the National Telephone Company's and the Post Office subscribers. He showed that on December 31, 1894, there were at Newport 271 Company subscribers, as against 85 Post Office subscribers; Barry Dock 607, as against 155; Swansea 262 to 7, whilst at Leicester there were 80 Telephone Company's

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subscribers in March, 1891, the date of opening, and 524 on December 31, 1894, as against 138 Post Office subscribers in 1885, and 38 at the present time. At Nottingham there were, on December 31st, 918 to the Company's line, which was opened in June, 1881, as against no Post Office subscribers at all. At Derby there were 38 subscribers to the Company's line at its opening in June, 1889, and 387 on December 31, 1894, as against 20 Post Office subscribers at the date of opening, and none at the present time. At Hull the figures were, on January 1, 1891, when the Company's line was opened, 32 subscribers, and on December 31st 713, as against no subscribers to the Post Office line when it was opened in June, 1881, and 52 at the present time, and so on. As to the relations between the National Telephone Company and the Association for the Protection of Telephone Subscribers in London, Witness desired to say that after arriving at the decision that the proposals of the New Telephone Company for working a separate telephone system in London under the conditions set forth in the Agreement between the New Telephone Company and the Association for the Protection of Telephone Subscribers, dated April 25, 1892, could not, with advantage to the public, or with any prospect of financial success to the New Telephone Company, be given effect to, and that in the interests of all parties concerned it was expedient, in order to secure a more efficient service than then existed, to remodel the plant of the National Telephone Company on the metallic circuit principle, negotiations took place between the representatives of the Association and of the National Telephone Company, with the result that certain assurances which were given by the National Telephone Company, accompanied by certain modifications of tariff, were accepted by the Association as a fulfilment of the obligations of the New Telephone Company to the Association, as set forth in the said Agreement. The assurances referred to were, that the National Telephone Company would continue the work, then in progress, of remodelling its London system upon the metallic circuit principle; and that work had been pushed forward with the utmost vigour, in redemption of the pledges given upon the conclusion of these arrangements.

Replying to questions by Sir Charles Cameron, WITNESS admitted that the telephone system at Stockholm was beyond doubt an excellent one, and the proportion of the subscribers was high. If the same proportion subscribed in London there would be 250,000 telephone subscribers in the metropolis alone.

A question being asked of Mr. Forbes relating to an agreement with the Mutual Telephone Company, of Manchester, WITNESS declined to answer it or to put in the Agreement, on the ground that in the event of future litigation such evidence might be used to the prejudice of the National Telephone Company.

The Committee deliberated for some time in private as to the course they would adopt in view of this protest, but eventually adjourned until Tuesday without announcing any decision upon the point.

TUESDAY, MAY 28TH.

Mr. J. S. FORBES, Chairman of the National Telephone Company, was further examined. He now withdrew his objection to the production of the Agreement between the Mutual Company of Manchester and the New Telephone Company, and laid it before the Committee. In answer to Sir Charles Cameron, he said that the New Company bought out the Mutual, and it remained the property of that Company, but the National Company possessed nearly all the shares, and had control. The New Company was in process of liquidation. The Post Office and the Company might be in arbitration some day or other, and it might not suit to reveal too much. He proceeded to show on what standing the companies had been merged. The companies were the National, the United Telephone Company, the Lancashire and Cheshire, the Northern District, the South of England, the Western Counties and South Wales, Sheffield Telephonic Exchange, the Caledonian, Universal, Isle of Man, Telephone Company of Ireland, Thanet Company, and the Home Telephone Company. The stocks of the first three companies were cancelled, and new stocks given in exchange. They were amalgamated on the basis of the market value of the day. Taking all the companies, the money spent in construction was £1,813,000, the amalgamation purchase value was £3,105,000, and what some might call water amounted to £1,292,000. Since the companies had been amalgamated under the National, beginning with 1890, up to the end of December, they had spent in sovereigns £1,459,000, which, with the value above given, represented £4,565,000. An agreement for mutual working without rivalry, and for inter-communication between the systems was made with the New Company, represented by the Duke of Marlborough, in July, 1892. Afterwards the National acquired the undertaking. A great many of the people in the New Company exchanged their shares for shares in the National Company, but those who preferred it got cash. £750,000 was the amount.

Sir CHARLES CAMERON: My point is this. We assume that it stands at £750,000 in your books. That is unproductive capital is it not?

WITNESS: There was the Manchester business, which was a service very well laid out.

Sir CHARLES CAMERON: Manchester cannot bear any material part of the £750,000. It was £60,000, so that a large part must be unproductive capital.

WITNESS: You lose sight of the fact that we have gone on spending money for these improvements in London, which, if we had not done, they would. It is cheaper to have done this thing and better for our subscribers than to have a company in London in competition with us. That is how I defend this transaction.

Mr. BENN asked if it was not where competition has reached a fair point that the rates have been reduced.

WITNESS: Yes, for the time being. But you must not lose sight of the fact that if competition goes on that must be covered, and the price in the end will be higher. He looked upon it as absurd to suppose that Great Britain could be accommodated with the telephone to the extent of 50,000 subscribers for an amount under £2,000,000. The figures he had given did not support that construction.

Sir JAMES FERGUSSON: Your licence ceases in 1911; but how long would it avail to go on and meet the requirements of the public?—As long as any man could make up his mind to spend money on a continually decreasing tenure.

The day might come—and possibly in nine years—when it would not be remunerative to you to expend your capital?—Not remunerative to anybody on the tenure. If we had 25 years to run instead of 16, or 42 instead of 25, the question of price assumes a totally different aspect. At first the development of the Company was extremely hindered. If the Company had had the means and the facilities here in London under the law they could have developed their system much more economically, much more rapidly, and could have supplied customers on a lower annual charge. In some respects expenses advanced with increased subscriptions, and in some respects they did not. When they reached a particular level of subscribers in an area up to a certain point the more subscribers the better, because they diluted the fixed charges, but beyond that number there might be expenses which would make the cost of subscribers high. Happily, this condition of things, when the addition of subscribers would tell the other way, had not yet arrived. The Company's interest would be for some time to go on developing business as rapidly as possible.

Mr. A. C. MORTON, M.P., was interposed as a witness at this point, Mr. Forbes' further examination being suspended. Mr. Morton laid before the Committee the report drawn up by Mr. H. Montague Bates, chief clerk to the Commissioners of Sewers of London, upon the replies to a circular issued to telephone users in the City, asking their opinion as to the efficiency and the cost of the existing service. The circular was issued to 3,450 subscribers to the National Telephone Company, being, as far as was ascertained, the whole of the users in the City, and answers were requested to two questions:—(1) "Do you, as subscriber to the National Telephone Company, consider their service efficient? If unsatisfactory, state in what respects." (2) "What is your opinion as to existing charges?" The replies received were 1,055. The opinion of the majority as to the inefficiency and costliness of the service confirmed in every particular the evidence given by the Chairman of the Streets Committee, Mr. George Berridge, and Mr. Bates before the Select Committee.

Mr. BEVERIDGE, of Glasgow, gave evidence as the telephone service in that city. There are 4,791 users, but 382 have more than one telephone, and this reduces the actual number of subscribers to 4,409. Petitions had been exhibited in public places for signature in reference to the nature of the telephone service. Out of 1,018 signatures, 970 were those of persons who regarded the service in Glasgow as inefficient, inadequate, and too expensive.

Mr. TULLY: You stated that there is £1,292,000 watered capital?—It is water, but there is a good deal of spirit in it.

To pay a dividend of 5 per cent. on that would require £64,000 a year; so each telephone subscriber, in order to enable you to pay this £64,000 a year, has to pay an increased price necessarily for his telephone?—Well, that is a proposition I do not know.

Where do you get the money to pay that?—It is in the subscription.

Doesn't it follow from what I say that it has to be charged in a certain proportion?—Yes, it has; and any people who propose to found another company will find themselves in the same position.

Mr. TULLY put the case of the Glasgow Corporation as a body that might maintain a telephone service with advantage.

Mr. FOBES said the Corporation would have to charge a paying rate. He did not know what corporations might do; but he did not think they were more far-seeing or able than companies. If they could start a telephone system without paying for it, of course it would be a very good thing to do. It would be of extreme advantage to the people who could afford to pay; but it would be a great hardship upon the inhabitants of Glasgow who would not and could not use the telephone. It would be a grievance to the great body of the people of a city if these cheap rates were to be brought about by corporations making use of the rates, or appropriating money in their keeping, because it would be expended for the benefit of merchants, manufacturers, and such people, who used the telephone and could well afford to pay a great deal more than they did.

Mr. TULLY: But the public are already paying through loss of business to the Post Office?—That is not my point. If the rates of a city are saddled with the expense of supporting the telephone service, it will benefit the tradesmen, merchants, financiers, and such people, who can afford to pay.

In reply to Mr. Snape, WITNESS said that the average of working expenses, £6. 4s. 7d., included the whole cost of working and maintaining the lines from day to day as a going concern, including the up-keep of material. They did not include debentures or interest on capital. Out of the receipts, 62 per cent. was working expenses. There was a very large amount for wayleaves. If municipalities had the telephones, they would not have to pay for the streets; but they would for wayleaves over private property. The Government would not have to pay royalty; but it might give a service at a price below its value to users of the telephone at the expense of the masses, who did not want the telephone. The people who would be benefited by such a change had ten times more value than their present subscription. He undertook to say that the bulk of new subscribers came from the increased knowledge of the value of the telephone, and not from the reduced price.

Mr. LAMB, of the Telegraph Department of the Post Office, was recalled, and gave evidence mainly in rebuttal or criticism of statements by other witnesses. He stated that in Germany there is a single-wire system throughout. France was now opposed to a reduction of rates in its service, and a recommendation to that effect had just been adopted by the Budget Committee. In Italy the law forbade telephone competition, but it was allowed in Rome, which had it before the law was passed. The

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reason was that competition was believed to be detrimental to the public service. Both in Norway and Sweden an additional charge was made for telephoning a message to a post office for transmission as a telegram. In Switzerland an increase of charge would be made in the case of persons who had 800 conversations or over per year. Gen. Webber had estimated that £17 would not be an unreasonable charge in the City of London for subscribers who wished to communicate with all the others; but in his estimate he had made no provision for junction wires between the exchanges. The fact was that the Duke of Marlborough in his plans had desired that the Post Office should supply junction wires for London generally. The estimates of cost for these were £178,000, and for the City proper about half, or £89,000. That capital expenditure was not included in Gen. Webber's estimate. This did not apply to the other estimates on behalf of the London County Council. He did not regard conduits as suitable for telephone wires, and that was also the opinion of Mr. Preece. The lines would be in many cases absolutely under all the conduits of the electric lighting cables. Gen. Webber had also assumed that there are 28,000 subscribers in the City. But there are only 27,827 separate tenancies in the City, and if the Middle Temple were included it would bring the total to 29,000. He did not approve of taking over the business in such a way that depreciation or loss would ensue to the general taxpayer, and prudence pointed to the maintenance of rates at a fair point which would afford a certainty of some profit. While he hoped that some day the telephones would be in the hands of the State, he thought it would be impossible to reduce the rates. If done at all it should be done on the ground of actual experience and not on the ground of mere estimate. He agreed with Mr. Preece's estimate as to the cost of laying down a system in London. It was an estimate based on practical experiment, and far more reliable than the estimates of gentlemen of no practical experience in carrying out such work. Everywhere competition in this service was giving way, and the tendency was to have one system. The telephone is in the hands of the State in France, Germany, Austria, and Belgium, and the State is acquiring possession in some other countries.

This concluded the evidence tendered before the Committee, which has now to consider its report.

CORRESPONDENCE.

PRESSURE CURVES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I observe among the records of electrical pressure which are published in the current number of *The Electrician* one relating to the Kensington and Knightsbridge Company for March 20th. Mr. Swinton placed his recording voltmeter in my laboratory on March 19th and 20th. On the 19th I purposely suspended my work, and took no more current than sufficed for domestic purposes, but on the 20th, at 10 p.m., I took a rather heavy current for a quarter of an hour, during which period my magnetic cut-out flew two or three times. There was in consequence a drop of about four volts, chiefly on my service connections. I think it is due to the supply company to point this out, because a drop of four volts is quite unknown in this district. I do not know what goes on in the daytime, but after dark even a two-volt variation, sufficiently quick to produce a perceptible flicker, is very rare.

These variations probably arise chiefly on the mains, due to changes of distribution of load, and are not perceptible at the feeding points. My house is midway between three feeding points and halfway between two batteries, but one of these had been destroyed by the fire at Kensington Court. The average pressure on March 20th, between 10 and 11 p.m. was between 100·5 and 101 volts, as measured by Clark cell and potentiometer.

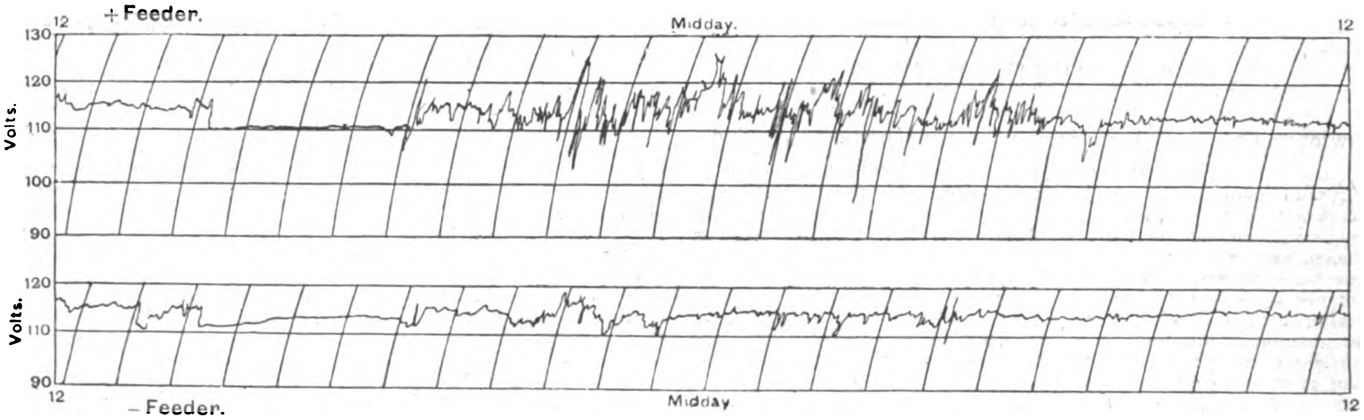
Mr. Swinton has evidently sent you the record for the 20th instead of the one for the 19th inadvertently, as I called the attention of his assistant to the matter at the time.—Yours, &c.,
A. P. Trotter.

28, Victoria-street, Westminster, London, S.W.
May 29, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Will you kindly allow me to point out that the diagram published in this week's *Electrician*, showing the electrical pressure maintained by the St. Pancras Vestry, is not correct, and does not truly represent the pressure for the 24 hours of May 2nd. In the first place the diagram represents us with batteries on the circuit from 3:30 till 7:30 p.m., and then a very varying pressure from 7:30 p.m. till midnight. The batteries were actually only supplying current on this day from 3:30 till 7:30 a.m., and the irregular line shows the pressure during the morning, when very few lamps were alight, the load consisting almost entirely of motors. The diagram showing the pressure from midnight till midday much more nearly represents our pressure for the other 12 hours of the 24; but even in this case we cannot accept as correct the pressure which is credited to us during the evening since on referring to our own recording voltmeter cards for May 2nd, showing the voltage at the feeding point adjacent to Fitzroy-square, we find that a steady pressure of 112 to 113 volts was maintained throughout, and further that these figures are confirmed by the readings of the voltmeters on the switchboard. Feeling that we have been misrepresented in the diagram, I shall be glad if you will insert this in your next issue, in order that our actual voltage may be better understood.—Yours, truly,
T. Cooper, Assistant Engineer,
Vestry of St. Pancras.

[We have pleasure in publishing two official pressure curves, taken on the same day of 24 hours, and at nearly the same point, as that taken by Mr. Swinton. That there is a succession of very considerable differences between the pressures on the two sections—the positive being markedly irregular in the morning, while the negative is nearly steady—is due to the fact that almost the whole of the motor load carried by the St. Pancras mains occurs on the positive section.—Ed. *E.*]



Pressure Curves taken from St. Pancras Mains at Fitzroy Square, May 2nd.

THE BOARD OF TRADE AND THE ELECTRIC LIGHTING ACTS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am very glad to see your head-note upon the question put in the House of Commons last Monday.

It may be reasonable for the Board of Trade to determine that the power to purchase all London Orders shall arise at the same time. But it was the intention of Parliament that the special terms of purchase under Section 2 of the Act of 1888 should only arise at the expiration of 42 years from

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the grant of the Order in question. And I contend that the Board of Trade have no right to say that an undertaking under the Electric Lighting Acts shall be compulsorily bought at the end of a shorter period upon the statutory terms, unless the undertakers make an agreement to the contrary with the Local Authority.

In the case of my Company—on whose behalf the question was put in the House—we had an unconditional consent from the Local Authority.—Yours, &c., SYDNEY MORSE.

4, Fenchurch-avenue, E.C., May 24, 1895.

ELECTRICAL TERMINOLOGY AND GREEK PARTICIPLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In answer to the trenchant and incisive letter of Mr. Portheim, which appeared in your issue of March 15th, in reply to my protest against the use of the word ka*th*ion, I beg to state that I was not forgetful of the existence of the Greek verb *καθίημς*, and am also aware that there are the present participle *καθίεις* and the aorist participle *καθέις*, but had not been informed of any participle *καθίωγ*, nor on consulting the grammar and dictionary at my disposal have I been able to find it.

If, however, Mr. Portheim *can* quote a passage from Greek literature in which this participle occurs, I should still consider that the word *ion* was originally intended as a derivative of *εἶμς* rather than of *ἵημς*, for otherwise the aspirate would be represented in English, and we should hear of *hions* instead of *ions*, in the same manner as we have *hysteresis*, and not *ysteresis*.

What is meant by "we surely consider the *kathion* in the light of a *carrier of ions* to the kathode" I am incapable of understanding, since I always considered that the kations are the ions *separated* at the kathode, and not the *carriers* of *ions in general*.

If Mr. Portheim will refer to the early electrical literature in which the ion separated at the kathode is mentioned, I feel certain that he will find that ka*t*ion is the term employed, and that his phrase, "good old kathion," is a misnomer.—Yours, &c.,

Royal Military College of Canada. JOHN WADDELL.

LEGAL INTELLIGENCE.

Fowler v. the Chelsea Electricity Supply Company (Limited): Landon and Others v. the Same.

In the Chancery Division on Friday, the 24th inst., these actions came before Mr. Justice North on motion for interlocutory injunction. The first action is brought by the tenant of a flat at No. 75, Cadogan-gardens, Chelsea, and the second by the landlord and tenants of other flats in the same house to restrain the defendant Company from continuing an alleged nuisance occasioned by noise and vibration.

After some discussion it was arranged in each case that the motion should stand till trial, the writs to be treated as statements of claim, the defendants to deliver statements of defence within 14 days, and leave being given to have the trials expedited.

Muirhead v. the National Electric Supply Company (Limited).

An action brought by Mr. John Muirhead against the National Electric Supply Company, to recover Director's fees for three years, came before Mr. Justice Day, in the Queen's Bench Division, on Friday, the 24th inst.

It appeared that the defendant Company carried on business as an electric lighting company at Preston, and the case for the plaintiff was that he became a Director of the Company in 1891, and continued on the board till 1894, and now claimed to be paid for his services during that period. The 107th clause of the Articles of Association of the Company provided that the remuneration of the Directors should be £200 per annum for the Chairman, and £100 for each of the Directors, together with such other sum, if any, as should be voted by the Company in general meeting. A clause of the Memorandum of Association fixed the rights of the Founders' and Ordinary shares, and then stated, "There shall then be set aside out of the profit of the Company such percentage thereof as shall from time to time be appropriated by the Articles of Association for payment of Directors' remuneration." It was contended for the plaintiff that the meaning of the clause was simply to apportion the profits as between the different classes of shareholders, and did not preclude any payment to the Directors until such profits had been made. The Company, as a matter of fact, had made no profits at all, but it was submitted that the Directors were entitled to be paid out of any funds that remained.

On behalf of the defendants, it was contended that by the true construction of the Memorandum of Association provision was made for setting aside out of the net profits such percentage as should from time to time be appropriated by the Articles of Association as remuneration to the Directors. The Directors were only to be paid out of the net profit, and there was no provision whatever in any of the documents which indicated that they were to be paid out of capital.

At the conclusion of the arguments of counsel his Lordship gave judgment for the defendants, but granted a stay of execution, with the view to an appeal.

Walsall Electric Company v. Walsall District Iron Company.

The plaintiffs recently brought an action against the defendants for the sum of £64. 16s. 11d., balance due for work done in connection with the putting down of an electric lighting installation at the defendants' works. The defendants contended that there had been a complete breakdown of plant, to which the plaintiffs replied that whatever irregularities there might have been were due to want of care on the part of the persons employed by the defendants to superintend the working of the plant. A settlement was ultimately arrived at between the parties.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices:—*

LABORATORY NOTES AND FORMS.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett. Strong portfolios can be had, price 1s. each. A full prospectus can be obtained post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s. —each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

"THE ELECTRICIAN."—A special notice concerning certain changes in the price, &c., of this journal will be found on page 158.

TENDERS INVITED.—The Electric Lighting Committee of the Huddersfield Town Council invite tenders for cables, transformers, switches, fuses, and covers for their electric lighting works during the ensuing 12 months. Tenders to be into Mr. A. B. Mountain, Andrew's-road, Huddersfield, by to-morrow (Saturday).

——— By command of the Postmaster-General, tenders are invited for the purchase of about 35 tons of old copper (wire, plates, &c.) and quantities of other metals, india-rubber covered wire, &c. Forms of tender can be obtained of Mr. Charles E. Stuart, Controller of Stores, General Post Office, Telegraph-street, E.C., and tenders must be sent in not later than 10 a.m. on Monday, June 17th.

——— *Extension of Time.*—The time for sending in tenders for the supply of electric light lamp pillars and copper canopies required by the Corporation of Brighton has been extended until 10 a.m. of Saturday, June 1st.

——— Tenders are being invited until June 29th by the Municipal Authorities of Braila, Roumania, for the concession for the lighting of the public streets either by electricity or gas.

——— The North-Eastern Railway Company invite tenders for telegraph apparatus, telegraph wires and line stores. Tenders, addressed to the secretary (Mr. C. N. Wilkinson) must be in by June 10th.

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TENDERS INVITED.—The Godalming Town Council invite proposals for the installation of the electric light for public and private lighting within the borough.

——— The Italian military authorities at Pavia are inviting tenders for the supply of 105,600 metres of rubber-covered telegraph wire 1·6mm. in diameter.

——— Tenders are invited by the General Direction of the Roumanian Posts and Telegraphs at Bucharest until June 15th for the supply of 4,000 Callaud cells for telegraphic purposes."

TENDERS ACCEPTED.—The Public Library Committee of the Worcester City Council, at their last meeting, discussed the report of the Sub-Committee appointed to consider tenders for the supply of fittings for the electric light in the Institute. The Committee recommended the acceptance of the tender of Messrs. Graham and Biddle, Oxford-street, London, for the sum of £768. After some discussion, however, it was decided to accept the tender of a local firm, the New British Electrical Installation Contractors, amounting to £849.

——— The Hanley Town Council have accepted the tenders of Messrs. W. H. Allen, Son and Co., for the supply of a condenser for their electricity works, for the sum of £755, and the tender of Messrs. H. and T. Danks, for boilers, &c., for £1,050.

——— The tender of Messrs. Baily, Grundy and Barrett (Limited) for carrying out the work in connection with the installation of electric fire brigade calls and street posts has been accepted by the Cambridge Town Council. The work is to be carried out from plans prepared by Mr. A. Barrett.

TENDERS RECEIVED.—The Electric Lighting Committee of the Chester City Council some time ago submitted to Lord Kelvin six tenders received for the lighting of the city for his consideration and report, and the Committee have now decided to recommend the tender of Thomas Parker (Limited) for acceptance.

SALE BY AUCTION.—Messrs. Wheatley Kirk, Price and Goulty will sell by public auction at the Mart, Tokenhouse-yard, London, E.C., on Thursday, June 13th, at 12:30 for 1 o'clock, the entire valuable property of the Val d'Aosta Syndicate, Limited (in liquidation), consisting of freehold works, mines, &c., with engines, boilers, plant, railways, water rights, &c., of which particulars are given in our advertisement columns. The plant is in first-class condition, and is especially suitable for carrying on the trade of copper depositing, refining, and smelting. This sale offers an exceptional opportunity for capitalists, as the works, plant and patent rights are practically sold as a going concern. The auctioneers, Messrs. Wheatley Kirk, Price and Goulty, of 49, Queen Victoria-street, London, E.C., and Albert-square, Manchester, will supply plans and descriptive particulars gratis, as will also the liquidator, Mr. F. R. Reeves, Mansion House-buildings, E.C., the solicitors, Messrs. Deacon, Gibson and Medcalf, 9, Great St. Helen's, E.C., and Messrs. Mackrell, Maton, Godlee and Quincey, 21, Cannon-street, E.C.

APPOINTMENTS VACANT.—The Liverpool Salvage Association require a practical engineer to act as superintendent of steam pumps, electrical installations, &c. Salary, £150 to £200 per annum. Applications to the Chairman, A 20, Exchange-buildings, Liverpool, by June 10th.

——— The Victoria Institute Committee of the Worcester Corporation require a science master. Salary £200 per annum. Applications to the Secretary by June 4th.

BUSINESS FOR SALE.—Mr. John M. Macleod, C.A., of 101, St. Vincent-street, Glasgow, has for disposal the old-established business of electrical engineers, bell hangers, &c., carried on by Mr. J. Scott, under the style of D. and G. Graham, at 130 and 140, Douglas-street, and Byars-road, Glasgow, together with the whole of the stock-in-trade, plant, machinery, &c. Offers must be sent in to Mr. Macleod by June 7th. Some further particulars appear in our advertisement pages.

APPOINTMENT.—Prof. W. T. A. Emtage, M.A., has been elected principal of the Wandsworth Technical Institute, at a salary of £350 per annum. The appointment is subject to the approval of the Technical Education Board of the London County Council. Prof. Emtage is at present Assistant Professor of Mathematics and Physics at the University College, Nottingham.

LIQUIDATIONS.—It was resolved on April 9th (the resolution was confirmed on April 24th) that T. L. Hemming and Co. (Limited), of 88, Snow-hill, Birmingham, be voluntary wound up. The assets and property of the Company have been sold to Hemming and Co. (Limited). Mr. S. Wright, C.A., 39, Corporation-street, Birmingham, has been appointed liquidator of the old Company.

——— A meeting is to be held at the office of Mr. W. E. Young, 26, Athol-street, Douglas, Isle of Man, on June 24th, at 11 o'clock, for the purpose of receiving an account of the winding-up of the Isle of Man Tramways (Limited).

BANKRUPTCIES.—Notice is given by the trustee (Mr. C. W. Meiter) in the bankruptcy of George Frederick Rogers, electrical engineer, of 5, Great Winchester-street, London, E.C., that creditors who have not yet proved their debts must forward proofs to him forthwith.

——— Notice is given that all claims in the separate estate of C. W. W. Young (late of Young and Buss, electric bell manufacturers, 18, Blantford-street, London, W.) must be sent in to Mr. H. W. Figg, 37, Upper Thames-street, London, E.C., by June 6th.

——— The creditors in the failure of the Ford Lloyd Manufacturing Company (Limited) include the following :—

	£	s.	d.
C. Atkins and Nisbett, London	£19	19	3
Johnstone, Benjamin and Co., London	28	2	3
Le Carbone, London	17	19	3
Summerling and Co. (Limited), London	58	0	0
Wells, Gallimore and Taylor, Birmingham	17	2	0
W. Wood and Co., Burslem	39	0	0
C. T. Maling and Sons, Newcastle	21	17	2

——— Notice is given of the release of the trustee (Mr. R. Sands) in the bankruptcy of Wm. Andrews, electrician, of 6, St. Anne's Valley, Nottingham.

ELECTRO-HARMONIC SOCIETY.—The annual general meeting of this society takes place to-day (Friday) at 4:30, at 28, Victoria-street, Westminster, London, S.W., to receive the annual statement of accounts, &c.

CATALOGUE.—The Willans engine is going ahead in America, and it seems not unlikely that the tardy conversion of our transatlantic cousins to high-speed practice will be followed by as universal an adoption of the central-value engine in the States as it has received in our country. We have just received a Catalogue, issued by the Bullock Manufacturing Company of Chicago, of the "central-valve" Willans engine. This firm is widely introducing the Willans engine in America. The Catalogue is admirably illustrated and bristles with information. There is a large photo of a 650-I.H.P. triple-expansion condensing Willans engine, which is now in use at a Lancashire cotton mill, and which should silence the objections of those who assert that the high-speed "central-valve" engine is not adapted to large powers. It is evident from the material compiled in this Catalogue that, at any rate as far as high-speed practice is concerned, the Americans are not above learning lessons from English engineers; and they are wise, for our experience of this class of engine has been eminently satisfactory.

TELEPHONES.—The Electrical Company (Limited), of 122 and 124, Charing Cross-road, Oxford-street (London, W.C.), send their latest list of telephones of various patterns, and telephonic apparatus and accessories. The list is fully illustrated, and contains clear diagrams of connections, prices, &c.

AGRICULTURAL HALL (LONDON, N.).—The electric lighting of the Royal Military Tournament at the Agricultural Hall, Islington, N., was carried out by Messrs. Bergtheil and Young. This is one of the few occasions in which an attempt is made to light the hall effectively by electricity. The private electrical installation of incandescent lamps for the Tournament is being supplied from dynamos and direct coupled gas engines of the Dawson Company's high-speed type.

AYR.—The Town Council, at their meeting on Monday, decided to extend the electric mains round by Miller-road and Alloway-place at an estimated cost of £700.

BATH AND WEST OF ENGLAND SHOW.—The annual show of the Bath and West and Southern Counties Society, opened at Taunton this week, proved a great success. Amongst the exhibitors are Mr. E. S. Hindley (who shows engines, pumps, dynamos, motors, circular saws, &c.), Messrs. Clayton and Shuttleworth (portable steam and petroleum engines, each fitted with all the most recent improvements), Crossley Bros. (gas and oil engines, large and small, including a special high-speed electric light engine of 20 I.H.P., fitted with special governing arrangement), John Fowler and Co., Leeds (portable engines), Marshall, Sons and Co. (portable engines, &c.), Ransomes, Sims and Jefferies (portable and fixed engines and boilers, and Ransome's force pump for the efficient cleaning out of traction and portable engines), Willcox and Co. (engineers' stores, tools, pumps, oil filters, &c.)

BATTLESHIP LIGHTING.—It is stated that at the forthcoming visit of the English Channel squadron to Kiel the electric lighting of the vessels will be out of the usual order. It is intended to light up the whole of the upper decks and the superstructures by incandescent lamps, and use a number of coloured lamps for the masts, stays, &c. The illuminating arrangements are to be under the supervision of Lieuts. Fraser and Carey, of the "Royal Sovereign" and "Empress of India."

CLUB LIGHTING.—The new Borough Club, Nottingham, is lighted throughout by electricity. The installation has been carried out by Mr. Joseph Blackburn, Gresham Works, Nottingham.

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COWES (I.W.).—The District Council have appointed Mr. F. H. Medhurst as electrical expert, to advise them in their scheme for lighting the district electrically, at an inclusive fee of 25 guineas.

DURBAN.—Mr. W. H. Preece, together with Mr. James Fletcher, the borough engineer, have prepared and presented exhaustive reports dealing with the question of the best of two schemes for lighting Durban by electricity. The proposal of the borough engineer is the utilisation of the steam plant in combination with sewage disposal works, and this scheme, with certain modifications, has Mr. Preece's recommendation. It is proposed that plant should be put down with capacity for supplying 60 2,000-c.p. arcs and 2,500 16-c.p. incandescents, with room for additional power when required. It is proposed to borrow £25,000 for the purposes of the scheme, and an annual income is estimated at about £9,000. It is proposed that a maximum of 1s. per unit should be charged for current, which it is hoped to reduce soon after the scheme is in working order. Mr. Preece further recommends that plans and specifications be prepared and tenders invited from all the great manufacturing firms in Great Britain, who should be requested to submit particulars of their various systems. In the borough engineer's scheme it is strongly recommended that all wires be placed underground. The report is to be considered at an early meeting of the Town Council.

EDINBURGH.—The Electric Light Committee having received an extensively signed requisition from the inhabitants of Stockbridge requesting an extension of the electric mains for private lighting to the Water of Leith Bridge, and having received the requisite guarantee in the matter have resolved to approve the scheme, which is estimated to cost about £1,200.

ELECTRIC MOTIVE POWER IN WEAVING MILLS.—Messrs. J. and J. Cash, of Kingfields, near Coventry, have recently placed an order for electrical plant, with a capacity for supplying current for 40 large looms, each driven by an independent motor. The plant is to be put down in new premises now being built by Messrs. Cash, and the order for the electrical machinery has been placed with the Coventry Electrical Engineering Company.

EXHIBITION.—There is to be an exhibition of railway appliances, &c., at the Imperial Institute, to be opened by Lord Herschell on June 1st, at which Messrs. Krupka and Jacoby will have on show a number of Dr. Lessing's dry batteries, for which they are the agents in this country.

EXHIBITION LIGHTING.—The arc lighting of the Empire of India Exhibition, now being held at Earl's Court, London, is carried out by means of six Brush series dynamos, each designed for 55 lights, and the regulation is effected by Brush-Geipel regulators of the water-resistance pattern. The incandescent lighting plant consists of Mordey alternators of the new type, having a joint capacity of 350 kilowatts. There are also two 75-kilowatt alternators, one direct driven and the other by belt. The exciting plant is in triplicate. The alternator and exciter boards consist of marble panels with the usual Brush switches and instruments. The boards are also fitted with double-pole change-over switches for throwing either of the alternator fields on to the common exciter omnibus bars, or for connecting each alternator to its own independent and direct-driven exciter. The arc-lighting board is arranged for five dynamos and five circuits, with hook and stirrup-pattern switches. The transformers are of the Mordey-Victoria type, having a joint capacity of 276 kilowatts.

GREAT NORTHERN AND CITY RAILWAY.—The Unopposed Bill Committee of the House of Commons on Tuesday passed the Bill which gives to the Great Northern and City Railway Company an extension of time until 1900 within which to construct their authorised electric railway from Finsbury Park to Moorgate-street, City. It will be remembered that an attempt on the part of the Great Northern Company to substitute steam for electricity was rejected by the Parliamentary Committee who considered the proposal.

HAMPSTEAD.—Mr. J. G. Weir, M.P., who lives in the Hampstead district, in forwarding a cheque for the quarter's current for electric lighting of his residence, compliments the Vestry upon the admirable arrangements made for private lighting. Mr. Weir says:—"There is, I think, a very general impression that the electric light is costly; in my experience this is quite a mistake. I have not lost a single lamp since my house has been lighted electrically by the Vestry, and I attribute this very much to the regularity of the current." The Vestry have received similar letters from other leading residents.——At the last meeting of the Vestry, the recommendations of the Lighting Committee that the necessary sub-station, feeder, and distributors for the private lighting of Haverstock Hill, from Belsize-grove to Eton-road, be laid down at an estimated cost of £892, and that a high-tension main for private lighting be laid down from sub-station 6A, in Heath-street, to the corner of Redington-road, at an estimated cost of £294, were approved.

HOPE-JONES ELECTRIC ORGANS.—At a gathering of press representatives and others interested in church organs and organ work, Mr. Hope-Jones gave an interesting explanatory discourse in St. George's Church, Hanover-square, London, W., on Wednesday last. After alluding to the value of the experiments on sound waves by Von Helmholtz, Mr. Hope-Jones explained how he had been working and gradually bringing his electrically worked organ up to its present state of perfection. Amongst the many claims which the inventor makes are: (1) the extreme facility with which the console can be worked; (2) the comparatively small space now occupied by the organ; (3) the readiness with which the console can be moved to any part of the building in which the organ is situate; and (4) the extreme simplicity of the electrical connections. The whole of the work of blowing the organ is practically accomplished by the aid of a small contact disc the size of a sixpenny piece. Mr. Hope-Jones stated that the more recently constructed organs contain features of great service to organists, which it would be absolutely impossible to accomplish with an organ as ordinarily constructed and worked. The cells for supplying current are ordinary Hellesen dry cells, which last from 3 to 12 to 18 months. For working the organ at Hanover-square 1,800 wires are used, and are entirely under the control of the organist. By aid of a new stop switch tone results can be obtained which are described as remarkably effective and musically perfect. The Hope-Jones Company are very busy, having on hand, in addition to many others, a four-manual organ for Worcester Cathedral.

ISLINGTON (LONDON, N.).—In order to anticipate any possible claims for nuisance or vibration from the proximity of the electric lighting works at Eden-grove, the Electric Lighting Committee, at the last meeting of the Vestry, recommended the purchase of three houses close to the station, and after a somewhat ragged discussion the proposal was approved.

KING'S LYNN.—In order that a private company may not obtain powers, at the last meeting of the Town Council a motion was made that the Council obtain a Provisional Electric Lighting Order. After some discussion, however, it was decided to defer consideration of the subject till the next meeting.

KINGSTON-ON-THAMES.—It has been decided to supply all places of worship in this town with electric current at 4½d. per unit net, instead of the usual price of 6d. The Local Government Board have sanctioned the borrowing of £7,772 for electric lighting purposes, to be repaid in 15 years. The original application was for £10,000, to be repaid in 25 years, and a deputation is to wait upon the Local Government Board to urge that the full amount be authorised. The Council have placed an order with Messrs. Siemens Bros. and Co. for the supply of cable for charging electric launches for the sum of £100. With regard to the supply of current for charging electric launches, Mr. Councillor Collings stated that the electric launch was undoubtedly the vessel that would be adopted in future; the demands for these launches was growing every day, and he thought this was sufficient to justify the Council in making arrangements for the supply of current. A satisfactory report has been presented by the Council's electrical engineer (Mr. J. E. Edgcome), which shows a small adverse balance of £76. A satisfactory demand for current is reported, and the success of the Council's scheme is assured. The report has been circulated amongst the members.

LEYTON, ESSEX.—A short time back the report of the Hall Building Committee with regard to electric lighting matters was referred back for further information as to cost, &c., and the committee now report that, having carefully gone into the subject, they are unable to supply any further details, but recommend that tenders be invited and received for the prosecution of the necessary works. The Committee strongly advise that no further delay take place. The hall and municipal buildings would have to be lighted, and the matter was one to be settled at once, and in recommending that the electric light be adopted, although at some additional expense over gas, this addition would be saved in a very short time. It was ultimately decided that the buildings should be wired for the electric light.

LIMERICK.—A correspondent of the *Cork Herald* points out that the electric lighting powers of the Limerick Corporation expire in September, and thinks that the fact of the gas committee and the Corporation being practically identical accounts for the want of enthusiasm displayed by that body in proceeding with the electric lighting order. Several of the leading townsmen are adopting the electric light in place of gas, and Messrs. Baker and Co., electrical engineers, of Sexton-street, Limerick, have, we understand, several large orders in hand.

NORTH STAFFORDSHIRE TRAMWAYS.—A special meeting of the Stoke-on-Trent Town Council is to be held to consider a communication from Mr. Elliott, secretary of the above Company with reference to a scheme for working the trams by electricity.

PROVISIONAL ORDERS.—The application by the Swindon New Town District Council for powers to supply electric current within

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the Council's district has passed through Committee, and is to be reported to the House of Commons in due course. A similar application by the District Council of Llandudno has been reported. The bill promoted by the Southampton Town Council has passed the Standing Orders Committee of the House. Winchester Corporation's Bill has passed the House of Commons, and only awaits confirmation by the Lords. The Carlisle Corporation Bill has been reported for third reading. Walthamstow has now obtained its Order for lighting the district electrically.

RESEARCH SCHOLARSHIPS.—Mason College, Birmingham, are offering three "Priestley" scholarships in chemistry, two "Bowen" scholarships in engineering, and one in metallurgy, of the annual value of £100 each, for competition. The scholarships are tenable for one year, renewable at the discretion of the Council of the College, and the first award will be made in September next.

RIO DE JANEIRO.—The electric light was recently inaugurated in the extensive locomotive shops of the Central Railway.

SHIP LIGHTING.—Last week a new Cunarder, the "Corinthia," was launched from the yards of the London and Glasgow Shipbuilding Company, of Govan, Glasgow. This is a sister ship to the "Sylvania," lately launched from the same yard. The entire vessel, including all holds, 'tween decks, engine and boiler spaces, and cabins, is lighted throughout with electricity. The electric lighting work has been carried out by Messrs. William Harvie and Co., of Glasgow.

SOUTH AFRICA.—The Johannesburg correspondent of the *African Review* states that nearly every company of importance in that district has now an electric lighting installation. All engine houses, mills, cyanide works, offices, &c., are lighted with 8-c.p. or 16-c.p. incandescent lights, and pit heads, rock houses, &c., with 500-c.p. to 1,000-c.p. arc-lights. The principal manufacturing firms represented are Messrs. Edison and Swan, Woodhouse and Rawson, Siemens and Halske, Brush Crompton, Mather and Platt, and Electric Construction Company. The Johannesburg telephone system is said to be the best of its kind in the world, all the most modern improvements having been introduced in connection with it. There is a movement now on foot to connect all the mines on the main reef with the town by a telephonic system. This would be of great economic advantage to the mining companies, though it is doubtful if local mine-store brokers would consider it as such.

SOUTHAMPTON.—A sub-committee of the Works Committee of the Harbour Board recommended at the last meeting that a pair of new armatures required for the electric cranes be ordered from Messrs. Statter and Co. for the sum of £135. The electric light at the Quay extension is now completed, the work having been carried out by the Board's employes under the direction of Mr. G. Taylor, the electrician. The original estimate of the consulting engineer (Mr. Aldridge) was £333, and the total cost has proved to be £244. 3s. 3d. Mr. Aldridge has certified the work as having been done satisfactorily, and the Sub-Committee recommend that a bonus of £10 be paid to Mr. Taylor for the effective carrying out of the work. In moving the adoption of the report, Mr. Bone, after referring to the satisfactory way in which the electric lighting work had been completed, stated that, with regard to their having an electric installation of their own, the Committee were still making inquiries, but did not think it advisable to proceed before they knew what was to be done with regard to the purchase of the local electric lighting company's station by the Southampton Town Council. If the purchase was immediately effected it would doubtless be to the mutual advantage of both bodies that they should take current from the town supply. If the purchase was not effected the Works Committee would be immediately prepared to bring up a report in connection with the putting down of an installation of their own. In the discussion which followed the question was asked as to the working of the electric trams ; this was stated to have been satisfactory, and the report was adopted. On the report of the Finance Committee, Capt. Emanuel objected to the delay of the Board's proceeding with their electric lighting project. They were paying for electric current no less than £530 per annum, which represented a capital outlay of between £13,000 and £14,000, whereas they could obtain a complete installation of their own for £4,000. This question had a distinct bearing upon the question of the purchase of the local company's undertaking by the Town Council. Mr. Bone replied that if the town took over the electric lighting station, a consultation between the Council and the Harbor Board would be advisable, it might probably save the expending a large sum of money, while the members must not overlook the fact that the Board had a contract with the electric light company to pay so much per annum for a number of years.

SNAEFELL (ISLE OF MAN).—Rapid progress is being made with the construction of the electric railway to the top of Snaefell, and it is anticipated that the line will be finished in time for the coming season.

STAFFORD.—The Electric Lighting Committee's report to the last meeting of the Town Council states that the electric supply station buildings are practically complete, the boilers have been satisfactorily tested, and the erection of the engines is now approaching completion.

STRAND (LONDON, W.C.).—From time to time the question of lighting this district by electricity has been under discussion by the Board of Works. Offers for lighting the district have been made by the Charing Cross and Strand Company and the Metropolitan Company, the latter, owing to the terms being more acceptable, meeting with most favour. At the last meeting of the Board a report from the Lighting Committee recommended that no steps be taken to light the district electrically, owing to interference with the streets and foot pavements. After a long discussion, in which the opinion of the members was about equally divided in favour of and against the report, it was ultimately referred back for further consideration. This district is the only important West London district in which the electric light for public lighting is absent, although several of the London companies supply current for private lighting in the district.

TELEGRAPH RATES.—Lord Rosebery received a deputation last week from the Association of Chambers of Commerce in favour of inter-Imperial telegraph rates between this country and the Colonies, and between the Colonies themselves, without such route passing through other countries. Sir A. Rollit, who introduced the deputation, pointed out the dangers our commerce might incur in case of war by the passage through possibly hostile countries of the means of telegraphic communication between the mother country and the Colonies. After remarks from other speakers, Lord Rosebery said he had no decision on the part of the Government to announce. The Government had the matter practically under consideration, and hoped to be able shortly to give a satisfactory reply.

WOLVERHAMPTON.—Complaints are made that the electric lamps used for illuminating the public thoroughfares of this town are extinguished before midnight, leaving the principal thoroughfares practically in darkness. Owing to the brilliance of the lights, the effect of extinguishing the lamps so early is very noticeable. An agitation is forming to secure the lighting of the electric lamps till daylight.

YARMOUTH.—On Thursday next, June 6th, a Local Government Board inquiry is to be held at the Town Hall into the application of the Town Council for powers to borrow £17,590 for electric lighting purposes.

COMPANIES' MEETINGS AND REPORTS.

Reuter's Telegram Company (Limited.)

The thirty-first ordinary general meeting of the shareholders of this Company was held on Wednesday this week, at the offices in Old Jewry, London, E.C., Admiral the Right Hon. Sir J. C. D. Hay, Bart., K.C.B., presiding.

The SECRETARY (Mr. W. F. Bradshaw) read the notice convening the meeting and the report of the Directors.

The CHAIRMAN: Gentlemen, I beg to move the adoption of the report, and congratulate the shareholders on the great improvement it shows over its predecessor. A profit of £4,485, as compared with a debit balance of £2,766 in 1893, means, of course, an improvement of £7,251. It would have afforded the Directors great pleasure to declare a dividend ; but the necessity of dealing with the loss on the operations of 1893 rendered this impossible. When I addressed you last year I mentioned that the fall in silver had prejudicially affected our business, and that we had readjusted our arrangements in the East in consequence. I am glad to say that the measures we then took were attended with the best results. Unfortunately, the economies effected were more than counterbalanced by the heavy expense to which we were put by the war between China and Japan. It is quite true that in our business we must be prepared for wars and rumours of war ; but the reporting of the contest between the two rival Powers in the Far East presented peculiar difficulties, and was attended with large outlays for special correspondents. The war, however, is now at an end, and I can see no reason why we should not be able to resume the payment of a dividend during the autumn, provided we are not again called upon to incur similar exceptional expense. It will afford shareholders satisfaction to learn that the Company gained the lawsuit to which I referred at the last general meeting, and was awarded sufficient damages to cover the legal expenses to which it had been put. I beg to move that the report and accounts now presented be adopted.

The Hon. MARK F. NAPIER, M.P., seconded the motion.

Mr. T. SIMMONS inquired whether the amount of £27,000, due to creditors, was not unusually large.

The CHAIRMAN: I thought that that question might be asked. The apparent disproportion affords proof of the sound way in which the business is conducted, considering that nearly one-third of the liquid assets consists of cash in hand. The main portion of the amount, due to sundry creditors for telegrams and agency charges, is, as a matter of fact,

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liquidated monthly, and our total assets are approximately 50 per cent. in excess of outside liabilities.

The motion was carried unanimously.

Resolutions were afterwards passed re-electing Baron de Reuter to his seat at the Board, and reappointing the auditors, Messrs. Welton, Jones and Co.

The proceedings terminated with the usual vote of thanks to the Directors and staff.

Consolidated Telephone Construction and Maintenance Company (Limited).

The following report of the Directors of this Company will be presented at the fourteenth annual general meeting of shareholders to be held at Winchester House, Old Broad-street, London, Thursday next, June 6th, at 12 o'clock :—

The operations for the past year show a manufacturing profit of £1,403. 9s. 1d. The amount available for disposal (after the usual provision for doubtful debts, and after writing off £63. 16s. 8d. from the new building account, £12. 19s. 4d. from furniture account, and reserving £57. 8s. 10d. for rentals paid in advance) is £2,866. 10s., from which the Directors propose to pay a dividend of £1. 10s. per cent., leaving a balance of £1,236. 6s. 10d. to carry forward.

The competition (principally foreign) in the manufacturing business has continued with unabated severity, the selling price of all articles having been largely reduced. The lease of the present factory terminates at Christmas next, and it is proposed, if suitable premises can be found, to remove the plant, machinery, &c., to the country, with the object of reducing the expenses of production, in the shape of labour, rent, and the heavy rates now being paid. Various manufacturing proposals have been submitted to the Directors, one of which, for the manufacture of an unique form of battery and accessories, has been adopted, the Company having obtained the sole right to manufacture all supplies required by the patentees of the "Capsule battery" for the whole period of the patent, viz., 14 years.

It is proposed to alter the "Memorandum of Association," to enable the Company to manufacture other articles than those solely electrical, and a resolution will be submitted to that effect at the extraordinary general meeting. The Directors are hopeful that this extension of busines will be advantageous to your Company. A resolution to alter Article No. 83, as to the number of Directors, will also be submitted.

The lawsuit in Belgium, undertaken in conjunction with the Edison Gower-Bell Telephone Company, against infringers of the patent held by the Company, resulted in a successful appeal against the previous decision, and the Court has ordered a claim to be sent in for damages. The Directors have resolved to defer they payment of their fees.

The subsidiary Company, the Anglo-Portuguese Telephone Company, continues to show satisfactory progress, as will be seen by the following comparative statement :—

Year ended March 31st.

Subscribers.		Rental.		Increase.	
1894.	1895.	1894.	1895.	Subscribers.	Rental.
2,320	2,439	£15,076	£16,040	119	£964

Mr. C. L. W. FitzGerald and Mr. J. H. Buckingham retire, and Mr. FitzGerald seeks re-election as Director, and the auditor, Mr. J. G. Griffiths (of Deloitte, Dever, Griffiths and Co.), also offers himself for re-election.

NEW COMPANIES, STATUTORY RETURNS, &c.

ALLIANCE METER COMPANY (LIMITED).—Agreements which were filed in March and April have been made by this Company with William Coward, of Leadenhall-street, London, E.C., which provide for the acquisition by the Company of the connection of the said William Coward in regard to the purchase and supply of electric and other meters in England and the Colonies, in consideration for the allotment of 2,000 fully-paid shares of £1 each.

EASTBOURNE ELECTRIC LIGHT COMPANY (LIMITED).—The annual return to April 8th has been filed. The nominal capital is £50,000, in £10 shares, of which 1,025 Ordinary and 40 Preference shares have been allotted, and the full amount has been paid.

EDISON GOWER-BELL TELEPHONE COMPANY OF EUROPE (LIMITED). The annual return to April 11th is filed. The nominal capital is £500,000, in £1 shares, of which 385,009 have been taken up ; 370,000 of these have been issued as fully paid, and £1 per share has been paid on the remainder.

ELECTRIC CYCLE SYNDICATE (LIMITED).—The annual return to April 18th has been filed. Out of a nominal capital of £3,000, in £1 shares, 2,827 shares have been taken up, of which 1,000 are considered as fully paid. The full amount has called on the remainder.

ELECTRIC LAMP COMPANY (LIMITED).—The annual return to November 10th last has been filed. The nominal capital is £4,000, in £1 shares, and 2,797 of these have been taken up. 2790 are taken considered as fully paid, and the full amount has been called on the remainder.

ELECTRIC TIME DISTRIBUTING AND CLOCK COMPANY (LIMITED). —The annual return to February 28th has been filed. Out of a capital of £5,000, in £1 shares, 2,084 shares have been taken up, and 2,000 of these have been issued as fully paid ; the full amount has been called on 82 shares, and 10s. per share on the remaining two shares.

MULHOLLAND, MAUGHAN AND CO. (LIMITED).—The annual return to October 24, 1894, was recently filed. The nominal capital of £5,000 is divided into 120 Founders' and 380 Ordinary shares of £10 each. All the Founders' and 177 of the Ordinary have been taken up, and the full amount has been called on the former and £5 on the latter.

NATIONAL ELECTRICAL ENGINEERING COMPANY (LIMITED).—The return, to April 10th, is filed. The nominal capital is £5,000, in £1 shares, and of these 2,614 have been taken up ; 2,000 have been issued as fully paid. The full amount has been paid on the remaining 654 shares.

NEW BRITISH ELECTRICAL INSTALLATION CONTRACTORS (LIMITED). The annual return, to March 4, 1893, was recently filed. The capital is £20,000, in £5 shares, and 100 of these have been subscribed for and allotted, and the full amount called. The annual return to February 10, 1894, is now also filed, and no change is recorded.

NORTH-EASTERN TELEPHONE COMPANY (LIMITED).—The annual return to October 4, 1894, has been filed. The nominal capital is £1,000, in 500 Ordinary and 500 Preference £1 shares ; 425 of the former have been taken up, and 14s. per share paid thereon, while 15 Preference have been taken up and 15s. per share called.

NORWICH ELECTRICITY COMPANY (LIMITED).—The annual return to May 8th has been filed, 2,695 £10 shares have been subscribed for, allotted, and paid out of the capital of £50,000.

ORIENTAL TELEPHONE AND ELECTRIC COMPANY (LIMITED).—The annual return to May 13th is filed. Of a nominal capital of £200,000, in £1 shares, 171,504 have been taken up, of which 171,497 were issued as fully paid to the original shareholders in the Oriental Telephone Company (Limited). £1 per share has been paid on 7 shares.

WYNDHAM ELECTRIC LIGHT COMPANY (LIMITED).—This concern is dead.

CITY NOTES.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend of 3s. per share (being at the rate of 6 per cent. per annum), free of income tax, for the quarter ended March 31st, payable on June 22nd. The transfer books of the Company will be closed from June 15th to June 21st inclusive.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended May 26th were £884, as against £931 in the corresponding period of 1894, being a decrease of £47. The total receipts for the half-year amount to £19,604, against £19,144 for the corresponding period of 1894, an increase of £460.

CROMPTON AND CO. (LIMITED).—A petition for reducing the capital of this Company from £300,000 to £280,000 is down for hearing before Mr. Justice Romer on June 17th. Creditors or shareholders desiring to oppose the making of an order for the reduction of the capital of the Company must appear at the time of hearing. Messrs. Deacon, Gibson and Medcalf, 9, Great St. Helens, E.C., are solicitors for Messrs. Crompton and Co. (Limited) in this matter.

THE ELECTRIC CONSTRUCTION COMPANY (LIMITED).—The Electric and General Investment Company notify that a drawing of Six per Cent. Second Mortgage Debentures in the Electric Construction Company (Limited) will take place at 1 and 2, Great Winchester-street, London, E.C., on June 7th next.

HASTINGS AND ST. LEONARD'S-ON-SEA ELECTRIC LIGHT COMPANY (LIMITED).—The annual meeting of this Company was held at Hastings on the 23rd inst., Mr. F. A. Langham presidin . The Chairman moved the adoption of the report, and said he regretted they were not in a position to pay a dividend. They were doing more work ; but, on the other hand, the expenses also had very largely increased. They had plenty of customers, and should have a great many more if they were in a position to supply more, and to carry their mains further in the town. They were crippled for want of capital. There were many people willing to take the light, but they would not supply it because of the expense of laying it on. The Directors found that the installation work was not a prosperous branch of the Company, and had determined to confine the business of the Company to supplying current. After some criticism, the report was adopted. Mr. G. Roddis was re-elected a Director, and a vacancy on the Board was filled by the election of Mr. A. L. Ward.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 26th inst. amounted to £1,135. The amount for corresponding week last year was £874.

RUSTON, PROCTOR AND CO. (LIMITED).—The annual report of the Directors of this Company to March 31st last states that, with the balance forward of £3,281, a profit balance is shown of £49,737, from which it is proposed to pay a dividend of 10s. per share, free of income tax, equal, with the interim dividend paid on November 1st last, to 7½ per cent. for the year. £8,000 is written off goodwill account, and £3,438 off the costs and charges incidental to the conversion of the Five per Cent. Debentures, leaving a balance forward of £3,065.

SNOWDON MOUNTAIN TRAMROAD AND HOTELS COMPANY (LIMITED) —During the week the Directors of this Company, which has been formed for the purpose of constructing a tramroad (to be worked by electricity) from Llanberis to the summit of Snowdon, have invited applications for 6,343 shares of £10 each, and £20,000 Four and a-Half per Cent. First Mortgage Debentures of £100 each.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended May 24th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,712.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, May 22.		Price Wednesday, May 29.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending May 29. Highest	Lowest
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	10/0	Anglo-American	46	48	46	48	4 3 4	Jan., Apr., July, Oct.	36	..
£2,993,560	Stock	20/0	Do. Preferred	84½	85¾	84½	85½	4 14 2	" "	85⅜	85
£2,993,560	Stock	5/0	Do. Deferred	8¼	8¾	8¼	8¾	..	..	..	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 17 1	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	12½	13	12¾	13¼	4 18 1	Mar., June, Oct., Dec.	13	12¾
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 8 6	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	154	158	154	158	4 8 7	Jan., Apr., July, Oct.	160	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	3½	4½	3½	4½	4 8 11	April and October	..	–
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10¼	9¾	10¼	4 7 7	" "	–	–
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	105%	108%	105%	108%	4 3 4	..	..	–
60,710	20	2/0	Direct United States Cable, 1877	9¼	9¾	9¼	9¾	4 0 5	Jan., Apr., July, Oct.	..	..
400,000	10	2/6	Eastern	16¼	16½	16¼	16½	3 18 9	" "	16½	16¼
70,000	10	6%	Do. 6 per Cent. Preference	17¼	17¾	17¼	17¾	3 7 7	" "	17¾	17⅝
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	123	126	123	126	3 3 6	May and November	124¾	–
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	109	106	109	4 12 10	February & August	..	..
250,000	10	6/6	Eastern Extension	16⅞	17⅛	16⅞	17⅛	4 7 7	Jan., Apr., July, Oct.	17 1/16	16⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	124	127	124	127	3 3 0	February & August	..	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	104	108	104	108	4 14 1	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	104	108	104	108	4 14 1	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	107	110	107	110	3 13 5	February & August	107½	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	111%	114%	111%	114%	3 10 2	May and November	..	–
180,227	10	2/3	Globe Telegraph and Trust	10	10¼	10	10¼	3 12 0	Jan., Apr., July, Oct.	10 3/16	10
180,042	10	6%	Do. 6 per Cent. Preference	16⅞	17⅛	16⅞	17⅛	3 10 0	" "	17⅛	16 15/16
150,000	10	7/2	Great Northern	21¾	22¼	21¾	22¼	3 15 7	Jan., April, and July	22 3/16	21¾
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	106⅝	106
17,000	25	37/6	Indo-European	44	47	44	47	5 6 5	May and November	..	..
37,548	10	2/6	London Platino-Brazilian	5	7	5	7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	106	110	106	110	5 10 1	March & September	..	–
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	106	109	105	109	3 14 7	..	..	–
11,839	8	4/0	Reuter's	3½	4½	3½	4½	..	April and October	..	–
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	123	128	124	129	4 13 0	" "	127¾	127
15,609	10	5/0	West African Telegraph	4½	5½	4½	5½	..	January and July	..	–
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	102	105	102	105	4 15 11	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	104	100	105	7 12 5	June and December	102	101¾
88,321	10	6d.	West India and Panama	¾	1	¾	1	..	..	⅞	¾
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11¼	10	10½	5 14 3	May and November	10⅜	10¼
4,669	10	6%	Do. 6 per Cent. 2nd Preference	9	10	8½	9½	6 6 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110	113	110	113	4 10 1	June and December	110½	..
64,242	15	6/0	Western and Brazilian	10¼	11	10¼	10¾	4 17 11	May and November	10⅜	10 5/16
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	6¾	..	–	6 5/16	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4¼	4¾	4¼	4¾	..	–	4½	4⅜
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	103	107	103	107	5 13 9	February & August	..	–
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	103	107	103	107	5 13 9	" "	..	–
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	5 18 8	May and November	..	–
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	101	103	101	103	5 17 8	March & September	..	–
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	–	..	..	..
224,850	10/0	2⅔d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	–	May and November	..	–
171,504	£1	8·215d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	..	..
484,597	5	2/6	National	5⅜	5⅝	5⅜	5⅝	4 5 1	June and December	5 13/16	5 9/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15½	16½	15½	16½	3 12 9	" "	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½	15½	14½	15½	3 17 5	" "	15	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅝	6⅛	5⅝	6⅛	4 1 8	–	6⅛	5 13/16
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	104	106	3 6 0	January and July	105¾	104¾
58,000	5	1/0	United River Plate	1	2	1	2	..	" "	..	–
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	85	90	85	90	5 9 11	" "	..	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	14	15	14	15	1 13 4	–	14⅞	14⅝
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15½	16	15½	16	3 15 0	..	..	..
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	–	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	..	–
8,322	£5	..	House-to-House Electric	..		..		..	–	..	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		..	..	..	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..			January and July	–	–
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7½	7¾	7¾	7⅞	..	..	..	–
111,000	5	..	London Electric Supply	..		..		..	–	..	–
49,900	£10	6/0	Metropolitan Electric Supply (fully paid) xd	10½	11	10¾	11¼	2 13 4	..	11	10¾
£150,000	Stock	4½%	* Do. 4½% Debs.	118	120	117	119	3 12 8	June and December	118	117
6,452	£10	2/6	Notting Hill Electric	7½	8	8	8½	..	..	8½	..
19,980	£5	4/6	St. James and Pall Mall	8¼	8¾	8¼	8¾	..	–	8⅝	8½
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9¼	8¾	9¼	3 15 8	–	9 3/16	9⅛
59,900	5	5%	Westminster Electric Supply (fully paid)	7¾	8¼	7¾	8¼	3 2 6	..	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅜	2⅝	2⅜	2⅝	5 14 3	–	2 7/16	–
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2¾	2¼	2½	4 16 0		2¼	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	113	116	113	116	3 13 7	March & September	..	–
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2½	3	2½	3	–	January and July	..	–
12,139	5	–	Edison and Swan United	1¾	2	1¾	2¼	..	..	–	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	–		–		–	..	–	..
120,000	2	..	Electric Construction	½	¾	½	¾	–	..	⅝	–
12,845	2	2/9⅔	Do. 7 per Cent. Cumulative Pref.	1½	2	1½	2	–	..	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1	1½	1	1½	..	..	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	February & August	22 3/16	21 9/16
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	101	103	102	104	4 2 4	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..		..	..
16,000	£10	..	Do. 8 per Cent. Preference	–		..		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	½	½	⅜	..	..	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	41	43	42	44	5 9 2	March and July	43¾	42
£150,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4 11 9	January and July	..	..
37,514	£5	–	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,870	10	12/0	W. T. Henley's Telegraph Works Ordinary	10	11	10	11	5 8 1	..	–	..
£30,000	10	7%	Do. 7 per Cent. Preference	..		13½	14½	4 16 7	..	14	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1¼%	City and South London Railway	45	47	44	46	2 14 4	May and November	46	45
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	..	–
£67,130	Stock	4%	Do. 4% Perpetual Debenture xd	13	133	13	133	3 0 2	May and November	132¾	..
37,590	£10	2%	Liverpool Overhead Railway	9½	9¾	9⅝	9⅞	2 0 6	..	..	..
6,295	10	5%	Do. 5% Preference	14¾	15¼	14¾	15¼	3 5 7	..	..	..
125,000	Stock	4%	Do. 4% Debenture	111	113	111	113	3 10 2	January and July	–	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 890. [No. 6. Vol. XXXV.] FRIDAY, JUNE 7, 1895. PRICE SIXPENCE.

NOTES.

The Board of Trade draft of the new Regulations and Conditions for the Safety of the Public, in the matter of electric supply, which we reprinted and commented upon in our issue last week, will have the effect, if put into force, of considerably modifying at least one branch of electric lighting —to wit, the use of small arc lamps for lighting shop and other exteriors. No one can have failed to notice the rapid and extensive increase of this class of apparatus, and anyone who has compared the relative economy and convenience of small arcs and large incandescent lamps for shop exteriors will probably have discovered the superior merits of the former. But, as has been pointed out to us by an arc lamp expert, all this seems likely to be quashed, and the use of arc lamps in this way "in any street" will become difficult if the 10ft.-from-the-ground rule is to be enforced. It is easy to see why large arc lamps, with bulky globes protected only by wire netting, should be placed beyond the possible thrust of a giant's umbrella; but it is not so easy to comprehend why it is that small arcs placed in suitable metal reflecting cases in front of shop windows should be treated more stringently than gas or oil lamps similarly situated.

Nor is this the only blow which the new proposed regulations may possibly direct against arc lighting. In Section VII., paragraph 47, it is provided that these lamps "shall not be used in situations where there is any danger of the presence of explosive dust or gas." The expert above referred to a man of unsurpassed experience in arc light matters, is inclined to regard this regulation as being too stringent, because this danger exists in every building where gas is used. We hardly think, however, that it can be the intention of the Board of Trade to prohibit the use of arcs and gas jets in one and the same building. As well lay down a law that no building shall have two or more gas jets, on the ground that one might be "escaping" while the others were alight.

If the effects and probable causes of lightning discharges were on every opportunity investigated with painstaking accuracy and recorded concisely and clearly, we should very soon be in a position to attach a correct value to the warning always brought forward by "practicians" as to the danger of arguing from Wimshurst machine sparks to actual atmospheric discharges. In his account of the damage done by lightning to some telegraph and telephone cables in the St. Gothard tunnel last autumn, Dr. Preller shows tolerably conclusively that the "side flash" phenomenon is no figment of the experimenter's imagination, and that a good earth and plenty of plain plate protectors and fuses afford but little security unless considerable inductance is added to the circuit, as suggested by Dr. Lodge and carried out in his well-known lightning arrester. The results of the experiments of Zielinski, quoted by Dr. Preller, although labouring under the normal disadvantage of relating to imitation thunderstorms, are nevertheless interesting as giving in a rough quantitative form the efficiency of impedance coils having various amounts of self-induction when applied to the protection of circuits of various resistances. It will be seen that, with resistance values such as are generally met with in practice, a very small impedance coil effectually shunts the discharge to earth. The manner in which the proportion of the discharge going to earth decreases as the resistance of the circuit increases should convince those who not unnaturally are impervious to mathematics that the effect is an inductive one; although the simultaneous publication of the results of a similar set of experiments on the same circuit, without the impedance coils, would in all probability have been even more convincing to those who still held the faith of the path of *least resistance*.

An engineering teaching institution, where the enrolment of students in the electrical engineering department alone is over two hundred, can well afford to do things on a more liberal and magnificent scale than even the best of English institutions of a similar kind. Some years ago an English professor of engineering amused his audience by boasting that "within the last year his civil engineering students had increased four hundred per cent."—*i.e.*, from one individual to five! In another column will be found a brief description of Purdue University, the engineering school of the State of Illinois, U.S.A., which rejoices in the above-stated abundance of electrical students.

At this institution there are five departments, each one located in a separate building, and each provided with a set of well-equipped laboratories and lecture rooms. Apart from the sumptuousness of the material arrangements, things appear to be very similar to those in our English technical institutions. The freshman goes through one year's training in physics, mathematics, &c., on lines which are practically

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independent of the particular branch of engineering to which he intends to devote himself subsequently. In the second year, the embryo electrical engineer turns his attention to purely mechanical engineering in the mechanical laboratory, and to the lighter branches of electrical science; and in the subsequent stages his mechanical laboratory work is directed more particularly to its electrical applications, and the studies are more highly specialised. As in this country, considerable value is attached to visits to actual engineering works, and the student, in his later stages, is required to write a thesis on some line of experimental work undertaken by him.

PERHAPS the most interesting point in connection with the researches of Prof. MINCHIN on "The Electrical Measurement of Starlight," an abstract of the Royal Society Paper describing which will be found in our columns this week, is the surprising agreement between the photo-electric and the photometric determinations of the magnitude of a given star. Thus, for example, the photometric estimate of the magnitude of Regulus is usually taken to be between 1·42 and 1·70, while Prof. MINCHIN's photo-electric estimate is 1·43. It is difficult to see that there is any real physical identity, or even connection between the two magnitudes, for, as a matter of fact, it is not so much star *light* as star radiation, between the limits of certain wave lengths, upon which the photo-electric measurement is based. While, of course, the photometric measurement is purely optical, the photo-electric method measures radiant energy in the infra-red and ultra-violet parts of the spectrum. It will be interesting to see whether, in the extended researches which Prof. MINCHIN is about to undertake, this close agreement will be found to hold for the majority or even a considerable number of stars. In the present stage we can only surmise that Regulus and the comparison star happened to be at about the same temperature. But the great range of temperatures in the generality of stars would lead one to expect that, as a general rule, the photometric comparisons of star magnitudes would give results appreciably different from the photo-electric ones.

THOSE who were interested by Prof. J. J. THOMSON'S researches on the effect of moisture, more especially aqueous moisture, on the conditions of electrical discharge in high vacua, which were so prettily and convincingly demonstrated at the meeting of the British Association at Oxford last autumn, may read with further interest the reprint of his lecture on "Electric Discharge through Gases" in our issue this week. The experiments and inferences detailed in this lecture are, in fact, preliminary to the important conclusions relative to the influence of aqueous moisture; and there is a further interest arising from the similarity of the apparatus and methods adopted in the two cases. Both chemistry and physics owe much to such lines of research as these; and it is more than probable that developments of both branches of science will be effected by similar investigations of physico-chemical action. It is, indeed, in the direction of the behaviour of gases under electrical stress and discharge that physicists and chemists are principally looking for the solution of the problems of ether and atomic phenomena. Though comparatively useless in technical and commercial work, as yet, the vacuum tube has rendered inestimable service to pure science.

IN a recent number of the *Comptes Rendus* the construction of a very sensitive galvanometer is described by M. PIERRE WEISS. Among the points of interest occuring in the Paper two are of special importance. In the first place, the magnetic system consists of two magnets arranged vertically instead of, as is usual in galvanometers, horizontally. By arranging these magnets with dissimilar poles uppermost a perfectly astatic combination is formed, which is not subject to any demagnetising tendency and consequent alteration with time. Such an arrangement is not new, for it has been adopted in some English instruments; but its advantages are as yet very little known to makers of galvanometers. In order to get the fullest sensibility out of this combination, the magnets should be close together, and the moment of inertia of the suspended system should be reduced to a minimum. In order to accomplish this, M. WEISS, in one of his galvanometers has adopted dimensions which remind us somewhat of the instruments made by Prof. BOYS. The needles are attached to the edges of a strip of mica 1·2mm. wide. They are 18mm. long and 0·2mm. in diameter. The mirror is attached to the bottom of the strip, and weighs only eight milligrammes, measuring 7mm. by 2mm. If this system is delicately suspended, and the controlling magnet adjusted till the movements of the needle are nearly "aperiodic," the measurements given by M. WEISS seem to show that this instrument is as sensitive as any which has yet been constructed. It is, however, almost impossible to compare galvanometers when each is adjusted to give its utmost deflection for a given deflecting force. So much depends on the stability of the zero, a quantity which is not easy to specify. It is theoretically possible to make any galvanometer infinitely sensitive by sufficiently diminishing the controlling field, but if this is attempted it is soon found that the indications of the instrument are unreliable and worthless. Galvanometers, if compared at all, must be compared under conditions in which they are well under control. M. WEISS's Paper clearly shows that the instrument constructed is extremely sensitive, but the author gives no information regarding the reliability of the deflections when the utmost sensitiveness was obtained.

Royal Society Soirée.—The annual conversazione of the Royal Society will be held on Wednesday, June 12th.

Cable Interruptions:

	Date of Interruption.
Chorillos—Iquique	June 4th, 1895.
Mollendo—Arica	June 4th, 1895.

Institution of Civil Engineers.—During the past session of this Institution a Crampton Prize has been awarded to Mr. John Richardson (of Lincoln), for his Paper on "The Mechanical and Electrical Regulation of Steam Engines."

Electric Mountain Railways.—The cars ascending Mont Cervin and the Gauergrat, to heights exceeding 10,000ft. above the sea, are to be propelled by electricity, the power being derived from a neighbouring waterfall.—A concession has been granted for an electric rack railway between Heiligenblut and Glocknerhause.

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International Telephonic Communication.—Negotiations are, it is stated, in hand between the Hungarian Government and the Servian Minister of Commerce, with reference to the establishment of telephonic communication between Budapest and Belgrade.

Non-Conducting Coverings for Steam Pipes.—Steam pipes are now being covered with a fabric made of large reeds laced together into mats. A layer of fossil meal is laid both below and over the reeds. The covering is being applied by Messrs. R. M. Moir and Co., of St. Swithin's-lane.

Obituary.—*The Times* Paris correspondent announces the death, at the age of 55, of Rear-Admiral Fleuriais. He was a distinguished scientist, and commanded one of the expeditions for observing the transit of Venus, and invented and improved an electric log. (See *The Electrician*, Vol. XXXIV., p. 392.)

Society of Engineers.—The Council of this Society announce that they have succeeded in making arrangements with the Council of the Royal United Service Institution for holding the future ordinary meetings of the Society in the Lecture Theatre of the Royal United Service Institution, Whitehall.

Static Electricity in American Paper Mills.—In certain paper mills in North Hoosick, N.Y., static electricity is giving trouble. In some cases sparks 6in. to 8in. in length are produced as the paper leaves the calender. A steam damper is used to prevent this, or a copper wire, well grounded, is made to rest on the web as it passes from the calenders to the reels.

Electric Light for the Kremlin.—The electric light is about to be put in at the Kremlin. The lighting will comprise 15,000 4 c.p. "candle-stick" lamps, 2,000 16-c.p. lamps and 40 arc lamps. The whole contract has been placed with Messrs Schuckert and Co., of Nuremberg, and has to be completed by the beginning of next year in time for the coronation festivals.

Alternating Current Patent Litigation in Germany.—The Helios Company of Cologne has sued the Corporation of Chemnitz and Messrs. Siemens and Halske, of Berlin, for infringing patents owned by them. The Helios Company demand the removal of all the infringing apparatus, and claim £2,000 damages. The Town Council has decided to let the matter go to the law court.

The Electrical Industry in London.—According to Mr. Charles Booth, in his latest volume of "Life and Labour of the People in London," the great majority of men employed in all the branches of electrical work in London are under 25 years of age. In another way the statistics of the electrical trades are highly interesting, for from them we learn that of some 5,000 men engaged in different electric works only 13 per cent. are members of a trade union.

Maschinenfabrik Oerlikon.—This firm delivered last month its 3,000th dynamo. The total number manufactured up to date is 3,318. Unfortunately, the aggregate output of this grand total is not stated. The total number of transformers manufactured is 1,843. More than one-half of these totals has been made up during the last two years. In the same time 69 electric travellers of a total capacity of about 755 tons were manufactured.

The Electric Lighting of the Chambre des Députés.—The contract for the lighting of the Chambre des Députés has, says *La Sémaine Electrique*, been given to M. Ch. Mildé, of the Société des Anciens Etablissements de Cail. Cail engines and Helmer dynamos will be used, the boilers being supplied by a Glasgow firm. The firm of Bréguet some time ago offered to put in an installation for £20,000, and to run it for £2,880 a year; but the work was finally put up to public tender.

Damage by Lightning.—During a severe thunderstorm on Thursday afternoon last week six labourers took shelter by a wheat stack at Pirton, near Hitchin. The stack was struck by lightning, one man being killed on the spot, another so badly injured that his recovery is doubtful, and three others were slightly hurt. The lightning also struck a house in the village of Pirton, and it and three adjoining houses were burnt down. At Southport, about half-past six o'clock, a house was struck by lightning, which travelled down the wall of one of the bedrooms, fusing a gaspipe, and setting the gas ablaze.

Leakage from Gas Mains.—Notwithstanding the reiterated asseverations of the gas journals that, as it was to the obvious interest of the gas companies to prevent leakage from their mains, it might reasonably be supposed that in this matter all was for the best in this best of all possible gas worlds, the recent outburst of repairing energy in the City which, judging by the olfactory sense, is none too soon, may be surmised to have some connection with the attention which has recently been drawn to the delinquencies of the gas companies by electric conduit explosions. Thus once more has electricity, out of the fulness of its heart, done a good turn to its rival.

The New Board of Trade Regulations.—The following "whip" has been sent round by the Chairman of the Electrical Trades' Section:—

Urgent and Important.—Revised Board of Trade Regulations under Electric Lighting Acts, 1882 and 1888.

Dear Sir: You will doubtless have seen a copy of the revised "Regulations and Conditions for ensuring a Proper and Sufficient Supply of Electrical Energy made by the Board of Trade under the Provisions of the Electric Lighting Acts, 1882 and 1888." The Electrical Trade Section of this Chamber have had these regulations under their consideration, and think it desirable that the views of central station engineers and others interested should be obtained before representations are made to the Board of Trade on the subject. We shall, therefore, esteem it a favour if you will kindly give these regulations your consideration, and send the Secretary of the Chamber at your earliest convenience any suggestions you may have to offer. A meeting of the Section will be held on Tuesday, June 11th, at 12 noon, to consider the regulations and any suggestions made, and to determine the nature of the representations to the Board of Trade.

Cathode Rays.—At a recent meeting of the Société Française de Physique, M. Curie described some experiments he had made to see whether light rays were deviated by a magnetic field in the same manner as cathode rays. He has obtained no deviation, although his apparatus permitted him to pass the light rays for a distance of 20cm. in a strong field, the direction of propagation of the light being perpendicular to the lines of force. The experiment was made in air, as well as in carbon bisulphide in which sulphur has been dissolved. The author, although he does not think the above experiments are conclusive proof that cathode rays are radiation of a different nature from that which constitutes light, yet thinks they tend to show that there is some difference. Furthermore, if the cathode rays are analogous to light rays, it is difficult to explain the absence of double refraction when a magnetic field acts on the cathode rays.

Magnetisation of Iron in very Weak Fields.—An interesting Paper on the "Magnetisation of Iron in very Weak Fields," by W. Schmidt, appeared in a recent number of *Wiedemann's Annalen*. The curves obtained for iron and steel show that for fields up to 0·06 C.G.S. unit the susceptibility is constant, thus confirming Lord Rayleigh's results. The author sums up the results of his experiments as follows:—Steel follows weak magnetising forces more quickly than iron. The susceptibility of soft steel is for small magnetising forces greater than that of iron. Thus for fields less than 0·06 C.G.S. unit the susceptibility of soft steel is to that of iron in the ratio of 4 to 3. For magnetising fields of about 1 unit the susceptibility of the two is about the same, while for greater field strengths the susceptibility of iron is greater than that of steel. The limits within which the susceptibility remains constant vary considerably for different samples, but the author considers that 0·06 C.G.S. unit may be taken as the upper limit with sufficient accuracy for most purposes.

Power Transmission Plant at Sacramento.—According to the American technical journals a plant of some interest is now in course of erection between Folsom and Sacramento, a distance of 30 miles. The power plant, which is located on the bank of the American river, consists of four pairs of wheels of the McCormick horizontal-shaft turbine type, enclosed in steel cases, having steel inlet pipes 8ft. in diameter, and double discharge tubes. By this arrangement in pairs the end thrust is neutralised. The governors used will be of the Faesch-Picard type, and will be supplemented with heavy flywheels on the water-wheel shaft. Each pair of wheels will have a capacity

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of 1,260 H.P., at 300 revolutions per minute, and will operate when under a head of 55ft. The hydraulic plant also includes two horizontal wheels for the exciters. The four generators will be of the three-phase alternating current type, generating current at 800 volts potential, and will be directly connected to the shafts of the wheels. Each generator will have a capacity of 1,000 H.P., and will weigh about 30 tons. Step-up transformers will transform the current generated to 11,000 volts. The conductors will be carried on two pole lines to the Sacramento transformer station, two lines being erected to prevent a shut down should one line get out of order.

Electric Snow.—An American story of a sufficiently remarkable snowstorm is attributed by *Electricity*, of New York, to Lieut. John P. Finley, one of the best-informed meteorologists in the United States, who, it is said, encountered the storm in making an ascent of Pike's Peak. He says the storm could best be described as a "shower of cold fire." In reality it was so charged with electricity as to present a scene more easily imagined than described. At first the flakes only discharged their tiny lights on coming in contact with the hair of the mule on which the lieutenant was mounted. Presently they began coming thicker and faster, each flake emitting its spark as it sank into drifts of the snow or settled on the clothing of the lieutenant or the hair of the mule. As the storm increased in fury and the flakes became smaller each of the icy particles appeared as a trailing blaze of ghostly white light, and the noise produced by the constant electric explosions conveyed an impression of nature's power which Lieut. Finley will never forget. When the storm was at its height "each flake of snow was like a drop of fire, electric sparks were shaken in streams from the lieutenant's finger tips, as well as from his ears, beard and nose, and a wave of his arms was like the sweep of flaming sword blades through the air, every point of snow touched giving out its little snap and flash of light."

The Use and Abuse of Examinations.—In the Mental Science and Education section, of the Australasian Association for the Advancement of Science, during its meeting this year at Brisbane, Dr. Henry Belcher contributed a Paper on "The Use and Abuse of Examinations." The advantages of the examination system were shortly stated as follows:—"It enables the teacher to stimulate the intelligence and test the progress of the pupil, and to fill up flaws and gaps due to imperfect apprehension, carelessness, or defective memory; it is a power almost indispensable to the teacher's efficiency, and is thus a potent factor in general education; it had an alterative and prophylactic effect upon private adventure schools, raising their tone both intellectually and morally. The author doubted whether it was wise to entrust the examination of pupils to persons other than their teachers. The disadvantages of the examination system were that the best part of a teacher's work escapes analysis; methods of higher teaching rise in quality and character, while methods of examination lie behind; by the selection of set books, and the publication of manuals thereon, an intolerable yoke and shackle is placed upon elementary scholarship; examinations appeal to the lower side of human nature—what will pay becomes the pupil's ruling thought. Certain subjects of great importance are neglected because they do not largely count for prizes and honours; and research is altogether neglected."

The Resistance of Diaphragms.—In a short note in the *Zeitschrift für Elektrochemie*, of June 5th, Dr. Fritz Krüger refers to some experiments on the resistance of diaphragms which are now being carried out in the electrochemical laboratory of the Berlin Technische Hochschule. Although, says Dr. Krüger, it is incorrect to speak of the resistance of diaphragms (porous-clay or porcelain), as these are non-conductors of electricity, the custom has become general, and one simply means by it the resistance which the electrolyte receives as it passes through the porous partition. In investigating the behaviour of porcelain and clay in different electrolytes, Dr. Krüger measured the diaphragm resistance by means of a Kohlrausch bridge and telephone. As electrodes he used platinum plates, the connecting wires of which were conducted through a double-bent glass tube in which they were fixed by means of a cork and sealing wax. The distance between the electrodes was the same in all experiments. Before commencing the test, Dr. Krüger soaked the diaphragms thoroughly in the electrolyte. First, the resistance of the electrolyte was ascertained, and then the diaphragm was inserted between the electrodes and the total resistance was measured. The difference between the two was taken as the required resistance. The results merely show that the resistance of the diaphragm increases with the resistance of the electrolyte, and is most likely proportional to the specific resistance of the latter. This method should, Dr. Krüger thinks, be suitable for ascertaining the value of various diaphragms for various electrolytic purposes, since, after the determination of the resistance of a diaphragm in one electrolyte with a known conductivity, the resistance for all other liquids with known conductivities can be calculated.

Electric Coal Haulage and Hoisting Wharf Plant.—The *Engineering and Mining Journal* describes, in a recent number, an extensive coal-handling plant, operated entirely by electricity, which has been running in San Francisco for the past few months with marked success. The plant consists of an electric hoisting and haulage system for unloading the coal-carrying ships and steamers, and distributing the coal into wharf and house bunkers for local and wholesale distribution. The plant consists of three 100-H.P. boilers and two 11 × 18 × 14 tandem compound high-speed 135-H.P. engines, running at 265 revolutions. Belted to these engines are two K.W. 250-volt compound-wound multipolar dynamos, running at 700 revolutions, and over-compounded 10 per cent. The load on the dynamo is very variable, often changing from no load to 75 per cent. of full load in from 5sec. to 10sec., and from full load to no load in about the same time. The hoisting plant consists of three special electric hoists, each having a capacity of 2,000lb. lifted at a maximum rope speed of 800ft. per minute. The motor is geared to an intermediate shaft by special gears with a very slight reduction in speed. The intermediate shaft is in turn geared to the drum shaft by means of eight groove V friction pulleys. On the end of the intermediate shaft is also a single-groove wheel driving the hauling-in drum which serves to haul in the bucket over the shoots when it has been raised to the proper height. The buckets have a capacity of 1,200lb. of coal each, and are raised from a depth of 60ft. to 80ft. The derricks are mounted on a track raised about 6ft. above the floor of the bunkers, and are so arranged that they can be moved along the wharf to accommodate themselves to the position of the hatches of ships. The capacity of each derrick is 400 tons in nine hours, although they have, under favourable conditions, worked up to 450 tons in nine hours. Two electric locomotives are used, with trains of four cars, to distribute the coal among the coal sheds. The locomotive has a draw-bar pull of 800lb., and is required to haul from four to six loaded cars, each car weighing 3,600lb., and having a capacity of 4,700lb. of coal. The train represents a gross load of 40,670lb.

Electromotive Force from Thermo-Chemical Data.—In the *Berichte der Deutschen Elektrochemischen Gesellschaft* appears a Paper by Le Blanc, in which he discusses and objects to the common method of deducing the E.M.F. of a cell or the E.M.F. required for electrolysis from known thermo-chemical data. This method is due to Thomson, and assumes that the chemical energy which disappears in a cell reappears entirely in the form of electrical energy. Knowing the heats of formation and solution of the various substances which can take part in an electro-chemical reaction, we can calculate the resulting E.M.F. Conversely, it is assumed that in any electrolytic process the electrical energy which disappears in the electrolytic cell reappears entirely in the form of energy of chemical separation. For example, let E denote the minimum E.M.F. required for the electrolysis; now, suppose a current, C, to flow for a time, t, then the work done by the electric current is $C t \times E$, and this expressed in heat units is $J C t E$, where J is Joule's equivalent. If H denotes the thermal values of the electro-chemical reactions produced, then $H = J C t E$, from which E can be calculated when the necessary heats of formation, decomposition, &c., are known. Now, the cases to which Thomson's rule was

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first applied gave quite satisfactory results. The theoretical calculation gave 1·08 volt as the E.M.F. of a Daniell cell, and 1·7 volt as the minimum E.M.F. required for the electrolysis of water under ordinary conditions. An experiment confirmed these results. But cases were gradually discovered in which the agreement between theory and experiment were not so satisfactory, and in which the observed E.M.F. was sometimes less and sometimes greater than that deduced by calculation. The rule, in fact, according to Le Blanc, only holds good for cells of which the E.M.F. is quite independent of temperature. The Daniell cell happens to be one of these; but there are comparatively few of them. The equation given above can be modified so as to take into account the change of temperature. Let dE/dT be the temperature coefficient of the cell, *i.e.*, the rate at which the E.M.F. varies with temperature. Then, as Helmholtz puts it, the equation given above becomes $H = J C t E - J C t T (dE)/(dT)$. This equation, again, assumes that the pressure remains constant; for example, it is known that a smaller E.M.F. than 1·7 volt will suffice for the electrolysis of water when the atmospheric pressure falls below the normal pressure. But as most electrolytic work is carried out under practically atmospheric pressure, the small variations of E.M.F. due to changes of pressure are not of any practical importance.

Rate of Loss of Charge in Bad Conductors.—A recent number of *Comptes Rendus* contains an interesting Paper by M. Branly on the rate of loss of an electric charge due to the effect of light in the case of badly conducting bodies. When the source of illumination is a body heated to a dull red, it is the chief condition of the illuminating surface which plays the chief part in the phenomenon. The nature of the charged body seems to have no effect. In the case where the illumination is rich in highly-refrangible rays, however, the case is quite different, and the chief results obtained are as follows:—A disc of wood or marble, polished or unpolished, shows a marked loss of electricity when illuminated. If the disc is negatively electrified, the loss is more rapid than if it is positively electrified; but the difference is very much less marked than is the case with metal discs, particularly if they are polished. Similar results are obtained with cardboard, terra-cotta, and glass heated to 100deg. The loss of a positive charge is rapid, while that of a negative one is slow in the case of varnished wood, or wood coated with a thin layer of oil, paraffin or tallow. With a metal disc coated with tallow, the loss when negatively electrified is slow, while the loss when positively electrified is very rapid. If a disc of polished wood, in which the loss of a negative charge is more rapid than that of a positive one, though the difference is not very marked, has the surface covered with a thin coating of plumbago, the loss with a negative charge becomes much more rapid than with a positive one. A metal plate covered with grease only loses a negative charge very slowly, the rate of loss of a positive charge being rapid. If, however, a thin coating of copper filings is spread over the tallow by means of a sieve, the loss with a positive charge becomes much more rapid than with a negative one. If powdered aluminium is used in the place of copper, the rates of loss in the case of positive and negative charges becomes nearly equal.

Electric Motors for Machine Driving.—The plan of having each separate machine in a shop driven by a separate motor, says *Engineering*, is of ancient date, as, if we remember rightly, small atmospheric motors were thus used in the works of Boulton and Watt, nearly a century ago. It is easy to show that with fairly efficient motors the amount of power required is considerably reduced, particularly as the shafting in an engineer's shop is usually badly maintained, forming a good instance of the old adage that the shoemaker's children go worst shod. On the other hand, the total amount of power used in a machine motor is usually exceedingly small, as a 50-H.P. engine will drive quite a large tool shop easily, and hence the total saving to be effected is often insignificant and quite insufficient to offset the extra cost of the motor, save under special conditions. It must, however, be confessed that the maintenance of the various driving belts is by no means insignificant, and often the breakage of a main driving belt may stop the whole of the machines for an hour or more. Nevertheless, the plan of independent driving has, up to the present, advanced but little, though the advent of the electric motor has caused a revival of the subject. At the gun factory at Herstal, Belgium, the system is being tried on quite a large scale, though the independent driving does not extend to each separate machine, but only to the main lines of shafting, which, though in different buildings, are all driven by one central engine by means of electric transmission. The plant comprises two 37 H.P. motors, nine 16-H.P. motors, and five others ranging from 3 H.P. to 21-H.P. The working of the plant has been very satisfactory, and overloads are, it is stated, quite as permissible as with belt driving, one 16-H.P. motor being run for several days at an output of 30 H.P. The system is, of course, much less cumbersome than belt driving, as in the latter case straight leads for the belts are required, whilst the electric mains can be run anywhere. In certain other instances, also, the electric system has great advantages, especially in cases in which it is impossible to bring the work to the machine, and so becomes necessary to take the machine to the work. The deck planer used by Messrs. Denny Brothers is a case in point, and the special tools for cutting out tubes and drilling holes, &c., in use at the Crewe Works, is another. The lead taken here has, we note, been followed in the United States, where Messrs. Cramp have adopted the planing machine mentioned above, and several other firms have copied Mr. Webb in the adoption of special portable tools electrically driven, which were described and illustrated in *The Electrician* of May 3rd, page 7.

The Waterloo and City Railway.—The contract for this railway was taken by Messrs. Mowlem on June 1st last year, and on the 18th of the same month the first pile of the river staging was driven. When the stage was completed, two cast-iron cylinders were let down from its centre, one over each tunnel of the two lines. Each cylinder was 16ft. internal diameter. The rings of the cylinder were 9ft. in length, the total being 45ft. from top to the cutting edge. The cylinders were brought down into the clay by union screw tackle. They were then underpinned by brickwork. The next operation was to construct the shields, and get them into position. When this was done, the shields were jacked forward in each direction, the work having been commenced in the middle of the two lines. The tunnelling had proceeded satisfactorily, but on November 26th the up tunnel had reached a point Citywards across the river through the clay, until the heading was under the Thames Embankment by De Keyser's Hotel, when the Metropolitan District Railway objected to further advance without the use of compressed air, although the clay still afforded from 6ft. to 10ft. of cover at that point. The down tunnel was commenced on January 16th in the present year, and was driven forward until, on April 26th, it had come within 20ft. of the former tunnel. It was not until May 22nd that the plant was ready for compliance with the requirements of the District Railway. In the direction of Waterloo the up tunnel was started on December 10th, but was stopped in February when under some property on the Surrey side. Owing to litigation, work on this tunnel was stopped until March 14th. Subsequently the work has been resumed, and the heading is now under Stamford-street. The down tunnel was commenced on January 28th, and was continuously pushed forward until water-bearing strata were encountered on the 4th of last month. A bulkhead and air-lock was at once put on. At the same time, an air-lock was built in a bulkhead in the up City tunnel, and a bulkhead only in the down City tunnel, the latter without any lock on. Mr. Galbraith, the Company's engineer, had suggested the simple expedient of constructing a cross passage between the two tunnels, and working the materials from both faces through the one lock. This has been of the greatest benefit, not only to the contractors but to the Company, as it has facilitated the resumption of the work at an earlier date than could otherwise have been practicable. All these impediments have been surmounted, and lengths of 50ft. of completed tunnel are being accomplished at every face per week. Each tunnel is thus advancing 100ft. from week to week completed, under the charge of Mr. Dalrymple Hay, the resident engineer.

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ELECTROMAGNETIC THEORY.—LXIX.*

BY OLIVER HEAVISIDE.

(Continued from page 43.)

§ **267.** A more comprehensive case than the last, bringing a fresh peculiarity into view, is that of the effect due to an initial charge at a single place when the cable is earthed at both ends. There are two solutions in terms of waves, one for the region to the left, and the other for that to the right side of the source. To find them put $a = -1 = \beta$ in (65), (66), § 263, and also $h = pQ$, as there described. Then we obtain

$$V_1 = \frac{\text{shin}\, qy}{\text{shin}\, ql}\, ql\, \text{shin}\, q(l-x)\, \frac{Q}{Sl}, \tag{18}$$

on the right side of the source, which is a charge Q initially at the place $x = y$. To obtain V_2, the potential on the left side, interchange y and x in the last equation.

We see that we have the same denominator shin ql as before. This is clearly because the terminal conditions, earth on at both ends, are unchanged. The denominator sums up the reflective action of the ends. But it is not to be supposed that changing the terminal conditions necessarily changes the determinantal equation. For that depends upon both terminal conditions, and a change in one may be balanced by a change in the other. Thus, if both ends were cut, the denominator would be unaltered, since the signs of both a and β would be reversed. It is their product that determines the subsidence rates, as we see by (65), (66), § 263, which show that, in the general case,

$$\epsilon^{2ql} = a\beta \tag{19}$$

is the determinantal equation.

Returning to (18), and using the result (4), we get

$$V_1 = \text{shin}\, qy\, \text{shin}\, q(l-x)\, \frac{Q}{Sl}\,(1 - 2\epsilon^{p_1 t} + 2\epsilon^{p_2 t} - \ldots), \tag{20}$$

with the same values of p as before. The final steady V is zero obviously, so there is no outside turn, and we get at once by putting $q^2 = -s^2$,

$$V = \frac{2Q}{Sl}\,\Sigma \pm \sin sy\, \sin s(l-x)\, \epsilon^{pt}; \tag{21}$$

or, since $\sin sl = 0$,

$$V = \frac{2Q}{Sl}\,\Sigma \sin sy\, \sin sx\, \epsilon^{pt}. \tag{22}$$

We have in the last two equations written V for V_1, because the interchange of x and y makes no difference. That is, (22) represents V at x due to Q initially at y, whether x be to the right or left of the source. Only one Fourier series is required to represent the essentially different results to the right and left of the source.

Putting $t = 0$ and dismissing constant factors, we see that if

$$u = \frac{2}{l}\Sigma_1^\infty \sin\frac{n\pi x}{l}\sin\frac{n\pi y}{l}, \tag{23}$$

the summation including all integral values of n from 1 to ∞, then u represents 0 everywhere between A and B, except at the point $y = x$, where it is infinite. But its space total is 1, because the space total of SV in (22) is Q at the first moment, before any of the charge has left the cable.

The function u therefore expresses an impulsive function, like the $p1$ with which we were concerned before, only now the variable is x instead of t, or the function is distributed in length instead of time. Such functions can be represented in various ways. Every Fourier series involves one form.

If we multiply a continuous function of y, say $f(y)$, by u, an impulsive function which exists only at the point $y = x$, the product is obviously zero except at that point, where it is infinite. But if we take the space total of the product $uf(y)$, the result is $f(x)$. For u only exists at x, and its total is 1. Thus,

$$\int uf(y)dy = f(x), \tag{24}$$

if the limits include the point x. If not, the result is zero. This is the property made use of in Fourier and other series when employed to express arbitrary functions. The function u, in the above or other special form, spots a single value of the arbitrary function in virtue of its impulsiveness.

Suppose, however, that the given function $f(y)$ had no definite value at a particular place, as happens when there is a discontinuity, or sudden jump from one value to another. Here $f(y)$ has any value between the two extremes. Under these circumstances, what should we expect the impulse to do, if it can only, through (24), lead to one value? To be quite fair, it should show the mean value. This is an excellent reason why it ought to do so, though not a proof that it does. Why it must may become clear later on.

Applying (24) to the problem in hand, with u as in (23), we see that

$$f(x) = \frac{2}{l}\Sigma_1^\infty \sin\frac{n\pi x}{l}\int_0^l f(y)\sin\frac{n\pi y}{l}dy \tag{25}$$

expands the arbitrary function $f(x)$ in a series of sines, so as to vanish at $x = 0$ and l (where, of course, if $f(x)$ does not vanish, the formula fails). We also see that

$$V = \frac{2}{l}\Sigma_1^\infty \sin\frac{n\pi x}{l}\,\epsilon^{pt}\int_0^l V_0 \sin\frac{n\pi y}{l}\,dy \tag{26}$$

represents the potential at x at time t after the moment when the potential was represented by V_0. The former Q is represented now by $SV_0 dy$, that is, the charge on the element of length dy.

The formula (25) may, as we have seen, fail either at the terminals or intermediately at a discontinuity. But the formula (26) does not fail at all, for any finite value of the time. Initially it is the same as (25) and may fail then. But the presence of the time functions makes V continuous. No matter how small t is taken, if not actually zero, there is no discontinuity. Sharp corners in V_0 are instantly rounded off by the time factors, though if graphically represented there might be no observable difference. We may take t so small that the time functions differed from 1 insensibly for millions of terms, yet go far enough, and we must come to time-functions differing insensibly from 0 with the same value of t. So V is necessarily made continuous in the smallest interval of time after the first moment, if it be initially discontinuous.

Another way of getting (22) is by using the coth function. Thus, by (18),

$$V_1 = ql\, \text{shin}\, qy\left(\cosh qx - \frac{\text{shin}\, qx}{ql}\, ql \coth ql\right)\frac{Q}{Sl}. \tag{27}$$

Noting that the first part is inoperative, the result (13) turns the last to

$$V = -\,\text{shin}\, qx\, \text{shin}\, qy\, \frac{Q}{Sl}\,(1 + 2\epsilon^{p_1 t} + 2\epsilon^{p_2 t} + \ldots); \tag{28}$$

and now, noting that the power of p is 0 in the first term, p_1 in the second, and so on, and putting $q^2 = -s^2$, we make

$$V = \frac{2Q}{Sl}\,\Sigma \sin sx\, \sin sy\, \epsilon^{pt}, \tag{29}$$

as before.

Finally, a third way. We have, by (18),

$$V_1 = ql\, \text{shin}\, qy \times \frac{\text{shin}\, q(l-x)}{\text{shin}\, ql}\,\frac{Q}{Sl}. \tag{30}$$

Now the part after the × was algebrized in §265; *see* equations (1) and (9) there. Therefore

$$V_1 = ql\, \text{shin}\, qy\, \frac{Q}{Sl}\left\{\left(1 - \frac{x}{l}\right) - 2\Sigma\frac{\sin sx}{sl}\epsilon^{pt}\right\}; \tag{31}$$

and now, on effecting the differentiations, which is done at sight by the power of p being constant in every term, we obtain (29) again. These variations will, if practised, enable the reader to operate quickly and safely.

§ **268.** Next, in further illustration of simple cases, let the line be cut at both ends. First, with an impressed force e at the point $x = y$. Then, by equations (39), (40), § 259, we have

$$V_1 = \frac{\text{shin}\, qy}{\text{shin}\, ql}\cosh q(l-x)\,.\,e, \tag{32}$$

$$V_2 = -\frac{\cosh qx}{\text{shin}\, ql}\,\text{shin}\, q(l-y)\,.\,e. \tag{33}$$

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To convert to Fourier series, put $q^2 = -s^2$ in (32), and reject the part involving $\sin sx$. Then

$$V_1 = \frac{\sin sy \cos sx}{sl}\, sl \cot sl \,.\, e. \qquad (34)$$

In this use (14), making

$$V_1 = e\frac{\sin sy \cos sx}{sl}(1 + 2\epsilon^{p_1 t} + 2\epsilon^{p_2 t} + \ldots), $$

which finally makes, by the power of p being a constant in every term,

$$V_1 = \frac{ye}{l} + \Sigma \frac{2e}{sl} \sin sy \cos sx\, \epsilon^{pt}. \qquad (35)$$

This is on the right side of e. On the left side, (33) makes

$$V_2 = -e + e\frac{\cos sx \sin sy}{sl}(1 + 2\epsilon^{p_1 t} + 2\epsilon^{p_2 t} + \ldots) \qquad (36)$$

$$= -e + \frac{ey}{l} + \Sigma \frac{2e}{sl} \sin sy \cos sx\, \epsilon^{pt}, \qquad (37)$$

which only differs from (35) in the outside term expressing the steady state. The values of s are as before, but the expansion is in cosines, not sines. The summation represents the negative of the final state, which is discontinuous.

As regards the final state, we have two condensers in sequence, of permittances Sy and $S(l-y)$, with the impressed force between them. The effective permittance is the reciprocal of the sum of the reciprocals of the separate permittances—that is, $Sy(1-y/l)$. Multiplying by e we obtain the charge, and then dividing by $S(l-y)$, we obtain ey/l, the final potential on the right side of the force. On the left side it is lower by the amount e.

§ 269. We may do the effect of a single charge at y in the same way. Let it be Q, then

$$V_1 = ql \frac{\cosh qy}{\text{shin}\, ql} \cosh q(l-x) \,.\, \frac{Q}{Sl}, \qquad (38)$$

by (65), § 263, with $h = pQ$. This is on the right side of Q, and on the left side the formula is obtained by interchanging x and y. Put $q^2 = -s^2$, and reject the part involving $\sin sx$. Then

$$V_1 = \cos sy \cos sx \,.\, sl \cot sl \,\frac{Q}{Sl} \qquad (39)$$

$$= \frac{Q}{Sl} \cos sy \cos sx\, (1 + 2\epsilon^{p_1 t} + 2\epsilon^{p_2 t} + \ldots) \qquad (40)$$

$$= \frac{Q}{Sl}\{1 + 2\Sigma \cos sy \cos sx\, \epsilon^{pt}\}. \qquad (41)$$

In passing from (39) to (40) the result (14) is used, and the further passage to (41) involves only a formal change by the power of p being a constant, as in former cases.

By the last formula we see that

$$u = \frac{1}{l} + \frac{2}{l}\Sigma_1^\infty \cos \frac{n\pi x}{l} \cos \frac{n\pi y}{l} \qquad (42)$$

is a unit impulsive function existing at the point $y = x$, like (23) in fact, so that the formula (24) applies, and an arbitrary function may be expanded in cosines thus :—

$$f(x) = \frac{1}{l}\int_0^l f(y)\left\{1 + 2\Sigma_1^\infty \cos \frac{n\pi x}{l} \cos \frac{n\pi y}{l}\right\} dy. \qquad (43)$$

The introduction of the time factor ϵ^{pt}, where $p = -n^2\pi^2/RSl^2$, in the summation will, by the preceding, represent what the initial potential $f(x)$ becomes at time t later by diffusion in the cable with its ends insulated. The final state is a uniform mean potential.

§ 270. Next take a case involving a different determinantal equation. Say there is earth on at A and disconnection at B. Then $\alpha = -1, \beta = 1$. So, with an initial charge Q at $x = y$, we have, by (65), § 263,

$$V_1 = \frac{\text{shin}\, qy}{\cosh ql} \cosh q(l-x) \,.\, ql \frac{Q}{Sl}, \qquad (44)$$

in which the interchange of x and y will give V_2. Or, putting $q = si$,

$$V_1 = sl \sin sy (\cos sx + \sin sx \tan sl) \frac{Q}{Sl}. \qquad (45)$$

The first part is inoperative as regards a Fourier series. So

$$V_1 = (\sin sy \sin sx)(sl \tan sl) \frac{Q}{Sl}. \qquad (46)$$

Here we see that we have a different operator to produce the series of exponentials, viz., $sl \tan sl$ or ql than ql. The trigonometrical expansion of this function is

$$ql \text{ than } ql = \frac{2}{1 + \left(\frac{\pi}{2ql}\right)^2} + \frac{2}{1 + \left(\frac{3\pi}{2ql}\right)^2} + \frac{2}{1 + \left(\frac{5\pi}{2ql}\right)^2} + \ldots \qquad (47)$$

Remembering the meaning of q^2, namely, RSp, this makes

$$ql \text{ than } ql \,.\, 1 = 2\epsilon^{p_1 t} + 2\epsilon^{p_2 t} + 2\epsilon^{p_3 t} + \ldots, \qquad (48)$$

in the way (14) was got, only now the p's are a different set, namely, the roots of

$$\cosh ql = 0, \qquad \text{or} \qquad \cos sl = 0; \qquad (49)$$

say $sl = \frac{1}{2}\pi, \frac{3}{2}\pi, \frac{5}{2}\pi$, &c.

So, by (46),

$$V_1 = \frac{2Q}{Sl} \sin sy \sin sx\, \Sigma\epsilon^{pt}, \qquad (50)$$

which is at once transformable to

$$V = \frac{2Q}{Sl}\Sigma \sin sy \sin sx\, \epsilon^{pt}, \qquad (51)$$

by making s be constant instead of a differentiator. In this example the normal functions of the type $\sin sx$ vanish at A only. At B they have maxima, so that their slopes vanish. This is to make the current vanish at B, where there is insulation. The change in the first normal function is very great. Being $\sin(\pi x/2l)$, it is just one half of the first normal function for a line twice as long, earthed at both ends. The corresponding p is the same as that for the line of double length, so that the subsidence of the first normal system in the present case of insulation at B takes four times as long to reach a given stage, as the subsidence of the first normal system of the same line does when it is earthed at both ends.

The first normal system is, of course, the most important. When t is big it is practically the only one worth counting. When t is smaller, the second one acquires significance, then the third, and so on, up to the first moment, when the whole series is required. But these Fourier series are frequently very unpractical for numerical purposes when t is taken small on account of the slow convergency.

§ 271. The above examples are sufficient to show the connection between the operational solutions and the corresponding Fourier series in the simple cases of terminal direct earth connection and complete disconnection, at least so far as the particular method employed is concerned, bearing in mind that principles are often as well illustrated by simple as by more complicated problems, if not better. The above process consists in first converting the reciprocal of the determinator shin ql or cosh ql, &c., to the sum of partial fractions by using known trigonometrical formulæ. These are easily algebrized, and the result is to give V or C or other quantity at some particular place. Thirdly, we operate on this result directly by whole differentiations, which merely means giving p a constant value in any term, and the result is the solution at any place in the form of a Fourier series.

Before passing on to another way of considering Fourier series operationally, some remarks about the functions called u above may be useful. They were considered merely as expressing unit impulsive functions located at a point $x = y$ situated between 0 and l. So far as that goes, they are quite similar. But in other respects they differ. They are both periodic, however. Every time x is increased by the amount $2l$, the sines u and the cosines u repeat themselves. But the sines u is an odd function of x, whilst the cosines u is an even function. So the sines u is negatived by changing x to $-x$. The complete meaning of the sines u is therefore an infinite row of positive unit impulses at the points $y = x, x + 2l, x + 4l$, &c., $x - 2l, x - 4l$, &c.; together with an infinite row of negative unit impulses at the points $y = -x, -x + 2l, -x + 4l$, &c., $-x - 2l, -x - 4l$, &c. On the other hand, the cosines u represents positive unit impulses at all the above places. Neither of the u's is a periodic repetition of a single impulse.

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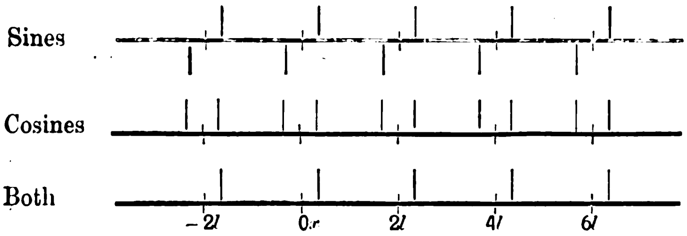
But if we take half the sum of the sines u and the cosines u, the negative impulses will be cancelled. There is left simply an infinite row of positive unit impulses at the points $y=x\pm 2nl$, where n is any integer. The diagram will serve to fix this plainly:—



The horizontal straight line is divided into equal lengths $2l$, and the vertical lines at x and $x\pm 2nl$, $-x$ and $-x\pm 2nl$ represent the distribution of the impulses in the three cases of the sines u, the cosines u, and half their sum. By (23) and (42), the new u is represented by

$$u=\frac{1}{2l}\left\{1+2\Sigma_1^\infty \cos\frac{n\pi}{l}(y-x)\right\}, \qquad (52)$$

and its meaning for our purpose is a function of y which is zero everywhere except at $x\pm 2nl$, where it is infinite, but so that its total is unity. This u is the periodic impulsive function concerned in the periodic form of Fourier's theorem. For, using (52) in (24), we have

$$f(x)=\frac{1}{2l}\int_0^{2l}\left\{1+2\Sigma_1^\infty \cos\frac{n\pi}{l}(y-x)\right\}f(y)\,dy, \qquad (53)$$

which expands an arbitrary function $f(x)$ whose values are given between the limits 0 and $2l$ into the sum of a series of sines and cosines with constant coefficients, and with a constant term expressing the mean value. Besides that, it makes the given values repeat themselves over and over again, with the period $2l$. That is, the impulse operator $\int u\ .\ .\ .\ dy$, in virtue of its periodic nature, makes $f(x)$ periodic as well.

When the period is infinitely long, if we put $s=n\pi/l$, we have $ds=\pi/l$ to represent the step from one s to the next, which is infinitely small in the limit, when the impulsive function becomes

$$u=\frac{1}{\pi}\int_0^\infty \cos s(y-x)\ .\ ds, \qquad (54)$$

and its meaning is a unit impulse at the point $y=x$ only. So, applying it through (24) to a function of y, we get

$$f(x)=\frac{1}{\pi}\int_{-\infty}^{\infty}\int_0^{\infty} f(y)\cos s(y-x)\ .\ dy\,ds, \qquad (55)$$

which is the form of Fourier's theorem applicable to any function given between $-\infty$ and $+\infty$. The mean value, should it be finite, may be considered separately.

(To be continued.)

THE EFFECTS OF LIGHTNING DISCHARGES ON UNDERGROUND CABLES.

BY C. S. DU RICHE PRELLER.

In the course of a recent inquiry into the effects of atmospheric discharges on electrical installations, the writer also had occasion to investigate the effects of such discharges on some of the underground telegraph cables laid through the St. Gothard tunnel (3,785ft. above sea level, 10 miles in length); and as the case bears on electric underground cables generally, a brief account and explanation of so interesting a phenomenon may not be out of place.

The Tunnel Cables are altogether five in number. The first two telegraph cables of 1881, supplied by Messrs. Felten and Guilleaume, were originally laid in a covered iron channel along the wall of the tunnel, about 8ft. above the rails; but owing to the rapid deterioration caused by the decomposing action of drop water charged with the products of incomplete combustion of engine fuel, notably carbonic acid, sulphurous acid, and ammonia, they were, in 1891, transferred to a trench, in which all the five cables are now embedded in alternate layers of gravel and sand, covered with granite flags and another super-

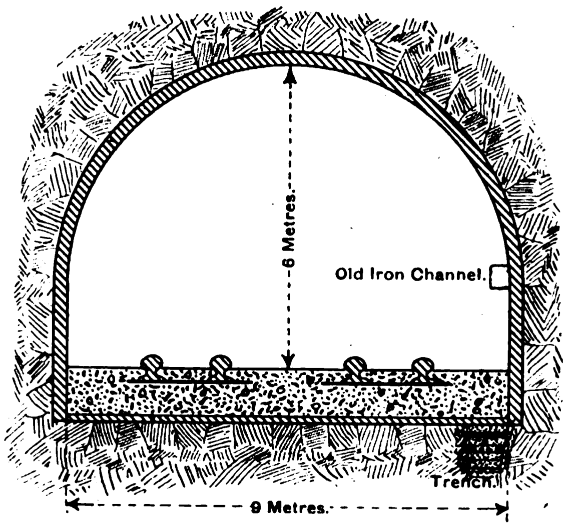


Fig. 1.—St. Gothard Tunnel. Transverse Section.

posed layer of gravel, as shown in Figs. 1 and 2.* The other three cables are the telegraph and telephone cables of 1891, supplied by Messrs. Siemens and Halske, and the telegraph

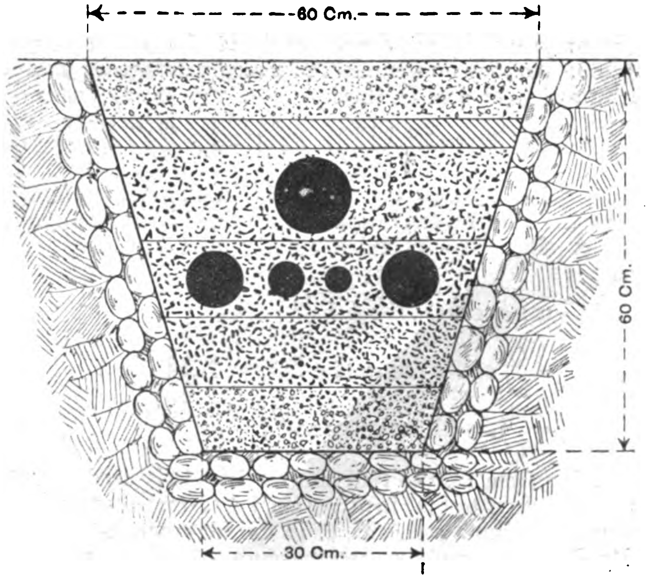


Fig. 2.—Cable Trench, St. Gothard Tunnel. Transverse Section.

cable of 1893, by Messrs. Felten and Guilleaume, which last-named was described in *The Electrician*, February 23rd, 1894.

The two cables damaged by atmospheric electricity are the railway service telegraph and concentric telephone cables of

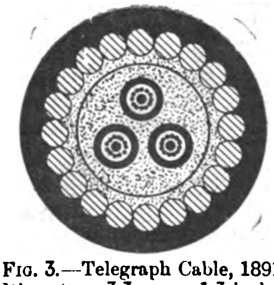


Fig. 3.—Telegraph Cable, 1891. Diameter = 3·3 cms. = 1·3 inch.

Fig. 4.—Telephone Cable, 1891. Diameter = 2·4 cms. = ·94 inch.

1891, of which cross-sections are shown in Figs. 3 and 4. The three copper conductors of the former are each 1·38mm. in

* In the Mont Cenis tunnel (7·6 miles), the conductors are still encased simply in lead pipes carried along the wall of the tunnel; in the Arlberg tunnel (6·4 miles) the trench was adopted at the outset, in 1883.

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diameter. The central copper conductor of the telephone cable is 1mm. in diameter, while the metallic return consists of a conductive layer of seven 0·4mm. copper wires connected by tinfoil. Both cables are precisely similar in construction, the conductors being served with jute, upon which follows a lead mantle, then asphaltum and paper winding, then the galvanised iron-wire sheathing, and then the outer coating of asphaltum. The joints of the cable lengths (550 yards each) are protected by Siemens lead coupling boxes. The tested electrical properties of both cables were as follows:—

At 15°C. = 59°F.	Telegraph cable. Per kilom.	Concentric telephone cable. Per kilom.
Copper resistance, ohms	12	0·25
Insulation resistance, megohms..	500	250
Capacity, microfarad.......... ...	0·25	0·3

The telegraph cable is connected up to the overhead lines at the terminal stations of the tunnel (Goschenen and Airolo).

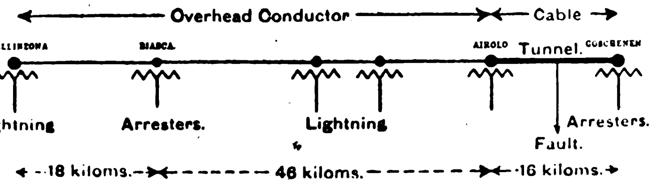

Fig. 5.

It is protected at both ends by double Siemens brass-plate lightning arresters (air-gap only 0·1mm.), each having a separate earth-plate sunk in turf-covered soil, and being, moreover, connected with the rails as well as with the water mains of the two stations respectively. The resistance to earth, tested after a spell of dry weather, was only 1·55 ohm. At Airolo Station the overhead 4mm. conductors coming from Bellinzona, 40 miles to the south, pass first through plate lightning

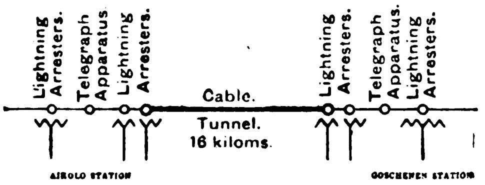

Fig. 6.

arresters and through platinum fuses 0·2mm. in diameter, then through the telegraph apparatus whose magnet coils have a resistance of 500 ohms, and thence through the double Siemens lightning arresters into the cable; and the same applies to the Goschenen station at the north end, as shown in the diagrams (Figs. 5 and 6).

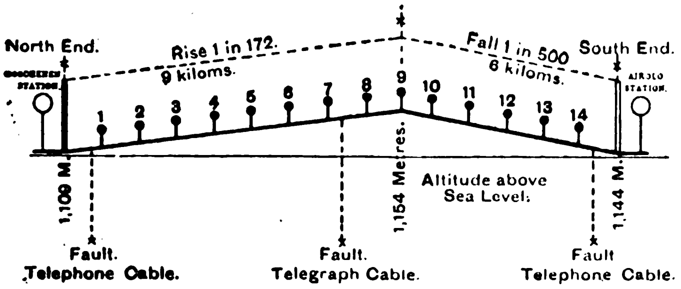

Fig. 7.—St. Gothard Tunnel. Profile.

The telephone cable connects, besides the two terminal stations, the 14 intermediate telephone stations in the tunnel, as shown in Fig. 7, the apparatus in each of them being contained in a zinc chamber. The cable is protected at both ends by Siemens lightning arresters, and constitutes, between the two tunnel termini, a self-contained metallic circuit, completely insulated from earth, and nowhere connected to overhead wires. The two cables were thus amply and carefully protected at both ends.

Damage by Lightning.—In the telephone cable, two defects, due to atmospheric electricity, were discovered last year (1894), one of them about 500 yards from Goschenen, and the other about 600 yards from Airolo, or about nine miles apart from each other. As the insulation resistance did not fall below eight megohms in each case, the defects were only discovered during one of the periodical tests, but they were in all probability due to the same discharge which damaged the telegraph cable some time before, under the following circumstances:—

On the day in question, the atmosphere was charged with electricity at both ends of the tunnel; but a thunderstorm, accompanied by a few, though by no means violent, lightning discharges, occurred only at Airolo. Soon afterwards a serious defect in conductivity was observed in one of the three conductors of the telegraph cable. Messages from Bellinzona failed to reach Goschenen, and although the conductor could still be used for local messages between the tunnel termini, two-thirds of the current were lost through leakage.

The fault was found to exist at a point nearly midway in the tunnel, or five miles from Airolo, although outwardly the cable was apparently in excellent condition, being perfectly dry, well embedded in sand, and showing no trace of damage either by chemical or mechanical action. The lightning arresters at Goschenen showed no trace of a discharge. On the other hand, at Airolo, the lightning arresters of the cable showed several black marks produced by lightning.

As regards the cable itself, it was found that at the point of leakage the inner side of the lead mantle of the damaged conductor bore a black mark about 1in. by $\frac{1}{3}$in., in the centre of which the lead had been partially melted. The jute serving between the lead mantle and the conductor was similarly blackened, and in the centre of the mark a hole about 1mm. in diameter was burnt through the jute and filled with carbonised—and, therefore, conductive—substance. On the conductor itself there was a black spot of about 1mm., on which, by aid of the lens, three punctures, produced by lightning, could be detected. The subsequently discovered damage to the concentric telephone cable in two separate places was of a precisely similar character.

Explanation of the Phenomenon.—In the opinion of the makers of the two cables, there was a simultaneous discharge at both ends of the tunnel from thunderclouds charged with electricity of the same sign, in consequence of which part of the electricity of opposite sign accumulated at the earthplates, flowed into the telegraph cable, and the two waves meeting midway of the tunnel, the insulation of the cable was unable to resist their maximum potentials at that point. According to this view, then, the damage was not due to a direct discharge.

According to another view, an oscillatory high-tension discharge occurred at one end of the tunnel, and its still higher tension midway in the cable coincided with a weak point in the insulation. As is well known, the fact that such discharges are oscillatory in character, of enormously high frequency, up to millions of alternations per second, was demonstrated by Lord Kelvin as early as 1853. Moreover, neither this nor the preceding view attempts to explain what is really the essential point, viz., why the lightning arresters failed to act.

In the writer's opinion, the phenomenon was due to a weak discharge and to the absence of impedance coils in combination with the lightning arresters. The station building at Airolo, being lower than the surrounding buildings, is not provided with lightning conductors, and this fact probably facilitated at the outset a discharge near the lightning arresters of the cable. If this discharge had been a violent one, or if it had come from the overhead lines and passed through the telegraph apparatus or the platinum fuses, the latter would have melted, and the occurrence would have attracted the attention of the officials, who, on the contrary, attributed the leakage at first to damage by mechanical or chemical agency. Experience, moreover, shows that violent and rapid atmospheric discharges have a much greater tendency to take the shortest and most direct path to earth than weak or sluggish discharges. If the discharge, after passing into the cable, had reached the lightning arresters at the Goschenen end, the self-induction of

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the telegraph apparatus in that station would probably have forced it harmlessly to earth. According to Lagarde (*Ann. Tel.*, 1887, p. 418), some atmospheric discharges do not exceed 1,500 volts, and, assuming this to have been the initial tension at the lighting arresters at Airolo, the much higher tension midway on the cable was quite enough to melt the insulation, even if the lead mantle had been double the thickness. As regards the damage to the telephone cable, it could only be due either to a side discharge or to induction, or to an indirect discharge at both ends of the cable. Here again it by no means follows that there were weak points in the insulation; moreover, being a concentric cable, it is peculiarly liable to phenomena of this kind; and in this respect the case strikingly confirms Dr. J. A. Fleming's observations concerning the increased condenser effect between the inner and outer members of long concentric cables,* albeit his experiments referred only to ordinary alternating currents, and not to lightning discharges.

Confirmatory Evidence.—The writer's conclusions derive, moreover, support from the exhaustive experiments made in 1893 by H. Zielinski† for the purpose of testing the efficiency of various forms of lightning arresters, as affected by the self-induction of the telegraph apparatus to be protected. From a battery of four Leyden jars charged by an influence machine driven from an electromotor, he obtained discharges of 17,000 volts, and corresponding sparks 5mm. in length between the balls (diameter 2cm.) of a spark micrometer. The self-induction of the telegraph apparatus was represented by impedance coils of 0·094, 0·28, and 0·56 secohm, and the resistance by a water

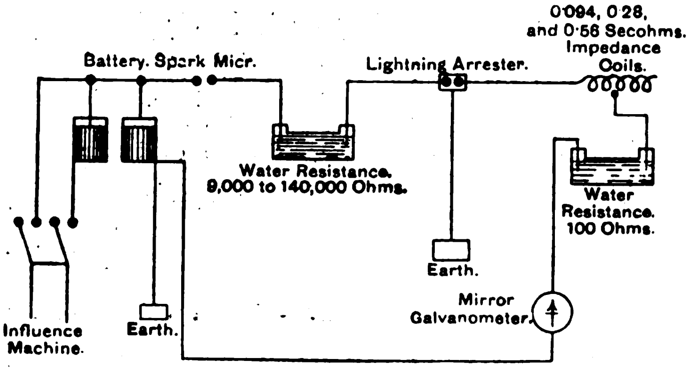

Fig. 8.

resistance of 100 ohms, while the discharges were varied by water resistances of 9,000 to 124,000 ohms, and the differences of efficiency between the full and weakened discharge were measured by a Wiedemann mirror galvanometer.‡ The arrangements of the apparatus is shown in the diagram (Fig 8).

From the results of more than 150 experiments with nine different forms of plate, comb, and spindle arresters, the writer has prepared the following table, which shows at a glance the mean efficiencies obtained, to wit, the percentage of the discharge which was forced to earth under varying self-induction of the impedence coils. The distance of the dielectric was in all cases 0·25mm.

Water resistances to weaken full discharge.	Self-induction of impedance coils.		
	0·094	0·28	0·56 secohm.
	Efficiency of lightning arresters in per cent.		
124,000 ohms	1·05	1·85	4·58
60,000 „	6·36	17·99	31·90
27,000 „	41·03	56·92	67·13
9,000 „	8[illegible]·25	86·88	91·75
0 „	100·00	100·00	100·00

* "On the Effect of Self-Induction and Capacity in Cases of Alternating Current Flow." *Journal* Inst. Elect. Eng., 1891, p. 387.

† *E.T.Z.*, 1893, p. 319, *et seq.*

‡ Similar, but more or less inconclusive, experiments were made by Lagarde (*Ann. Télégraphiques*, 1887, p. 418, and 1889, p. 32), who used a Riess air thermometer instead of a galvanometer, and in lieu of the telegraph apparatus, inserted only a water resistance of 500 ohms, thus entirely neglecting the important factor of self-induction.

It is seen that even the minimum self-induction of 0·094 secohm sufficed in all cases to obtain an efficiency of 100 per cent., viz., to force the full discharge to earth, whilst the efficiency decreased as the discharge was weakened. The experiments further showed (*a*) that the efficiency of the arresters was not appreciably affected by the earth-plate resistance, even when the latter was increased to 100 ohms; (*b*) that the result was practically the same whether the arrester was placed in the main or in a shunt circuit, and (*c*) that the efficiency of the nine different forms of arresters varied only within very narrow limits. The main factor was in all cases the effect of the impedance coil.

Conclusion.—With a view to more effectually prevent damage by lightning to the underground cables, the St. Gothard Railway Company have replaced all the original lightning arresters (*a*) by tinfoil safety fuses 4cm. (1·6in.) in length, melting at ¾ or 1 ampere, and (*b*) by lightning arresters composed of carbon blocks separated by a mica plate 0·3mm. in thickness, these arresters being intended for high-tension, and the tinfoil fuses for low-tension discharges.

It remains to be seen whether these remedies will prove effectual. It may be questioned whether impedance coils, so placed in front of the lightning arresters as to obstruct the flow of the ordinary current as little as possible, would not be preferable to safety fuses, since, in the event of an atmospheric discharge, the cable may easily be damaged before the melting of the fuses has interrupted the circuit.

Until the traffic through Alpine or other long tunnels is worked by smokeless electrical locomotives, the vitiated atmosphere due to steam traction will always render the repairs of underground cables extremely difficult and troublesome, and hence no precaution can be too elaborate. But, in the case under notice, no blame whatever can attach to the makers of the damaged cables, for neither the most careful construction of the cables themselves, nor the most perfected system of safety fuses, arresters, and earth connections, nor even impedance coils, can afford absolute protection against the vagaries of lightning discharges.

THE COST OF PRODUCTION OF ELECTROLYTIC ALKALI AND BLEACH.

A Paper on this subject has lately been contributed to the *Zeitschrift für Electrochemie* by C. Haeussermann, and is noticeable on account of the care which has evidently been taken in its composition to present, wherever possible, conclusions based on data recognised as valid in standard works treating of the alkali industry ordinarily carried on by purely chemical methods. In consequence of this claim to consideration we excerpt such passages as are needed to elucidate the basis of the estimates ultimately arrived at, and append the final summary of cost.

The calculation is based on an output of 5,000 kilos (approximately five tons) of caustic soda of 96 per cent. strength, together with the corresponding quantity of bleaching powder produced from the amount of chlorine equivalent to that of caustic soda, and necessarily resulting from the process of electrolysis. No credit has been taken for the hydrogen appearing as a bye-product of the caustic soda in the cathode compartment, as no remunerative use for it exists at present. The author parenthetically remarks that the output of alkali (by weight) per ampere-hour would be greater for potash than for soda, the difference between the molecular weights of the two alkalies (56 and 40) being comparatively large, and suggests that attention should be turned to the electrolytic production of caustic potash, a good market for which may be found up to a point at which all wants which can only be satisfied by the dearer alkali have been met. Bearing in mind, however, the comparative scarceness, and consequent high price, of potash salts, an unlimited market for caustic potash at a practicable price is not to be expected, and for the prosecution of a large staple alkali trade the use of sodium salts is a necessity. Utility is therefore served by an estimate based on the adoption of common salt, rather than of potassium chloride, as a raw material.

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The first item in the estimate is energy. It is assumed that the energy will be obtained from coal through the agency of a steam engine. A working year of 350 days of 24 hours is postulated. Taking a current efficiency (as distinct from an energy efficiency) of 80 per cent., one ampere-hour corresponds with a production of 1·19 grm. of caustic soda and 1·05 grm. of chlorine, *i.e.*, 28·56 grms. and 25·2 grms. for 24 hours. For a production of 1 kilo of NaOH for 24 hours, a current of 35 amperes will therefore be requisite. The voltage needed is set down as 3·5 volts, which figure yields the result 122·5 watts for 24 hours per kilo of caustic soda. We may say that 3·5 volts is a decidedly low estimate; it is doubtful whether at least 4·5 volts would not be required in practice with any apparatus hitherto devised and tried on a considerable scale. Granting the assumed voltage, the energy needed for the production of 5,000 kilos of caustic soda works out at 832 E.H.P. for 24 hours. The equivalent quantity of chlorine liberated suffices (with allowance for loss in collection and conveyance of the gas and unavoidable imperfection in absorption by lime) to produce 12,500 kilos (12½ tons) of bleaching powder containing 35 per cent. of available chlorine. Taking 1·1 mechanical horse-power as necessary for obtaining 1 electrical horse-power, 915 H.P. must be developed by the engine driving the installation. About 85 H.P. should be added for running minor portions of the plant, *e.g.*, pumps and similar auxiliaries. About 1,000 H.P., therefore, becomes a fair estimate for the entire factory. For engines of considerable size a consumption of 0.8 kilo of coal per horse-power hour need not be exceeded, and this at the price of 1.2 mark per 1,000 kilos (say 12s. per ton) corresponds with an expenditure of 230.4 marks (£11. 10s.) for fuel burnt every 24 hours. Additional expenses, *e.g.*, those of management, lubrication and repairs, cannot be foretold with equal accuracy; but from general experience it appears that the cost of such necessary addenda may be fairly taken to equal that of the fuel. It follows that the total cost of the current necessary to set free 5,000 kilos of caustic soda (in 24 hours) is 460.8 marks (£23).

The second item in the estimate is salt. About 8,000 kilos of salt, allowing for waste, will be required, and this quantity, at 15 marks per 1,000 kilos, is equal to 120 marks. The use of brine pumped direct from the well would, of course, lower this value.

The caustic soda being obtained in dilute solution, and being in the presence of a large quantity of common salt, a considerable expenditure for evaporation has to be provided for. The liquor coming from the cathode compartments will be about 8 per cent. strength, and will amount to about 63 cubic metres per 24 hours. To get rid of the accompanying salts, evaporation of the lye to a specific gravity of 1·45 is requisite, and subsequently to this the strong solution of caustic soda must be further heated until it has become solid and the alkali is in a marketable form. Seeing that the process of evaporation is in no way different for electrolytic caustic soda from the method commonly in use, standard figures, such as those given in Lunge's classical work, may be accepted. These give the cost for 5,000 kilos of caustic soda as 60 marks. Similar remarks apply to the part of the estimate dealing with lime for the bleaching powder and with packing, these sources of expense being 112.5 and 272.5 marks (60 marks being for the packing of the caustic soda and the remainder for the bleaching powder). Labour in like manner may be taken for caustic soda at 45 marks, and for bleaching powder at 62.5 marks. The remaining labour employed about the factory (for other than attendance on the power plant) cannot be accurately computed, but may be roughly taken at 75 marks, on the basis that 25 hands are employed at an average wage of three marks. The cost of repairs to the plant (apart from the portion engaged in the production of power) must be arbitrarily assumed to equal one mark per 100 kilos of output, *i.e.*, 175 marks for the whole.

The amortisation of the capital of the factory is divisible into two heads, viz., that concerned with the buildings and that relating to the working plant. Putting the area covered by the buildings at 12,000 sq. metres, and taking the cost per sq. metre at 30 marks, the capital expended under this head would be 400,000 marks, 5 per cent. of which is 20,000 marks or 57.15 marks for 24 hours. For the plant a capital expenditure of 600,000 marks would be required, 10 per cent. on which is 60,000 marks, *i.e.*, 171.42 marks for 24 hours.

We are now in a position to put in tabular form the various items of cost for the daily expenditure of an electrolytic plant of a capacity of 5,000 kilos (5 tons) of caustic soda and 12,500 kilos (12½ tons) of bleaching powder for 24 hours.

	Marks.		£	s.	d.
Energy	460·80	=	23	0	0
Salt	120.00	=	6	0	0
Coal	90.00	=	4	10	0
Lime	112.50	=	5	10	0
Packing	212.50	=	10	10	0
Labour	182.50	=	9	0	0
Repairs (to anodes, &c.)	175.00	=	8	10	0
Amortisation	228.58	=	11	10	0
	1,581.88	=	78	10	0

To this sum the office expenses and insurance have to be added; these may be taken as 25 per cent. or more of the total expenditure. In English units the cost of producing 5 tons of caustic soda and 12½ tons of bleaching powder works out at close on £100, a sum which leaves no very great margin for profit in view of contingencies.

ON THE RESISTANCE OF GALVANIC ELEMENTS.*

BY DR. PAUL SCHOOP.

Some surprise was occasioned by a fact which was discovered in the course of some experiments undertaken by the Oerlikon Company and the author before setting up a secondary battery at the central tramway station in Hirsland-Zurich. The battery, which was arranged in series, consisted of 300 cells, each containing three positive and four negative plates, having a resistance on open circuit of $300 \times 0·005$ ohms $= 1·5$ ohm. With a discharge of 20 amperes a fall of potential of $20 \times 1·5 = 30$ volts, due to the internal resistance of the battery above, was to be expected. The result, however, did not bear out this anticipation, but proved more favourable to the battery considered as a transformer, since, with a discharging current of 20 amperes, the potential difference merely fell 7-10 volts—*i.e.*, only one-third of the calculated amount. This circumstance led the author to experiment on the resistance of cells when a current is passing.

It was found by Kohlrausch's method, which is applicable when no current is passing, that the resistance of a discharged cell was greater than that of a charged one. The resistance of a cell left standing on open circuit increases continuously, and this is probably due to the formation on the plates of lead sulphate, which is a very bad conductor. In the case of a freshly-charged cell, left standing on open circuit, the resistance decreases first, which may arise from the plates, on the breaking of the circuit, being saturated with rather concentrated sulphuric acid, which is a worse conductor than the more dilute 30 per cent., and also from the presence of gas in and on the layers of active material, which may contribute to the rise of resistance by diminishing the contact of the electrodes with the electrolyte. The resistance of the cells on open circuit depends on the strength of current employed in charge and discharge, as well as on the temperature and the concentration of the dilute sulphuric acid. The resistance varies with the electrical condition of the electrodes, and these, as already mentioned elsewhere, vary with time. When a cell is examined from time to time, it is generally found that the resistance has altered slightly between each measurement. The resistance of a cell on open circuit is lower the nearer the plates are placed together, the greater their surface, and the higher the temperature of the cell; and is lowest in new cells at the commencement of their use. It varies in cells in commercial use between 0·0001 and 0·02 ohms, the cells with large plates having very low resistance, while that of cells with small plates is proportionately higher.

The resistance of a cell can be approximately estimated by observing its potential difference with different large charge and discharge currents. If the cell had no resistance, and if the influence of the separated ions on the electromotive force were independent of the current density, the cell would maintain the same potential difference for wide variations in the strength of current during charge and discharge. But if there is an ohmic resistance in the cell, then on an increase in the current during discharge (discharge is better than charge for this purpose) the decrease in potential difference will be equal to the quotient of the resistance of the cell by the strength of current passing through it. The observations of potential difference were made with a dead-beat D'Arsonval

* From the *Zeitschrift für Elektrochemie.*

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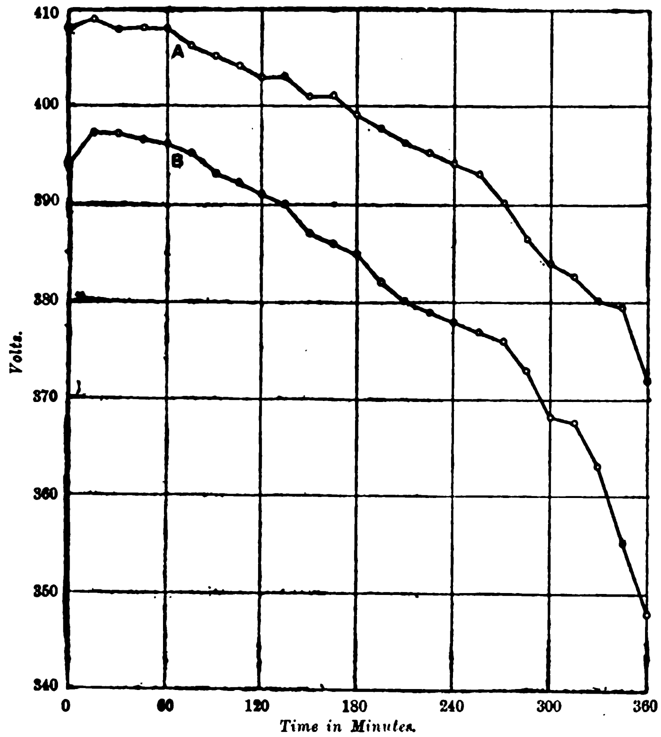
galvanometer, the mirror of which came to rest within a second after making contact. A cell with Tudor plates was discharged, the current being kept constant by a suitable adjustment of the resistance of the circuit. The discharge lasted six hours. Every 15 minutes first the potential difference was noted, then for two seconds the discharge circuit was broken, and the galvanometer readings observed. At the moment of breaking the deflection increased, and remained stationary, so that the reading could be taken; then the circuit was again closed and the discharge continued at a constant rate (35 amperes).

Table I.‡

Time in minutes.	Terminal potential during discharge.	Potential difference on open circuit.	Difference.
0	394	408	14
15	397	409	12
30	397	408	11
45	396·5	408	11·5
60	396	408	12
75	395	406	11
90	393	405	12
105	392	404	12
120	391	403	12
135	390	403	13
150	387	401	14
165	386	401	15
180	385	399	14
195	382	397·5	15·5
210	380	396	16
225	379	395	16
240	378	394	16
255	377	393	16
270	376	390	14
285	373	386·5	13·5
300	368	384	16
315	367·5	382·5	15
330	363	380	17
345	355	379·5	24·5
360	348	372	24

The numbers divided by 200 give the potential difference in volts. The resistance of the battery at rest was about 0·005 ohm, the resistance of the galvanometer was about 10,000 ohms. The



Curves plotted from Table I. A = Curve connecting Time and P.D. on open circuit. B = Curve connecting Time and Terminal Potential during discharge.

density of the sulphuric acid was 1·18 at the beginning of discharge, the temperature of the room was 15°C., the distance between the plates was 12mm.

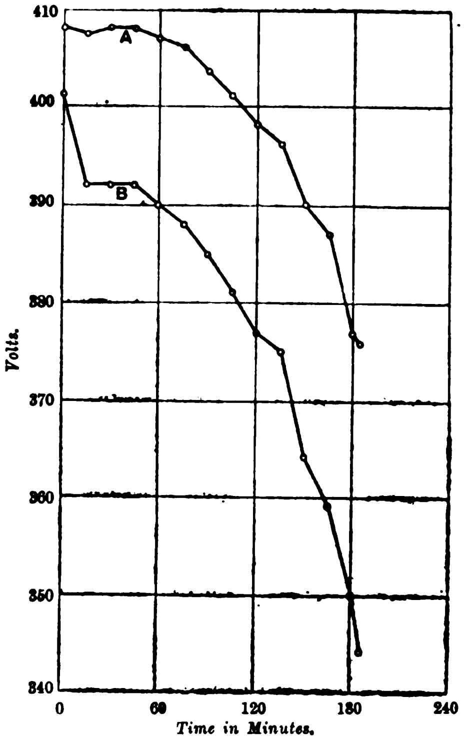
‡ We have taken the liberty of plotting the observations contained in these tables in the form of curves.

The following table (II.) gives the discharge of the same cell with a current of 62 amperes after it had been recharged with a current of 35 amperes, until gas was given off at both electrodes. Between the completion of charge and the beginning of discharge there was an interval of 12 hours' rest. It may be assumed that the electrical

Table II.‡

Time in minutes.	Terminal potential during discharge.	Potential-difference on open circuit.	Difference.
0	401	408	7
15	392	407·5	15·5
30	392	408	16
45	392	408	16
60	390	407	17
75	388	406	18
90	385	403·5	18·5
105	381	401	20
120	377	398	21
135	375	396	21
150	364	390	26
165	359	387	28
180	350	377	27
185	344	376	32

conditions of the cell during this discharge did not materially differ from those in the preceding case. The increase in the current is 27 amperes. Now, on comparing the potential difference for the



Curves plotted from Table II. A = Curve connecting Time and P.D. on open circuit. B = Curve connecting Time and Terminal Potential during discharge.

times at which the capacity condition of the cell is the same, as for example, at 30 or 60 ampere-hours discharge, the following points may be noted (Table III.):—

Table III.

Discharge in ampere-hours.	Terminal potential at 35 amperes.	Terminal potential at 62 amperes.	Difference.	Resistance in ohms.
31	396	392	4	0·00074
62	390	390	2	0·00037
93	386	385	1	0·00018
124	380	377	3	0·00055
155	376	364	12	0·00222
186	367	350	17	0·00315

It appears that the resistance of the cell differs in amount, and is lowest when it is half discharged. Beyond that point the resistance increases, and reaches about 17 times its minimum value.

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But as already mentioned, these figures do not quite correspond with the truth, for it would have to be assumed that the E.M.F. of the cell was constant during the whole of the discharge, which is not the case. Now the influence of the decrease of E.M.F. is entirely eliminated in both sets of experiments if one may assume that the decrease in both experiments is the same with regard to the ampere-hours discharged. This, however, is not quite the case, as the decrease of the E.M.F. is greater under corresponding conditions with a higher rate of discharge than when a lower rate has been employed. The calculated values of the resistances given above, therefore, are somewhat too high towards the end of discharge. The resistance of working batteries is therefore subject to very considerable variations, and during discharge at certain periods are many times smaller than those batteries on open circuit.

F. Streintz has already investigated the resistance of a cell with Tudor plates during charge and discharge, but did not examine closely its distribution on the individual electrodes. The method employed by the latter is not open to the objections which can be made to that used by the author, which does not separate the resistance from the potential difference of the cell. In spite of that the results obtained by these two different methods are in the main the same: they both throw light on the fact which was observed at the central station, and which at first seemed remarkable. The determination of the resistance occurring at the electrodes is all the more difficult, because Fuchs' method is not at all free from objection when it is used for the determination of potential difference in a closed circuit. For a closer confirmation of what has been stated readers may be referred to the recently-published work of the writer's on "Secondary Batteries," Part I. (Halle: W. Knapp).

ELECTRICITY AT THE NEW YORK NAVY YARD.*

The great extent to which electricity is employed in the new warships of the United States Navy would naturally lead one to infer that at the New York Navy Yard, where the principal naval electrical depot is located, there would be an extensive electrical establishment. This, however, is far from being the case, owing doubtless to the parsimony of Congress in its appropriations for other than the most pressing necessities of the naval service. Even in the electric lighting of its great workshops the Navy yard is behind the meanest private establishment, notwithstanding the pressure brought to bear on each successive Congress by the Secretary of the Navy for appropriations necessary to purchase and instal a plant of the necessary character and capacity.

The machine shops aboard all of the larger men-of-war afford facilities for ordinary electrical repairs, thus relieving the yard shops to some extent. Aside, however, from repair work and the calibration of instruments, an important function of the yard electrical department is in the inspection and testing of electrical naval supplies and machinery, the exigencies of the service requiring that nothing shall pass into use until its reliability has been thoroughly established by the most rigid tests or inspection.

In the machine shop are lathes, shapers, milling machines, &c., driven ordinarily by a small steam engine. A 12-kilowatt Edison dynamo is belted to the line shaft which transmits power to the machine tools, and under ordinary circumstances this dynamo furnishes current for lighting the shops and testing rooms. In case it becomes inexpedient for any reason to run the steam engine, the lighting circuit and dynamo are connected up with the Navy yard street mains, the dynamo then being used as a motor to drive the machinery.

The current for heavy testing is supplied by the direct connected equipment imported from abroad, consisting of a Siemens generator of 80 volts and 400 amperes capacity, and a 40 H.P. Belliss double cylinder vertical engine.

For lighter work a smaller outfit is used, consisting of a 2 kilowatt General Electric dynamo direct driven by a Case engine. Both of these equipments, as well as the machinery above mentioned, are placed on substantial foundations entirely separate from the floor and foundations of the building so as to avoid transmitting any jar or vibration to the balance room.

Ten per cent. of each lot of lamps is tested, and in the event that 30 per cent. of the lot fails to come up to specifications the entire shipment is rejected. The insulation test consists in immersing the wire in salt water 24 hours, then submitting it to heat at 200°F. seven hours a day for seven days, and finally giving it another salt water bath for 24 hours. Wire intended for 110-volt circuits is tested between each bath and the baking under a pressure of 300 volts, and is rejected unless the insulation shows a minimum resistance of 1,000 megohms per nautical mile throughout the series of tests. The baking is accomplished by placing the coil of wire in the centre of an oven, the walls, floor, and roof of which are covered on the interior with steam pipes. The coil of wire is supported on blocks so as to avoid contact with the hot pipes.

Among the multitude of supplies, instruments, &c., in the store room are to be found direct-connected marine electric lighting sets, electric projectors, and electric engine signalling apparatus. The latter interesting device is to transmit signals from bridge to engine room on board ship, replacing the gongs and pull wires commonly used for that purpose. The mechanism in the engine-room is a duplicate of that on the bridge. In practice the officer on the bridge pulls the handle over to the right or left, according to the direction in which he wishes the vessel to be propelled, until the pointer attached to the handle indicates the speed at which it is desired to run the engines. The needle of the engine room apparatus moves in synchronism with the lever on the bridge, pointing out the speed and direction desired. The signal is acknowledged from the engine room by moving over the handle there until its pointer coincides with the signalling needle, which has the effect of moving the needle of the apparatus on the bridge exactly as the needle in the engine room was moved. Thus, both engineer and pilot have a constant indication of the speed and direction of the engines.

* Abstract from the *Electrical World* of New York.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) **FRIDAY, June 7th,**

ROYAL INSTITUTION.

9 p.m. Friday Evening Discourse: "Phénomènes Physique des Hautes Régions de l'Atmosphère," by Prof. Alfred Cornu, F.R.S.

MONDAY, June 10th,

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting at the Royal United Service Institution, Whitehall. The following Paper will be read: "Safety Appliances for Elevators," by Herbert W. Umney.

TUESDAY, June 11th.

ELECTRICAL TRADES' SECTION.

12 (noon). Meeting of the Section at Botolph House, Eastcheap, to consider the new Board of Trade Regulations.

FRIDAY, June 14th,

PHYSICAL SOCIETY.

5 p.m. Meeting at Burlington House. The following Papers will be read: (1) "The Measurement of Cyclically Varying Temperatures," by H. F. Burstall; (2) "The The Thermal Constants of the Elements," by W. F. Deerr; (3) "An Electromagnetic Effect," by F. W. Bowden.

Alternate-Current Dynamo Electric Machines.—At a recent meeting of the Royal Society, Dr. J. Hopkinson and Mr. E. Wilson read a Paper on this subject. The Paper deals experimentally with the currents induced in the coils and in the cores of the magnets of alternate-current machines by the varying currents in and the varying positions of the armature. It is shown that such currents exist, and that they have the effect of diminishing to a certain extent the electromotive force of the machine when working on resistances as a generator without a corresponding effect upon the phase of the armature current. It is also shown that preventing variations in the coils of the electromagnet does not, in the machine experimented upon, greatly affect the result, and that the effect of introducing copper plates between the magnets and the armature has not a very great effect upon the electromotive force of the armature, the conclusion being that the conductivity of the iron cores is sufficient to produce the main part of the effect. A method of determining the efficiency of alternate-current machines is illustrated, and the results of the experiments for this determination are utilised to show that in certain cases of relation of phase of current to phase of electromotive force, the effect of the local currents in the iron cores is to increase, instead of to diminish, the electromotive force of the machine. The large majority of the experiments described were made in the summer of 1893, and a considerable part of the Paper was then written. The authors were assisted by Mr. F. Lydall, one of the student demonstrators at King's College at that time.

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(The Oldest Electrical Journal, 1861—1878.)

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1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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SPECIAL NOTICE.

Owing to the growth of the electrical and allied industries the demands for space in "THE ELECTRICIAN" are, for the greater part of the year, so pressing that a permanent increase in the size of the journal has become necessary. To meet the increased cost involved by this step, and by other improvements, such as heavier paper and more numerous illustrations, the price of "THE ELECTRICIAN" has from May 3rd been advanced to 6d.

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THE TELEPHONE INQUIRY.

When a Government is in want of a policy, or a minister in want of a cue, it is usually sought for inside one of the Parliamentary Committee rooms. The device is not generally esteemed very dignified, and is often only a roundabout way of shelving the subject altogether. None of these things, however, can be said of the Parliamentary inquiry which has just completed its examination of witnesses in respect of the telephone service and its relations with the State. The report may take probably a considerable time to prepare, if the voluminous evidence is to be impartially weighed and digested; or it may be got ready very quickly if, as might happen, the Committee are unable to offer any definite recommendation except for the publication in full of all the evidence tendered. On the whole, we are in that position ourselves, and we make no apology for offering some comments at this stage of the case, feeling sure that nothing we can say one way or the other will affect the broad conclusions to be drawn from the numberless suggestions and inexhaustible statistics placed at the Committee's disposal.

One of these conclusions certainly is that the public will learn to set a more correct estimate on the value of opinions proffered by self-chosen advocates of particular and novel schemes of telephonic administration. For knocking the bottom out of irrepressible faddists there is nothing so sure as a public inquiry; and it must be said of this one, to its

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credit, that not a few personages who thought themselves authorities have left the Committee room emptied of their reputation, if not of their conceit. It is very easy to collect any number of complaints against the telephone system—or, for that matter, against any human system whatsoever; but when men come forward with schemes of reform they should at least take the trouble to understand something of what they are talking about. Representatives of municipalities, who are greatly to the fore just now, are very much lacking in this respect; and the National Telephone Company's contention that its business would be worked less efficiently by municipal bodies than by private enterprise found no little support in the character of the testimony offered by typical members of the former. Not excepting the "evidence" tendered by that superfine organisation the London County Council, the municipal witnesses were, we must admit, far from showing any special capacity for working the telephone. In point of fact, the major part of the witnesses failed to grasp the true problem to be solved, namely, how to convert an imperfect telephone system into one corresponding with that of the perfected telegraph system which exists in Government hands. None but the official witnesses fully realised this point—the only one indeed worth considering. What the telephone has suffered from hitherto has been, it may be confidently asserted, a species of parochialism, gradually, it is true, developing on a bolder and more national basis, but still hampered and afflicted by the petty and narrow limitations under which its early years were spent. Nobody is particularly answerable for this; railways grew up in a similar way. Telephones were for a good while supposed to be merely elongated speaking tubes, serviceable for purely local purposes. The plans, therefore, were localised; and if they do not fit in very well with the larger requirements which have arisen in these days, nobody can wonder at it. The latest understanding arrived at by the Post Office with the National Telephone Company is a frank admission that competition over the same area is not merely inexpedient but impossible, and the State merely claims the trunk lines as being part and parcel of its main telegraph system. Co-operating in this way it is not unlikely that the Company's administration will go on improving to the level of the one administered by the State; and whether the whole may finally fall into the hands of the Post Office will depend very much on how far this dual arrangement contrives to work harmoniously to the satisfaction of the public. There is no half-way house between State acquisition and State abstention, except possibly that which has been already arrived at.

Of the many "progressive" suggestions which came out into the light in the Committee room, none was more prominent than that of municipal telephones. The supporters of this latest development of municipalisation did not, as we have before remarked, cut a very impressive figure. Against the running of local telephone exchanges by local authorities there is the very obvious argument that where the Government itself has failed to compete successfully with the company which at present holds the field no municipality, however powerful, could possibly succeed. The same considerations which have prevented the State from pursuing a competitive game, namely, the taxpayers' pockets, might be expected to operate in the case of local authorities. There is, however, something to be said in favour of the practicability of municipal telephony. England and Scotland afford many striking examples of what can be done municipally wherever a strong municipal spirit is in existence. When two companies compete in the same town telephone users are moved to cast in their lot with one or the other by purely business motives; the concern which can induce the public to believe that it offers on the whole the better service will win, and the advent of the day of victory will be hastened by the innumerable petty vexations inherent to the rivalry of the two exchanges. But given the existence of a real grievance against the telephone company and an able municipality backed by a powerful municipal spirit, and we should be sorry to risk the dogma of editorial prescience and omniscience by dogmatically predicting disaster. With the magnificent network of trunk wires on its hands, the National Telephone Company was, indeed, in an impregnable position; but to-day the trunk wires are open to all comers and municipal telephony has as good a chance as it is ever likely to have. Whether it is economically expedient or morally right to adventure the ratepayers' money in such a campaign of competition is a big question, which we need not now discuss. All we contend is that municipal telephony cannot be contemptuously dismissed as utterly impracticable, and that one single successful instance of it would in all probability save the necessity of a second.

One of the most useful pieces of evidence furnished to the Committee was that by Mr. STAATS FORBES, the President of the National Telephone Company, giving statistics of users and charges for this and other countries where the telephone is in popular demand. We have never been the apologists of this Company; but we gladly admit that the figures adduced by its able representative before this Parliamentary Committee go far to exculpate the management from many of the accusations which have been freely hurled against it for many years past unchallenged. Compared with those of other countries, its charges are not higher, and its services are not less efficient or popular when the national conditions are fairly taken into account. No importance can be attached to statistics of complaints against this one company, seeing that no corresponding efforts have been made to obtain similar figures from other countries. If a round-robin could be got from all quarters we suspect that a majority could be obtained for voting the telephone an unmitigated nuisance which everybody would wish to see abated, and perhaps even abolished altogether. And this, not because of its defects, but by reason of the demands it makes on the nervous energies of its users. But it is too late to consider their nerves; the only question is the efficiency of the service; and obviously this can best be obtained by a system which is virtually controlled by one administration.

NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(Continued from page 161.)

40. Kennelly's Break Test *(continued).*—In tests to false zero it is important to put the resistance added to the battery circuit between the bridge and key, and to have the earth connection direct on the other side of the key. The polarisation current from the cable when the testing key is released flows partly through the galvanometer and third arm of the bridge to earth, and is partly shunted past the galvanometer through the ratio arms and across the key. By putting the resistance between bridge and key it augments the resistance of the shunt circuit and makes the galvanometer more sensitive to the false zero current; whereas, if put between key and earth, it would be directly in the path of the current through the galvanometer, and thereby reduce the sensitiveness of the latter.

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The following example of a Kennelly break test may be useful:—

Battery used had internal resistance 72 ohms and E.M.F. 40·5 volts.

Ratio of bridge, 100/1,000; therefore $a = 100$ and $\mu = 10$. The resistance to add to battery for a given current in milliamperes to line was found by

$$\left(\frac{\mu}{\mu+1}\right)\frac{1{,}000\ E}{\text{milliamperes}} - \left(b + \frac{\mu a}{\mu+1}\right) - \frac{\mu}{\mu+1}R.$$

In this case:

$$\frac{\mu}{\mu+1} = \frac{10}{11}.$$

$$b = 72$$

$$\frac{\mu a}{\mu+1} = \frac{10}{11} \times 100 = 91$$

$$\frac{\mu}{\mu+1}R = \frac{10}{11}R.$$

The formula is therefore $\dfrac{36{,}818}{\text{milliamperes}} - 163 - \dfrac{10}{11}R.$

Now, as R is the resistance measured on bridge with a given current to line, the value of $\frac{10}{11}$ cannot be known till a preliminary reading is taken, with the approximate added resistance found by the first two terms of the above formula.

For one milliampere the approximate added resistance

$$= 36{,}818 - 163 = 36{,}655 \text{ ohms.}$$

For two milliamperes,

$$\frac{36{,}818}{2} - 163 = 18{,}246 \text{ ohms.}$$

For three milliamperes,

$$\frac{36{,}818}{3} - 163 = 12{,}109 \text{ ohms.}$$

	Ohms.		Ohms.
For 4 milliamperes......	9,041	For 12 milliamperes ...	2,905
„ 5 „	7,204	„ 16 „ ...	2,138
„ 6 „	5,973	„ 20 „ ...	1,679
„ 8 „	4,439	„ 24 „ ...	1,371

Adding the first approximate resistance for one milliampere (36,655 ohms), the balance obtained was 992 ohms (R).

The added resistance was therefore reduced by

$$\frac{10}{11} \text{ of } 992 = 902 \text{ ohms.}$$

Putting 35,753 ohms in, the test was taken again, balance being 990 ohms, which was taken as the correct resistance of cable up to break, plus resistance of break, with 1 milliampere.

For 2 milliamperes the approximate resistance, 18,246, was first reduced by 900 (judged from last test). The balance was then 800 ohms, $\frac{10}{11}$ of which = 727. The resistance, 18,246, was then reduced by 727 ohms, and a balance obtained of 802 ohms, which was the resistance of cable up to break, plus resistance of break, for 2 milliamperes. The same thing was done through all the above currents, except that after a few more readings the value of $\frac{10}{11}$R could be judged sufficiently nearly from the reading immediately preceding. The readings observed were as follows:—

	Ohms.		Ohms.
For 1 milliampere	990·0	For 8 milliamperes ...	625·0
„ 2 „	802·0	„ 12 „	600·0
„ 3 „	729·0	„ 16 „	587·5
„ 4 „	690·0	„ 20 „	582·0
„ 5 „	664·0	„ 24 „	575·0
„ 6 „	649·0		

Six pairs (in which the currents were as 1 : 4) were worked out from these results by the formula given above,

$$B - (A - B) = \text{Distance of break in ohms,}$$

where B and A are the results obtained with currents in the proportion of 4 to 1 respectively.

1st Pair (Currents 1 and 4).

A =	990
Subtract B =	690
Subtract	300
	390

2nd Pair (Currents 2 and 8).

802
625
177
448

3rd Pair (Currents 3 and 12).

729
600
129
471

4th Pair (Currents 4 and 16).

690
587·5
102·5
485

5th Pair (Currents 5 and 20).

664
582
82
500

6th Pair (Currents 6 and 24).

649
575
74
501

Mean of the six results:

	390
	448
	471
	485
	500
	501
	6)2,795
Mean	466 ohms.

The actual distance of the break was afterwards found to be 470 ohms. The mean of the 2nd, 3rd, and 4th pair which gave the closest result was:

	448
	471
	485
	3)1,404
Mean	468 ohms.

It will be seen that the resistance of the break itself varied from 520 ohms with one milliampere to 105 ohms with 24 milliamperes.

The false zero is sometimes taken as half the swing of the galvanometer from instrument zero, the swing being taken immediately on releasing the battery key.

41. Battery E.M.F. by Varley Slides.—The slides being useful for the above tests, it may be desirable to briefly explain their use. By using them the galvanometer is balanced to zero, which is a great consideration on board ship.

The action is best explained by reference to the potentiometer. This is simply a stretched wire A B (Fig. 112) of uniform section and any convenient length, say one yard, throughout the length of which is an accurately divided scale. A current being passed through the wire, say from A to B, we have a certain difference of potential between the ends, which is distributed uniformly per unit length of the wire as shown by the dotted lines. For instance, if A B is divided into a number of equal parts the potential at, say, the point 8 is eight times that at point 1, twice that at point 4, and so on.

Without knowing the current flowing through the wire or its resistance, we can, by means of a standard cell, find the potential at one point on the wire, from which the potential at all other points can be found.

The negative pole of the standard cell is connected to the negative end B of the wire, and the positive pole to a galvanometer and key. If the free end of the wire is now placed in contact with the wire A B and moved along it (the key being closed) a position will be found where no current passes through the galvanometer.

The E.M.F. of the standard cell is then exactly balanced by the opposing potential in the wire, and therefore the potential at this point is equal to that of the standard cell. Supposing

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the balace obtained with the movable wire was at 0·7 on the wire A B, with a standard cell of 1·4 volt; we know then that the potential along A B is

$$\frac{1\cdot4}{\cdot7} = 2 \text{ volts per division.}$$

Now we may replace the standard cell by any battery whose E.M.F. we require to measure. If the point of balance with the battery is at 9, as in Fig. 113, the E.M.F. of that battery is 18 volts, and if at, say, 7·75 the E.M.F. is 15½ volts, and so on.

It is not necessary to know the E.M.F. or resistance of the battery that produces the current in A B. It must, however, have an E.M.F. greater than that of the battery balanced against it.

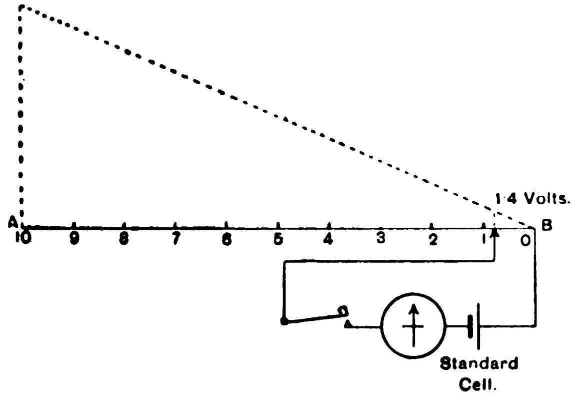

Fig. 112.

For the sake of distinction, let us call the battery which produces the current in the wire the "spare battery," and that whose E.M.F. is being measured, the "test battery" (Fig. 113). The wire potentiometer cannot be used for more than moderate voltages with the high-resistance cells used in cable testing, because the wire would have to be of higher resistance, smaller diameter, and longer length than practicable, in order to get sufficient range of potential.

The resistance is made as high as possible by the use of a wire of platinum alloy of high specific resistance, and in some instruments three, four or more lengths are employed connected in series. The wire must also be of small diameter to bring up the resistance, but it is not possible to carry this very

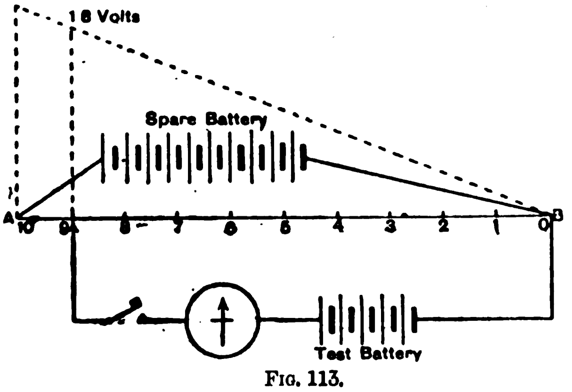

Fig. 113.

far, as the contacts made on the wire in course of time lessen ts diameter in places, and slight inequalities of section have more effect in wires of small diameter. When a high resistance potentiometer is necessary it must be constructed of independent coils of wire connected in series.

But in any such series of coils there is not the fine adjustment that can be got with a wire. On the wire contacts can be made so close together that the point of balance can be obtained exactly, but in a series of coils we cannot get nearer than the difference of potential per coil. On one contact the balance might be out by a deflection to the left, and on the next by a deflection to the right, and there would be no means of getting between. The number of coils might be increased, but it is not practicable to increase their number to any considerable extent, or to sub-divide them into a sufficiently large number of small coils.

Mr. Varley has met this difficulty by the arrangement of resistance coils known as slides. With only 201 coils 10,000 sub-divisions can be obtained.

In order to explain the action of the slides, let us take a simple case of 21 coils, which can be divided in the same way into 100 equal parts.

Let A B (Fig. 114) consist of 11 coils of equal resistance, and C D 10 coils. Let the whole resistance between C and D be equal to that of two coils on A B. Let there be two contact pointers E and F connected to the ends of C D, rigidly connected together, but insulated from each other. These can be moved along A B so as to enclose any pair of coils. It is evident that between the pointers E and F the resistance to any current flowing between A and B is equal to one only of the coils on A B, since the two coils between the pointers are shunted by an equal resistance.

The potentials produced by the spare battery connected to A B are shown by the dotted lines. Between E and F there is the same fall of potential as on any single coil on A B outside the pointers, and the fall of potential at the ends of any pair of coils on A B between the pointers E F is subdivided into 10 parts along C D. And since the resistance

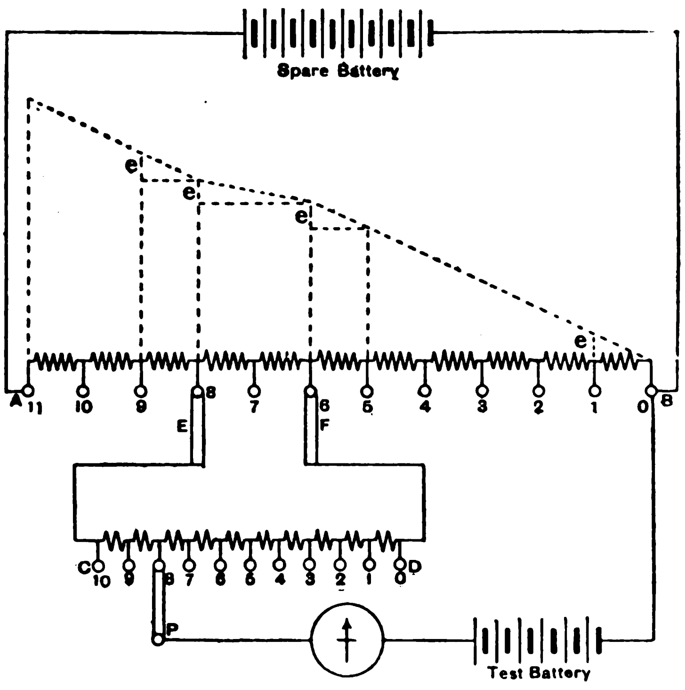

Fig. 114.

between the pointers in any position is equal to that of one coil on A B, and the pointers can be moved anywhere on A B, it follows that we have the same thing as if each coil was divided into 10 parts, giving a total number of 100 divisions.

Suppose a test battery connected up as shown in Fig. 114 to this small set of coils, and that no current passes through the galvanometer when the pointers are in the postions shown, namely, F at 6 and P at 8. The E.M.F. of this battery will then be 68 times the difference of potential per division.

By substituting a standard cell in place of the test battery, we have, say, F at 0 and P at 7 when no current passes through the galvanometer.

If the E.M.F. of the standard cell is 1·4 volts, we have then

$$\frac{1\cdot4}{7} = 0\cdot2 \text{ volt per division,}$$

and the E.M.F. of the battery tested is

$$68 \times 0\cdot2 = 13\cdot6 \text{ volts.}$$

The small resistance C D acts as a vernier to the large resistance A B, and as the vernier can be moved to all parts of A B it practically divides each coil on A B into 10 equal parts, making 10 × 10 = 100 divisions of the entire resistance.

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In Varley's slides there are 100 coils in C D and 101 in A B, the extra coil being, as before, to make up for the shunted pair of coils, which are equal in resistance to one.

It is possible, therefore, in the slides to divide the potential into $100 \times 100 = 10,000$ equal parts. The resistance of the coils on A B is 1,000 ohms each, making 100,000 ohms for the whole.

The vernier set of coils C D consists of 100 coils of 20 ohms each, making 2,000 ohms, equal to two coils on A B.

There are two ways of measuring the E.M.F. of a battery by the slides as follows:—

(1) By connecting an independent spare battery to the slides, and balancing with standard cell; then putting the battery, whose E.M.F. is to be measured, in the place of the standard cell, balancing again and comparing the two readings on the slides. The connections are as in Fig. 115.

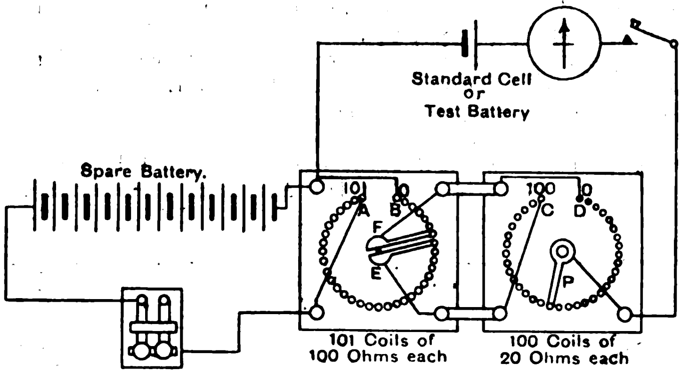

Fig. 115.—Slides.

The fall of potential over the resistance of the slides, produced by the independent battery is shown in Fig. 116. The E.M.F. of this battery must be greater than that of the battery to be tested.

One balance is obtained with the standard cell connected as shown in the figure; then the cell is removed, and the battery to be tested connected up in its place, and a second balance obtained on the slides. The double pointers are moved first to the nearest position to balance, and then the single pointer to get the balance exactly. Balance is obtained when both battery circuits are closed by the keys and the galvanometer remains at zero.

In reading the slides the following should be observed:—

Read first from the double pointer, taking the figure from the pointer nearest zero. Multiply this by 100 and add the reading on the single pointer.

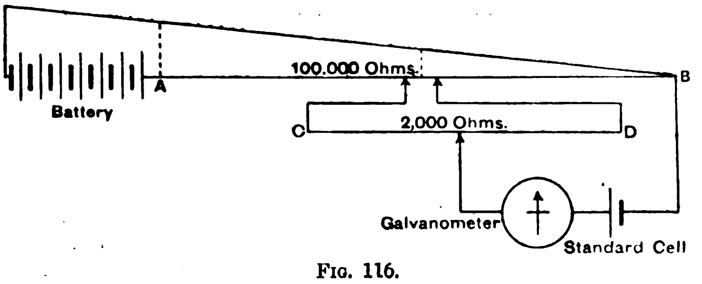

Fig. 116.

For example, say the standard cell is balanced when the pointer nearest zero (of the double pointer) is at 2 and the single pointer is at 74. Also that they are respectively at 87 and 8 when the battery is balanced in place of the standard cell. The readings are then respectively 274 and 8,708, and if the standard cell is 1·4 volts the E.M.F. of the battery is

$$1{\cdot}4 \times \frac{8708}{274} = 44{\cdot}5 \text{ volts.}$$

This method is absolutely accurate, but it requires an independent or spare battery on the slides, which may not always be available.

(2) The second method is without an independent or "spare" battery. In its place is put the battery whose E.M.F. is to be tested, that is direct on the slides, between terminals 0 and 101 on the large coils A B. The connections are otherwise the same, and one balance only is required, namely, with the standard cell connected, as in Fig. 115.

Suppose the reading with the standard cell balanced to be 315. Then the E.M.F. of the battery is

$$1{\cdot}4 \times \frac{10,000}{315} = 44{\cdot}5 \text{ volts.}$$

This result is really the difference of potential at the battery terminals, but, owing to the high resistance of the slides (100,000 ohms), only differs from the actual E.M.F. by an inappreciable amount. Strictly, the above result should be increased by the fraction

$$\frac{\text{battery resistance}}{100,000}$$

of the whole to give the E.M.F.

For example, with a battery of 100 ohms the amount to add would be

$$\frac{100}{100,000} \times 44{\cdot}5 = {\cdot}0445 \text{ volt,}$$

which would make the E.M.F. only 44·54 instead of 44·50, or an error of only $\frac{1}{10}$th of 1 per cent. Even with a battery of as high a resistance as 500 ohms the error is only 0·22 volt or an error of $\frac{1}{2}$ of 1 per cent.

The above correction can, however, be applied when the resistance of the battery has been measured; but it will be seen that in most cases it is inappreciable and certainly negligible when the battery resistance does not exceed 100 ohms.

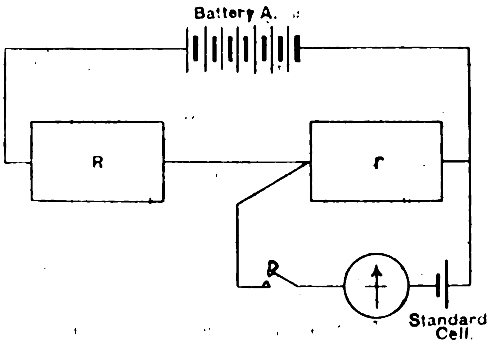

Fig. 117.

If slides or potentiometer are not available, the same test can be made by the aid of two resistances, one a fixed high resistance (R) and the other an adjustable resistance (r), connected up as in Fig. 117, where battery A is to be measured for E.M.F.

The amount of resistance required in the adjustable box (r) depends upon the amount of high resistance employed in R and the E.M.F. of the battery A. It is desirable to have some idea beforehand what approximate amount of adjustable resistance will be required to balance. This can be found by the relation

$$r = \frac{R}{\frac{E}{e} - 1},$$

where E is the approximate E.M.F. of the battery, e that of the standard cell, and R the fixed high resistance. Making R 100,000 ohms, we find that, with a standard cell of 1·43 volt and a battery of approximately 50 volts, we must provide for a range of

$$\frac{100,000}{\frac{50}{1{\cdot}43} - 1} = 2940 \text{ ohms,}$$

or not less than 3,000 ohms. If the fixed high resistance is made larger than 100,000, the range of adjustable resistance will have to be increased in about the same proportion. It would not therefore be convenient, with about 50 volts to measure, to make the high resistance more than about one-third of a megohm, in order to keep the adjustable resistance within the range of the ordinary 10,000-ohm resistance box. With higher volts however the fixed resistance could be made

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greater while keeping within the range of the ordinary adjustable box.

The connections having been made as in the figure, the small resistance (r) is adjusted until there is no deflection on the galvanometer when the key is closed. The E.M.F. of the battery is then equal to

$$e\left(\frac{R}{r}+1\right) \text{ volts,}$$

where e is the E.M.F. of the standard cell. For example, say, with a standard cell of 1·43 volts, balance is obtained with 2,380 ohms in the adjustable box, the fixed resistance being 100,000 ohms. Then E.M.F. of battery is

$$1{\cdot}43\left(\frac{100{,}000}{2{,}380}+1\right)=61{\cdot}5 \text{ volts.}$$

This is identically the same as the second method given for the slides, but using resistance boxes instead of slides. The same remarks as to percentage error therefore apply, and the result to be strictly correct should be increased by the fraction $\frac{b}{R+r}$ of the whole, where b is the battery resistance.

Thus in the last example, if the battery resistance was 200 ohms, the result to be strictly accurate would have to be increased by

$$\frac{200}{102{,}380}\times 61{\cdot}5=0{\cdot}12 \text{ volt,}$$

making the E.M.F. = 61·62 instead of 61·5. The lower the battery resistance the less this correction becomes, and generally it is small enough to be neglected.

The tests for E.M.F. described are null methods, allowing of great accuracy and convenience of observation, and are readily carried out on board ship. The test by comparison of deflections through a high resistance is not so convenient on board ship nor capable of such accuracy.

The method of comparison by discharge throws is open to objection when one condenser is used for both discharges; but the throws may be made more nearly equal by using a condenser of larger capacity for the standard cell, thus increasing its throw. The E.M.F.'s are then directly proportional to the throws and inversely proportional to the capacities. This method is not a reliable one for board ship, chiefly on account of the marine galvanometer suspension being quite unsuited for reading momentary swings. Neither can the throws be read with any accuracy on a suitably suspended galvanometer with slow swing on account of the motion of the ship.

(To be continued.)

LABORATORY OF THE ELECTRICAL INSPECTOR TO THE CITY COMMISSIONERS OF SEWERS.

We publish this week a brief description of the temporary premises occupied by Mr. A. A. Voysey, the electrical inspector to the City Commission of Sewers. This laboratory is one of the first of its kind, and before proceeding to give a catalogue of its contents, it may be of interest to summarise the duties which have been placed upon the shoulders of the electrical inspector under the Electric Lighting Orders relating to the City of London. The local authority is empowered by the Orders to appoint one or more electrical inspectors, and had they failed to do so the Board of Trade would have taken the matter in hand. The duties of the electric inspector are: (*a*) the periodic inspection and testing of all the "undertakers'" electric lines and works; (*b*) the certifying and examination of meters; (*c*) such other duties in relation to the undertaking as may be required under the provisions of the Order. The fees to be taken by the inspector, the manner in which they are to be disposed, and the way in which he is to go about his work, are all prescribed by the local authority and approved of by the Board of Trade. In regard to the testing of mains the inspector has to give reasonable notice beforehand to the company concerned, and except in special cases he is not entitled to have access to the mains at any points other than those at which the company has access itself to the mains. No given section of the network may be tested more than once in three months, except in cases of emergency. In addition to the testing of mains, the electric inspector, when required to do so by a consumer, has to test "the variation of electric pressure at the consumer's terminals" and make such other tests of the apparatus on the consumer's premises as may be necessary for determining whether the company are doing their duty. The electric inspector has also to see that the testing stations, which have to be established by the electric lighting undertakers, are kept in proper order, and to examine and record the readings of the instruments set up in them. Another function of the electric inspector is the certifying of meters and the testing of the same upon consumers' premises. It will thus be seen that the electric inspector has important and multifarious functions to perform, and in the performance of them he must require no little tact and vigilance, unless he is to prove on the one hand a very thorn in the side of the company, or on the other hand a negligent guardian of the public safety and convenience.

Pending the completion of the new offices of the Commission of Sewers, Mr. Voysey has to make shift in temporary accommodation in a well-lighted room 29ft. by 23ft. in the basement of the Wool Exchange, Basinghall-street. Meter

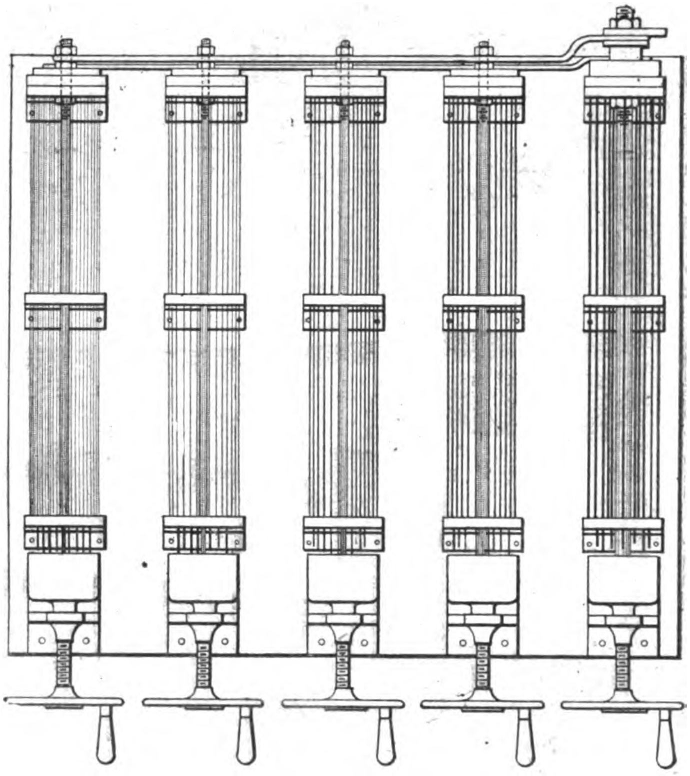

FIG. 2.—Ferranti Regulating Resistance.

testing is expected to be the chief business of the laboratory, and to that end the following arrangements have been made. Alternating current at 100 ∿ is supplied from the City of London Company's mains at 200 volts to the primary of a special 10-unit Ferranti transformer. This transformer has three secondary windings, one wound to give 100 volts and 2 amperes, another to give from 90 to 110 volts by 2-volt steps and 2 amperes, the third to give from 2 to 20 volts by by 2-volt steps and 500 amperes. The 100 and 110-volt coils are intended to supply the shunt coils of meters, and are joined in series. A 13-way commutator is provided by which the pressure of the supply to what we may call the shunt circuit can be varied from 90 volts to 110 volts by steps of 2 volts, or from 190 volts to 210 volts by similar steps. The third secondary supplies current at low pressure to a separate circuit, in which may be connected electrical quantity meters or the series coils of energy meters. A commutator which will carry the full current of 500 amperes is used, by which the pressure may be varied as required from 2 to 20 volts. The current passes from the commutator through fuses and a double-pole switch

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to a copper strip extending round two sides of the room. A polished teak board, 4½in. by 1½in., supported by iron bolts fixed in the wall, carries the 1½in. by ⅓in. copper strip, the lead being screwed on the back of the teak and the return on the front. Slate shelves on solid wood corbels, placed 2ft. 6in. below the copper strip and 3ft. from the floor, carry the measuring instruments, which consist of four Kelvin balances (deci-, deka-, and hekto-ampere) and a watt balance reading up to 20 kilowatts. Two Kelvin electrostatic voltmeters are provided for the purpose of measuring pressure. A view of the voltmeters and two of the balances is given in Fig. 1. Above each balance the copper strip is cut, and the instrument connected across the break, those not in use being short-circuited by means of a copper bar and winged nut terminals. Similar breaks are provided for the insertion of meters in the circuit.

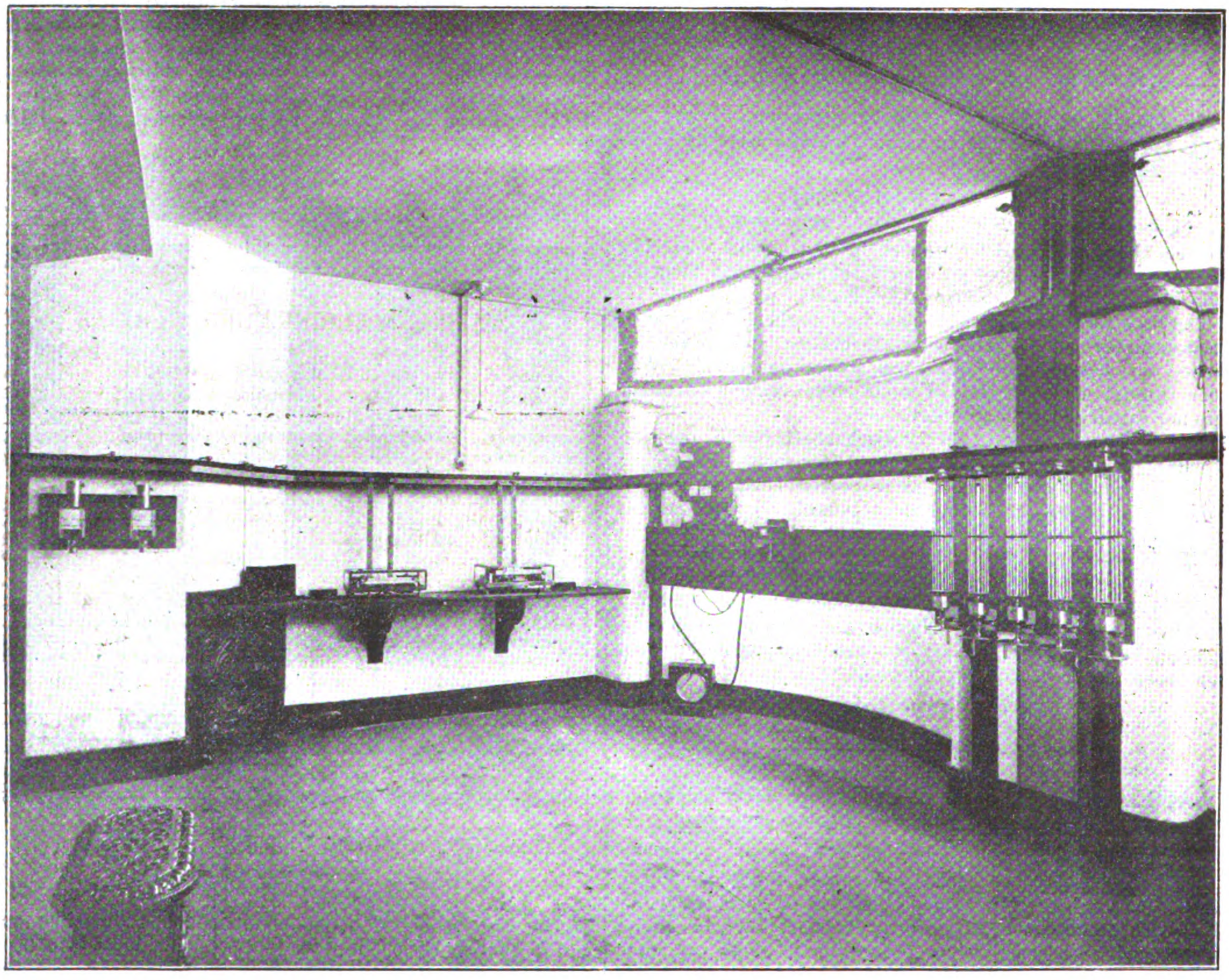

FIG. 1.—Laboratory of the Electrical Inspector to the City Commissioners of Sewers.

The current supplied to the meter circuit passes through a Ferranti non-inductive resistance, by which it can be regulated by tenths of an ampere up to 500 amperes. This regulating resistance (Fig. 2) is a particularly neat and compact piece of apparatus, and is similar in principle to that made by the same firm for the purpose of meter testing at Portsmouth. Five vertical copper rods connected together at the top by a copper bar are surrounded concentrically by German silver wires of different lengths, which are also connected together at the top, but insulated from the copper bars. Below each set of wires is a mercury cup, which can be raised or lowered by a hand-wheel actuating a screw. As the cup is screwed up the ends of the German silver wires dip successively into the mercury, which puts them in parallel and connects them in series with the copper bar, which carries the current down into the mercury cup. The first set of resistances consists of 10 wires, each carrying one-tenth of an ampere, or a total of 1 ampere; the second consists of 9 wires, each carrying 1 ampere, or a total of 9 amperes; the third of 7 wires, each carrying 10 amperes, or a total of 70 amperes; the fourth of 7 wires, each carrying 20 amperes, or a total of 140 amperes; and the fifth of 7 wires, each carrying 50 amperes, or a total of 350 amperes. Therefore, when the five cups are all in their highest position, the resistance will carry 570 amperes. It would be quite easy, if required, to provide the observer at any one of the balances with a means of regulating the resistance, by cords passing from the handwheels on the mercury cups round the room.

For the purposes of measuring conductor and insulation resistances, comparing capacities and potential differences, a Kelvin reflecting galvanometer and testing table is provided The galvanometer has separate high and low-resistance coils, and is placed with a Jacob transparent scale and stand on brackets let into a solid brick pillar. This pillar is part of the building, but looks as if it had been specially designed to carry a galvanometer. Opposite it is the testing table, with a sloping top of polished teak, on which are fixed a 4-dial pattern Wheatstone bridge, a standard ¼ megohm, a 0·3 microfarad standard condenser, and two Carhart Clark standard cells with galvanometer shunts, reversing keys, short-circuit plugs and all the usual testing-room paraphernalia. The connections are so arranged that the alteration in the position of two plugs effects the change from the Wheatstone-bridge connections to the connections for the direct deflection test for insulation or

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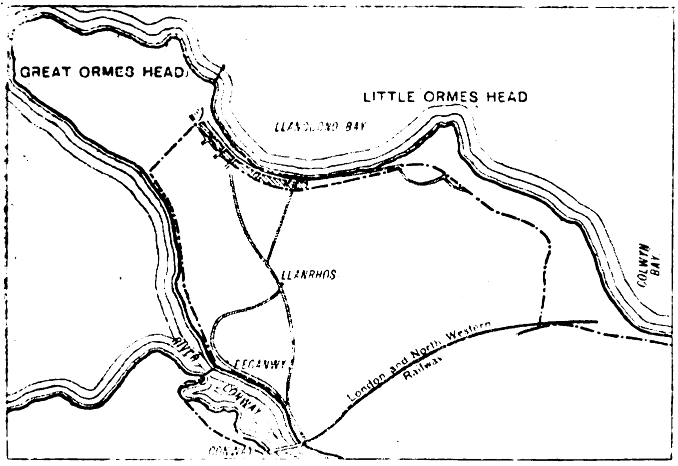
capacity. On a shelf below are 100 dry cells. The table and instruments have been supplied by Messrs. Nalder Bros., and fitted up under Mr. Voysey's direction. A standard barometer and thermometer, and the invaluable Fuller's circular rule, complete the present equipment of the laboratory.

COLWYN BAY-CONWAY ELECTRIC TRAMWAY.

The accompanying sketch map shows the route of an electric tramway which it is proposed to run from Colwyn Bay through Llandudno to Conway across the river, a distance of about 10 miles. The scheme is at present in the initial stage. The promoters have obtained the consent of the Colwyn Bay and Conway authorities, but so far have been unable to obtain the Llandudno consent. The matter was referred by the District Council to the Llandudno ratepayers, the poll resulting in an adverse majority, due principally to the strong cab interest. The promoters have taken counsel's opinion on the subject, and find that the objection of the Llandudno District Council is comparatively unimportant owing to the fact that the consents of the authorities controlling two-thirds of the route have been



Llandudno Electric Tramway.
Sketch Map showing Proposed Route. Proposed Line of Tramway shown thus —·—·—·—

obtained, and they therefore propose to proceed with the necessary plans and to apply for a Provisional Order. Nothing has as yet been decided upon as to system, but in all probability the system will be that employed on the South Staffordshire line. It will be noticed that the river Conway is crossed by the line, and to do this it is proposed either to erect a swing bridge or else to convey the tram in an electrically propelled ferry. The joint engineers are Mr. Alfred Dickenson and Mr. S. V. Clirehugh.

RECENT ADVANCES IN ELECTRO-CHEMISTRY.

In the May number of the *Journal* of the Franklin Institute will be found an interesting Paper by Mr. J. W. Richards on "Recent Advances in Electro-Chemistry," which summarises very thoroughly the various applications of this branch of science to arts and manufactures at the present time. The author points out that "to be qualified as an electro-chemist, the scientist must, first of all, be a chemist, knowing all that is implied by that term; and in addition to this, he must also be well-informed in applied and theoretical electricity"; and that to meet the demands for men with these qualifications, chairs of electro-chemistry have been established by the German universities, while in the United States, the John Hopkins University is considering the advisability of following their example. When, we wonder, will the matter be taken up in this country?

After a list of the principal societies and journals devoted to the subject follows a *résumé* of the principal applications of electro-chemistry, of which only a few can be referred to here. Though it does not appear that there is much hope that the problem of obtaining electrical energy directly from the combustion of carbon will be solved in the near future, still it is very satisfactory to learn in how many chemical industries electrical methods are supplanting those in former use. The bleaching processes, and those for the manufacture of caustic soda, are well known, but the employment of electricity for the refinement of sugar is less familiar, and it is interesting to learn that 1 E.H.P. will suffice to refine daily the syrup from 100 tons of beetroot, and that the process is in successful use in several German factories. In the manufacture of chloroform, too, the electrical method is found to be so cheap that it is superseding all others; while in the case of aniline dyes, the use of the electric current is extensive. In the manufacture of safety matches about 2,000 tons of potassium chlorate are used annually, nearly the whole of which is produced electrolytically. In the Jura Mountains there is a plant of 2,000 H.P. turning out 600 tons annually; and there is another in Dalecarlia of 6,500 H.P. But perhaps the most interesting product of the electric furnace is the calcium carbide, which has attracted so much attention of late. This was obtained by Mr. T. W. Willson, of North Carolina, in the course of experiments undertaken with the view of producing alloys of calcium and aluminium. This substance, which had been previously produced by Wöhler and others by chemical means, has, as is well known, the curious property of yielding calcium hydrate and acetylene gas on the addition of water. Acetylene has the highest illuminating power of any known hydrocarbon, and in a Paper recently read before the Society of Arts, Prof. Vivian B. Lewes made some rather sensational references to its future possibilities. An acetylene flame consuming 5 cubic ft. of gas per hour gives a light of 240 c.p.; and 1 ton of calcic carbide, yielding 11,000 cubic ft. of gas, can be made for £4. Other, and even more important uses for this gas may be found in the field of technical chemistry. For example, by passing electric sparks through a mixture of acetylene and nitrogen, hydrocyanic acid is formed, from which cyanides can be made.

AN AMERICAN ENGINEERING "UNIVERSITY."*

Purdue University at La Fayette, Ind., is the engineering school of the State, and owes its existence and support to gifts, State appropriation, and the Morrill bills, from which most of the State universities of the United States receive a considerable portion of their income. The University was established about 20 years ago. Its growth was not rapid until within the past 10 years, during which time, under the able management of President J. H. Smart, it has rapidly developed, until it stands among the leading technical colleges of the United States.

In the organisation of the University there are five distinct schools; those of civil, mechanical and electrical engineering, of science, and of agriculture; each provided with well appointed laboratories and separate faculties, but all available for the students of any one course, so far as the work of the other courses will be of advantage to the particular course considered. As this description has to do with the purely electrical work of the University, it will be confined to work done in the electrical building, a large brick structure with stone trimmings, which is given up to the uses of the department. The department of electrical engineering was established during the academic year of 1888-89 under the direction of Dr. Louis Bell, and, from a beginning with three students in that year, the department has grown until the present time, when the enrolment in electrical engineering is over 200.

The course in electrical engineering is, throughout the freshman years, almost identical with that in civil and mechanical engineering and the students have the benefit of the thoroughly appointed courses in shop work, drawing and machine design provided in the school of mechanical engineering. In the junior year, the courses begin to diverge and the work is arranged so as to include instruction in the finely-equipped mechanical laboratory, and other class and lecture work of the schools of civil and mechanical engineering, and, at the same time, make preparation for the senior work by providing instruction in the electrical laboratory, and class and lecture work on elementary electrical subjects, throughout the year. In the senior year, work in the mechanical laboratory is continued, but most of the time is spent in electrical engineering, which is arranged so as to give prominence to four distinct lines of study, as follows:–

1. Experimental work in the electrical laboratory, involving the operation, testing and construction of the usual electrical machines and apparatus met with in practice; the study of direct currents incandescent, arc and power systems; of alternators, transformer, and multiphase machines; of methods of exact electrical measurement, and often the testing or installing of commercial systems under the conditions of actual engineering practice.

2. Lectures throughout the year on the general practice of electrical engineering, including the design, commercial operation and maintenance of electrical apparatus and machinery.

* Abstract from the *Electrical World* of New York.

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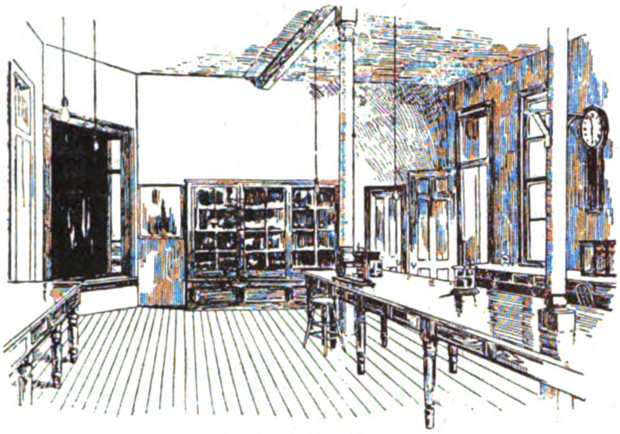
3. Work in the drawing room in the actual calculation and design of electromagnetic mechanisms, dynamos, alternators, transformers, electrical systems of power distribution and other special applications of electricity.

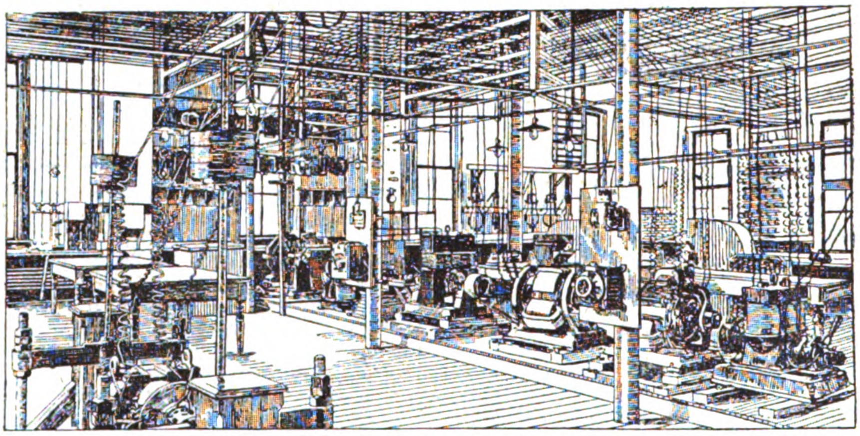


Junior Laboratory.

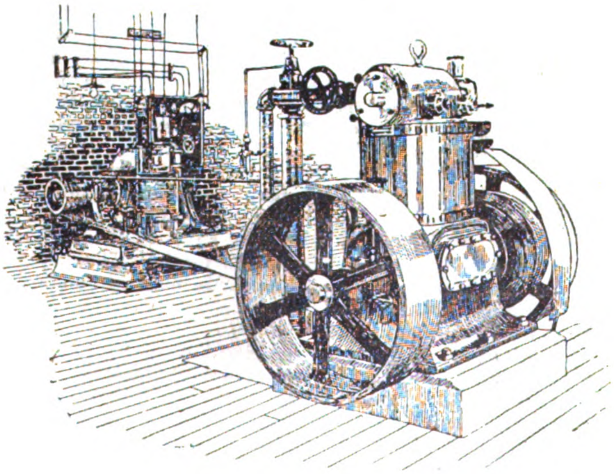
4. Lectures and recitations on the mathematical theory of electricity and magnetism.

In addition to the above, the preparation of a well-developed thesis and a trip of inspection to various electrical centres of industry is considered a part of the year's work.

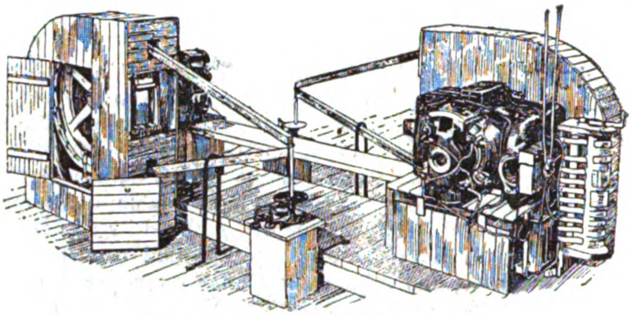
From the general view of the dynamo laboratory, it will be seen that all the larger machines are mounted on two heavy foundations extending the entire length of the room, and run from a jack shaft below the floor, each machine being provided with a friction clutch operated from the centre of the room. The jack shaft is driven by a motor with differential winding for constant speed and taking current from a 500-volt generator driven by an engine in the mechanical laboratory. This motor is provided with a tachometer and ammeter, so that the exact condition of working of the entire laboratory can be readily ascertained. This method of driving the laboratory has, for the year that it has been in operation, proved itself to be exceptionally convenient and makes possible much work that could not otherwise be performed. The aggregate power of the machines, dynamos and motors connected with the work of this room is over 200 H.P.



General View of Dynamo Laboratory.

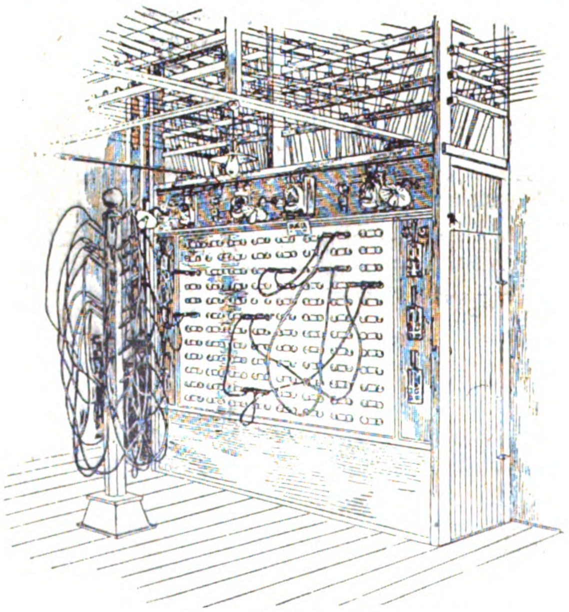


500-volt Generator and Engine.



Mounting of Street Railway Motors.

A set of German silver resistance coils are so arranged that any required resistance from 0·08 to 1,250 ohms can be readily obtained, and of sufficient capacity so that dynamo currents may be carried as high as 500 amperes for the lower resistances. For higher resistances a lamp board on which each lamp is provided with separate terminals gives a range in available resistance, for dynamo work, of any value from 1 to 40,000 ohms.



General Switchboard.

For alternate current working, there are alternators and multiphase machines and transformers of nearly every make.

There are five street railway motors of different types, two of which are shown mounted for regular class work in the laboratory,

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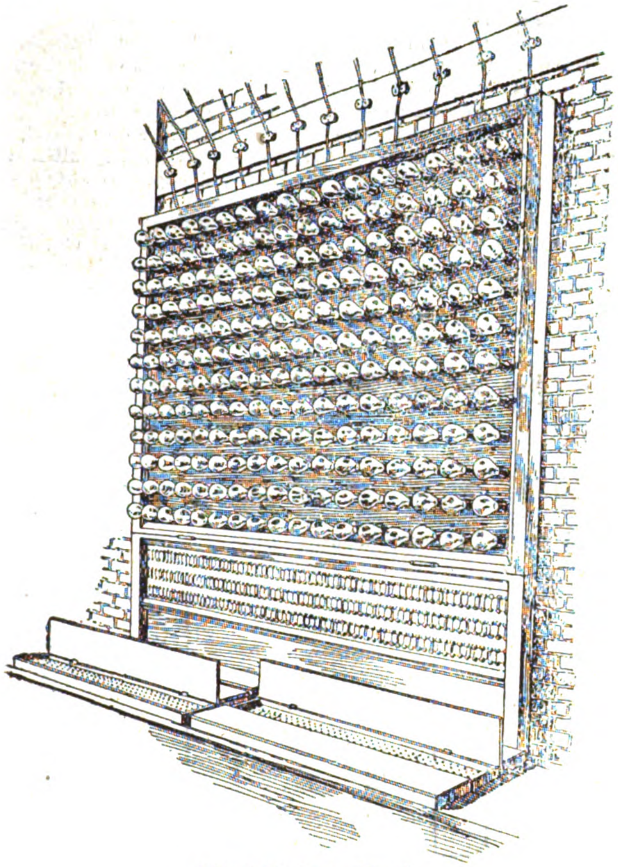
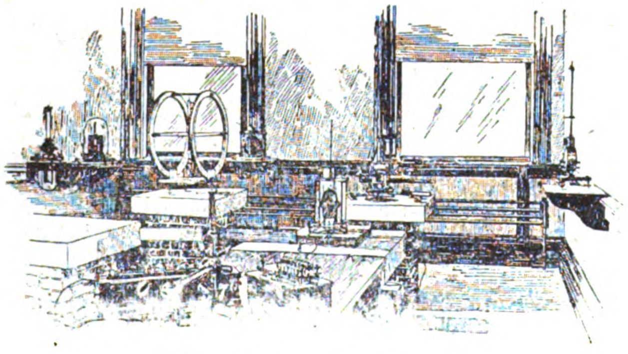
and on which a considerable amount of interesting data has been obtained.

All dynamos, motors, instruments, or other pieces of apparatus throughout the building can be connected to the general switch-board in the dynamo room, so that it is possible to secure at that point any combination of machinery, instruments and apparatus that may be desired for any piece of experimental work undertaken.



Adjustable Lamp Board.

The instruments include Kelvin electrostatic electrometers and voltmeters, Ayrton and Edelmann quadrant electrometers, 12 voltmeters of Weston and other types with multiplying coils, potential galvanometers, and other instruments. For current measurement are included two Kelvin balances, ten ammeters of Weston and



Pier Room No. 4.

other types, four Siemens electro-dynamometers, and a number of tangent, sine, Weidemann, Kelvin, D'Arsonval, Rosenthal and other galvanometers. There are also the following pieces of apparatus of importance: a Kew unifilar magnetometer, an Anthony standard resistance box, a standard subdivided microfarad condenser, an Ayrton secohmmeter and standard of self-induction, standard cells and other apparatus of less importance. The department offers a line of graduate work leading to the degree of mechanical engineer.

American Institute of Electrical Engineers.—Dr. Louis Duncan has been elected president of the Ame ican Institute of Electrical Engineers for the ensuing year.

ELECTRIC DISCHARGE THROUGH GASES.*

BY PROF. J. J. THOMSON, F.R.S.

One of the most important and interesting branches of physical science is that which deals with the connection between electrical and chemical effects. The investigations on electrolysis made within these walls by Davy and Faraday proved that the important class of electrical phenomena associated with the passage of electricity through liquids, are connected in the closest way with chemical action. They proved that no electricity will pass through most liquids unless chemical action occurs, and that for each unit of electricity which passes through the liquid there is a definite amount of chemical decomposition. This case, though it is one where the laws are most accurately known, is but one among many electrical phenomena which are inseparable from chemical action. So many instances of this kind have been discovered that we may perhaps venture to hope that we are not far from the time when it will be universally recognised that many of the most fundamental questions in chemistry and electricity are but different aspects of one and the same phenomenon. Anything which throws light on the connection between electricity and matter, interesting as it is on its own account, acquires additional interest when regarded as elucidating the connection between chemical and electrical effects, and no phenomena seem more suitable for this purpose than those which are the subject of the discourse this evening—the discharge of electricity through gases. For in gases we have matter in the state in which its properties have been most carefully studied, while the investigation of the electrical effects is facilitated by the visibility of the discharge, affording us ocular, and not merely circumstantial, evidence of what is taking place. The points to which I wish to refer particularly this evening are, firstly, some phenomena connected with the passage of electricity from the gas to the electrode, or from the electrode to the gas; and, secondly, some of the properties of the discharge when its course lies entirely in the gas.

By taking a long discharge tube, say, one 50ft. long, and observing the luminous discharge through a rotating mirror, we can trace the course of the luminosity due to a single discharge, say, one due to once breaking the primary circuit of an induction coil; if we do so, we find that the luminosity follows the direction of the positive current through the tube. That is, the luminosity begins at the positive electrode; it then rushes down the tube with enormous velocity; but when it gets to the negative electrode, it receives a check; it does not disappear at once in that electrode like a rabbit going down a hole; but lingers around the electrode some time before entering it. In consequence of this delay in the positive discharge in getting out of the gas, there is an accumulation of positive electricity in the neighbourhood of the negative electrode until the potential fall at this electrode increases to about 200 or 300 volts. The positive electricity which accompanies the discharge thus finds considerable difficulty in getting from the gas to the metal, though, as I hope to show you later on, as long as it keeps in the gas, it meets with what we may, in consideration of the views sometimes enunciated on this subject, call a ridiculously small amount of resistance, its real difficulty is to get out of the gas.

Though this effect has long been known, it is so important that I will venture to show one or two experiments which illustrate it. The arrangement of the first experiment is shown on the screen (*see* Fig. 1), the apparatus consists of a main discharge tube, across which is fastened a diaphragm made of excessively thin platinum leaf; there is a side passage from the tube, leading from one side of the diaphragm to the other, this is connected to a barometer tube, and by raising the cistern containing the mercury I can stop up the passage by a pellet of mercury. We will first observe the discharge when the side passage is open; you see that the discharge, instead of passing across the thin piece of platinum leaf, takes the very much longer route round the side tube, so as to avoid crossing the metal. We will now raise the mercury cistern and close the side tube by a pellet of mercury; the discharge now has no alternative but to cross the metal at some part of its course, and you see that the main portion of the discharge goes back into the main tube. In another experiment the metal diaphragm is replaced by a very thin plate of mica; when the side passage is opened the discharge goes round, but when this is closed by a pellet of mercury the discharge prefers to go across the mica than through the mercury.

A second experiment, which shows the same thing, is the following: Two long electrodes are fused into a bulb (Fig. 2), so that the tip of an electrode is a considerable distance from the place where it passes through the glass. We will now send an alternating discharge through the tube, and you will see, I think, that the discharge, instead of going straight across the short distance between the ends of the electrodes, goes from the tip of one electrode to the place where the other passes through the glass,

* Friday evening discourse delivered before the Royal Institution.

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thus staying as long as possible in the gas before passing into the metal. The appearance of the discharge shows that the positive electrode is at the end of the wire, the negative at the junction of the wire with the glass.

Another interesting example of the difficulty the discharge experiences in passing from gas to metal is the discovery made by Profs. Liveing and Dewar, that when the discharge passes through a gas containing a large quantity of metallic dust, the light from the discharge, when examined in the spectroscope, does not show any of the lines of the metal.

The difficulty which the positive electricity finds in passing from the gas to the electrode depends a great deal upon the nature of the gas, as well as upon that of the electrode; it is influenced by the position of the gas and the electrode relatively to one another in the electro-chemical series.

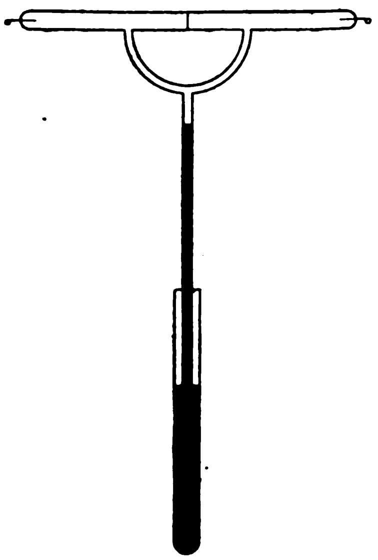

Fig. 1.

I have lately made a series of experiments on this point in the following way. An alternating discharge from a high-tension transformer was made to pass between two electrodes fused into a bulb, which could be filled with the gases under examination. Another electrode, connected to an electrometer, passed into the bulb, and was arranged so that it could be moved about from one part of it to the other. When the electrodes were metal and the bulb was filled with the electro-negative gas oxygen, the electrode received a positive charge in whatever part of the bulb it was situated; if now the bulb was filled with hydrogen at atmospheric pressure, then in the regions remote from the arc the electrode received a positive charge, but in the immediate neighbourhood of the arc itself it received a negative charge. When the pressure was

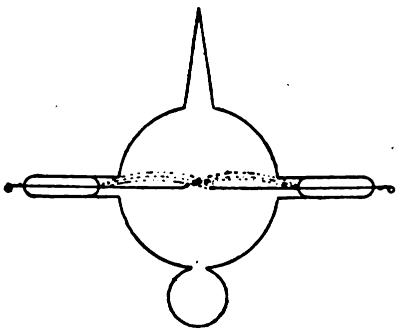

Fig. 2.

reduced, the region in which the charge was negative contracted, and finally, at pressures about one-third of an atmosphere, seemed to disappear, and the electrode got a slight positive charge in whatever position it was placed. If now, instead of using metallic electrodes, we use well-oxidised copper ones, and repeat the experiment in hydrogen, working at a pressure when there was only positive electricity when the electrodes were bright and polished, we find that with the oxidised electrodes every particle of positive electricity is taken out of the tube, and a negative charge is left. This negative charge remains until the copper oxide is completely reduced; when this occurs, the negative charge disappears, and is replaced by positive. Thus, under the same conditions as to the nature of the gas and the pressure, the bright copper electrodes leave a positive charge in the gas, while the oxidised ones leave a negative charge.

The most probable explanation of these results seems to me to be the view that the communication of electricity from gas to the electrode, or from the electrode to gas, is facilitated by the temporary formation of something of the nature of a chemical compound between the gas and the metal. In all such compounds the metal is the electro-positive element, and has the positive charge, the gas being the electro-negative, and carrying the negative charge. Now consider the case when the negative charge is on the gas, and the positive charge on the metal; then the gas and metal have got the charges proper to them in any compound they may form, and are thus in a fit state to combine, or, according to this view, allow the negative electricity to pass from the gas to the copper. But, now, suppose the gas was positively electrified, the gas and the metal have now opposite charges to those proper to them in a compound, and before the union of gas and metal in this state could result in anything but a most unstable compound, an additional process must be gone through, *i.e.*, the charges on the gas and metal must be interchanged. Thus, the conditions for the combination of the gas and metal are more complex when the gas is positively electrified than when it is negatively electrified, and thus, on the view that the communication of electricity between the gas and the metal involves a sort of chemical combination, we see that the negative electricity will escape more easily from the gas to the metal than the positive. Now consider the case when the gas was hydrogen, the electrodes oxidised copper; the hydrogen combines now not with the metal, but with the oxygen, forming water, in which hydrogen is the electro-positive element; thus, in this case, it is the positively charged hydrogen which is in the state best fitted for pairing. The consequence is the positive charge would be most readily removed from the gas and the negative leit—exactly the opposite to that which occurred when the electrodes were bright. This reversal, as I stated before, is verified by experiment.

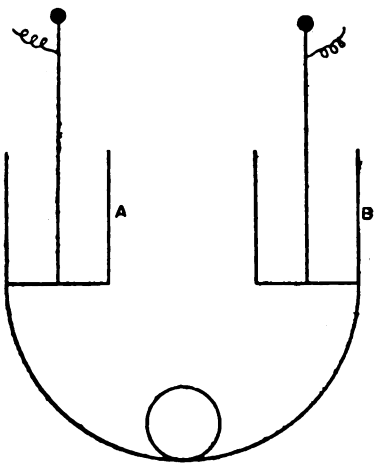

Fig. 3.

I have hitherto only spoken of the phenomena which accompany the passage of electricity from the electrode to the gas, or from the gas to the electrode. I shall now pass on to consider the properties of the discharge when it is entirely confined to the gas. We may produce a discharge which, during the whole of its course, shall be confined to the gas in the way represented in the diagram (Fig. 3). The two poles of a Wimshurst machine are connected to the insides of two jars A and B, while the outsides of these jars are connected together by a metal wire wound so as to form a coil. The electricity from the Wimshurst machine charges up the jars, the difference of potential between the poles increases until a spark passes. The passage of the spark puts the insides of the two jars in connection, and the jars are discharged. The discharge of the jar, as was proved from the theory of electro-magnet action by Lord Kelvin more than 40 years ago, and shortly afterwards confirmed by the experiments of Feddersen, is an oscillatory one, producing currents surging backwards and forwards through the wires with extraordinary rapidity. The subject of these oscillatory currents is one which in this year is tinged with melancholy. The year had hardly commenced when we lost Hertz, whose splendid work on these electrical oscillations is known to you all. The Managers of this Institution have marked their sense of the importance of this work by devoting a special lecture this session to this work alone, and they have entrusted that lecture to a most distinguished worker in the same field as Hertz. It would therefore be presumptuous on my part to refer in any detail to Hertz's work, but no physicist, and least of all one who is a member of Maxwell's University, could pass over in silence the death of Hertz. When Hertz began his magnificent experiments on electric oscillations there were many theories of electrical action. When he had finished them there was only one, Clerk Maxwell's.

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Hertz's work was done with very much quicker vibrations than those produced by the apparatus now on the screen; this, however, gives rise to currents through the coil changing their direction some million times a second. If we place in the coil an exhausted bulb, the bulb in reality will be the secondary of an induction coil, and will be exposed to electromotive forces tending to produce circular currents parallel to the plane of the coil. I will now place a bulb inside this coil, and you see that a circular ring discharge passes through it, and this discharge passes entirely in the gas. The gas in the bulb now in the coil is the vapour of silicon tetrachloride; it happens to be the bulb which gives a brighter ring than any others I possess.

If this ring discharge passes through air at different pressures, the colour of the discharge changes very considerably. The first bulb I put in was at fairly high pressure, about $\frac{1}{10}$th of a millimetre or so. I will now put in another at a lower pressure, and then one at a still lower pressure. Mr. Newall, who has been working at the spectra of these discharges, finds that at the pressure in the first bulb the spectrum is due to nitrogen; at the second stage it is due to mercury vapour; the bulb was pumped by a mercury pump, so that there is in the bulb a certain quantity of mercury vapour. The apple-green colour in the more highly exhausted bulb is due to some compound of sulphur, which has got into the bulb from the sulphuric acid used to dry the gas. Mr. Newall finds that if the ordinary discharge from a coil between electrodes is taken in such a bulb, there is no trace of this sulphur spectrum. He has also found that when the bulb is at a pressure intermediate between what I may call the mercury and the sulphur stage, when the mercury and sulphur lines are both visible, these sets of lines come from different layers, the sulphur lines coming from a layer nearer the surface than the other. If we take the discharge through a bulb containing oxygen, you see that the ring discharge is succeeded by a bright glow; at first the colour is some-

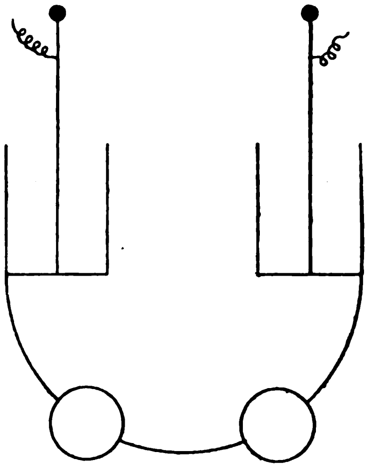

Fig. 4.

what opaque, but gradually gets more transparent and changes colour. This gives a continuous spectrum crossed by a few bright lines. If we take the discharge through cyanogen you see that the glow is even more persistent than the oxygen, though it is not so bright; all the gases which show this glow belong to the class of substances which polymerise—that is, whose molecules can combine with each other. I imagine that what takes place in bulbs filled with these substances is that the discharge produces a polymeric modification, and that this gradually returns to its original state, and while doing so gives out a phosphorescent light. It is in accordance with this that at a high temperature where ozone cannot exist a discharge through an oxygen bulb does not show any glow.

I said at the beginning of this discourse, that gases were exceedingly good conductors of electricity. I will now endeavour to show an experiment which proves that statement. The apparatus which I shall use for this purpose is a slight modification of the one I have used for producing the ring discharge; the only difference is that in the wire connecting the two coatings of the jars there are two loops instead of one (*see* Fig. 4). In one of these loops an exhausted bulb is placed to serve as a kind of galvanometer; the brightness of the discharge is an indication of the strength of the current flowing round the coil. If I place a second conductor in the other loop, currents will be started in it and part of the energy of the discharge will be absorbed; this will leave less energy available for the bulb in the first, so that the discharge in this bulb will be dimmer. The effect produced on the discharge will depend upon the conductivity of the substance placed in the second loop. The effect is not directly proportional to the conductivity; in fact, a perfect conductor would not produce any diminution, nor would an absolute non-conductor; for a given period and with apparatus of given dimensions, there is a certain conductivity which gives a maximum effect; this follows easily from the theory of induction of currents, but at this late period in the evening I will take a shorter course and prove it by an experiment.

I put a piece of brass in this loop, and you see it produces but a small effect upon the brightness of the discharge. Instead of brass I now insert a plumbago crucible, which, though a conductor, is not nearly so good a one as the brass, and you see the discharge in the indicating bulb is completely stopped. I will now place in the second loop an exhausted bulb; you see it produces a decided diminution in the intensity of the discharge in the galvanometer bulb. I now replace the bulb by another of the same size containing dilute sulphuric acid; you see it does not produce nearly so large an effect as the exhausted bulb; this might be due, as we have seen, to the sulphuric acid being either too good or too bad a

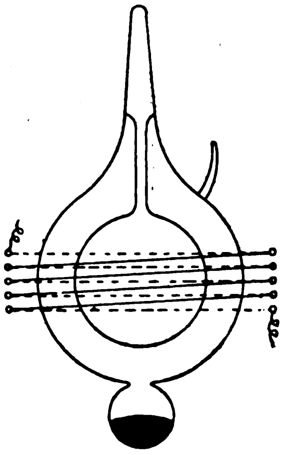

Fig. 5.

conductor. I can show that it is the latter by putting a bulb in filled with a stronger solution, which has a higher conductivity than the weak solution; if the smallness of the effect produced by the weak acid were due to its being a better conductor than the gas, then increasing the conductivity would still further diminish the effect of the acid, you see, on the contrary, that the strong acid produces a distinctly greater effect than the weak, hence the rarefied gas in the bulb is a better conductor even than the strong electrolyte.

Let us consider for a moment the molecular conductivities of the two substances, the rarefied gas and electrolyte. The pressure of the gas is about $\frac{1}{100}$th of a millimetre, while in the electrolyte there are sufficient molecules of the acid to produce, if they were in the gaseous state, a pressure of more than 100 atmospheres; thus the

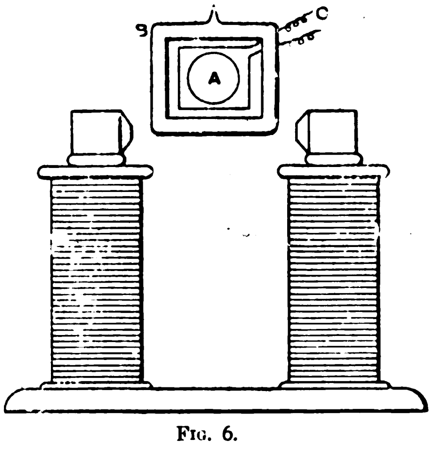

Fig. 6.

conductivity of the gas estimated per molecule is about 10 million times that of the acid; this is greater than the molecular conductivity of even the best conducting metals.

If the pressure of the gas is diminished below a certain point, the conductivity begins to diminish. I have here an experiment which I hope will show this. The apparatus (Fig. 5) consists of two bulbs, one outside the other; the inner bulb contains air at a low pressure, while the space between the two bulbs is a very high vacuum containing practically nothing but a little mercury and its vapour. The amount of mercury vapour in this space is, at the temperature of the room, exceedingly small, but as the apparatus is heated the vapour pressure increases, and we are thus able to produce a fairly wide range of pressure in the space between the

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bulbs. The outer sphere is surrounded by the coil connecting the outer coatings of the two Leyden jars. When the space between the bulbs is a conductor, the alternating currents circulating in the coil will induce in this conductor currents whose inductive effect is opposite to that of the currents in the coil; and in this case this layer will screen off from the inner bulb the electromotive force due to the alternating currents in the coil. If, on the other hand, the space between the bulbs is a non-conductor, the inner bulb will be exposed to the full effect of these forces. We now try the experiment: you observe that when the mercury is cold, and consequently the pressure in the space between the bulbs very low, a bright discharge passes through the inner bulb, while the space between the bulbs remains quite dark; when we heat the mercury so as to increase the pressure of its vapour, a bright discharge passes through the outer layer, while the inner bulb is quite dark; the outer layer is now a conductor, and by its action screens off from the inner bulb the induction of the coil.

The last experiment I have to show is one on the effect produced by a magnetic field on the discharge. When the discharge has to flow across the lines of magnetic force, the pressure of the magnetic field retards the discharge; when, however, the discharge flows along the lines of magnetic force, the discharge is helped by the magnetic field. This is shown in the following experiment. A (Fig. 6) is a bulb; B a square tube, one side of which is placed between the poles of an electromagnet; the coil C, which connects the outside coatings of the jars, can be adjusted so that when the magnet is "off," the discharge passes through the bulb, but not round the square tube; when, however, the magnet is "on," the discharge passes in the square tube but not in the bulb. In the square tube the discharge passes along the lines of magnetic force, and is helped; in the bulb it passes across them and is retarded.

AN AMERICAN COMBINED WATER AND STEAM POWER STATION.*

Logansport, Ind., the county seat of Cass County, is a thriving city of about 16,000 inhabitants, situated at the junction of the Eel and Wabash rivers. Up to last December the city was paying a local lighting company $10,000 per annum for 100 street lights of 2,000 c.p., operated upon the moonlight schedule. The question of the city owning and operating its own plant had been discussed for the past five years, but it was not until the summer of 1893 that the matter began to take definite shape, with the result that last December the city's plant was started, and as far as can be judged within the short time that it has been in operation, bids fair to prove a profitable venture on the part of the city.

The city owning the water power which had been furnishing the power for the city water works for years, that power naturally suggested itself as the most desirable, principally on account of the low cost. Just before the Eel river enters the Wabash, the former has a natural fall of about 6ft., with a width of about 400ft. A 6ft. dam increases the maximum fall to 12ft., but it is only during about five months of the year that the maximum power is available, during the dry season the head often falling as low as 8ft. It was therefore decided to build a combined water and steam-power plant, both of equal capacity, so that the plant could be operated, if necessary, entirely by steam.

The station building is a substantial brick structure, T-shaped, the dynamo and engine room being 72ft. by 96ft., and the boiler room 40ft. by 80ft. The entire floor space of the main building is taken up by the turbines, electrical apparatus and engines, with the exception of a corner 24ft. by 30ft., which is partitioned off and serves as a store room and office. Above the stone foundation walls, 12in. brick walls with 18 by 24 pilasters are carried to a height of 20ft. to the roof, which is supported by 12 wooden trusses having a 72ft. span. A wire tower 8ft. by 12ft., 10ft. high, is located in the centre of the roof, and is large enough to receive the several circuits without crowding. In the centre of the boiler room a brick stack, 6ft. by 6ft. inside, and rising with a slight taper to a height of 90ft., is ample to accommodate the present and future boiler capacity.

The head race runs along the south side of the building, and before it could be made available had to be deepened at an expense of £800. The water enters the flume through an iron rack and head gates, set about 15ft. from the building, the distance being bridged over so as to give easy access to the building. The water wheel flume is 30ft. wide and 112ft. long, extending the full length of the building under the west side. The wheel pit is all blasted out of solid limestone, and walled up to the main floor, the distance from bottom of wheel pit to main floor being 21ft. The floor in the flume is 8ft. above the bottom of the wheel pit. The floors are supported on steel I-beams, supported by iron columns.

The turbines are located along the west side of the dynamo room, and are all of the Improved Little Giant type. The equipment at present consists of four of their newly-designed improved cylinder gate wheels; two 48in. turbines, rated at 130 H.P. each, at 84 revolutions, and three 36in., giving 70 H.P. each at 112 revolutions, an average head of 10ft. being assumed in each case. Each turbine is geared to its line shaft in the ratio of 1 to 4. Standard ring-oiling, ball and socket bearings are employed. Each wheel is also fitted with a Woodward water-wheel governor.

The electrical equipment consists of two 1,250-light "Standard" alternators and three 60-light 2,000-c.p. "Standard" arc dynamos, all furnished and erected by the Standard Electric Company of Chicago, who, by the way, were the general contractors for the entire plant, with the exception of the site and building, which were furnished by the city. The dynamos are symmetrically arranged along the centre line of the dynamo room, the alternators being belted to the larger turbines, while each of the smaller wheels serves to drive one of the arc dynamos. From the generators all wires are led under the floor to a three-panel marble switchboard fitted with all necessary appliances in the way of current and pressure indicators, switches, ground detectors, rheostats, &c. From the switchboard overhead conductors lead out to the wire tower, where each circuit is provided with lightning arresters before leaving the building.

Along the east side of the dynamo room are four centre crank automatic engines, having a combined capacity of 440 H.P. Three of the engines have 13in. by 12in. cylinders, giving 65 H.P. All of the engines are speeded to 300 revolutions and take steam at a pressure 110lb. The engines are placed at such a distance from the dynamo that in changing from water to steam power, or *vice versâ*, it is merely necessary to shift the dynamo belt from one to the other, proper allowance having been made for the difference in diameters between engine and turbine pulleys. It is, of course, desirable that in either case the "pulling" portion of the belt be next to the floor; this necessitates reversing each dynamo in changing over, which is probably the only objection that could be urged against the arrangement, and is fully offset by its flexibility.

In the boiler room are five horizontal tubular boilers, 60in. by 16ft. each, a 500 H.P. feed water heater and two boiler feed pumps, either pump being large enough to feed all the boilers at a piston speed of about 24ft. per minute. The boilers are fitted with gas burners, natural gas being piped to the plant, but at present the city is burning coal, Indiana block coal being delivered to the station at $1.25 per ton. With gas furnished at 7½ cents per 1,000ft., it has been found that coal is slightly cheaper. The engine and boiler equipment was furnished by the Erie City Iron Works, and at the test made by the city's consulting engineer, proved not only fully up to the guarantees made by the contractors, but in some respects even better results were obtained than were anticipated.

The outdoor wiring consists at present of one incandescent and three arc circuits, the latter containing 34 miles of No. 6 weather-proof wire. For the incandescent circuit a No. 00 feeder is run a distance of half a mile to a centre of distribution, from which the lights are distributed through about 10 miles of mains and branches.

It was stated at the beginning of this article that the plant is looked upon as a paying investment by the city. The total capacity of the plant, as constructed at present, will furnish 180 2,000-c.p. arc lights and 2,500 16-c.p. incandescents. The entire cost to the city in round numbers will be £12,000. One hundred and fifty of the arc lights will be used for street lighting, and will, therefore, bring no direct revenue to the city. The remaining 30 arcs the city will rent as commercial lights at $6 per month, giving an income of at least $2,000 per year. Of the 2,500 incandescent lights, it is expected that 1,500 will be disposed of as commercial lights and 1,000 for residences, the income at meter rates, 7 cents per kilowatt-hour, being estimated at $14,000 per year, making a total of $16,000.

In estimating the operating expenses, which are given at $10,000 per year, it must be borne in mind that during five months of the year (February to June) the entire plant can be operated by water power, which, as stated, costs the city nothing. Part of June and July one-half steam and one-half water will be used; July, August, and September all steam, and from that till January half steam.

In the $10,000 are included cost of coal, salaries ($600 per month), oil, carbons, incidentals and depreciation at 5 per cent. The management of the plant is under the direction of a council committee, appointed for that purpose. The salaried positions consist of one superintendent and electrician, one assistant electrician (dynamo tender), one engineer, one fireman and two trimmers.

Inside wiring for incandescent lighting is paid for by consumers, the city doing the work at a trifle above cost. Lamp renewals are paid for by consumers, the city selling 16-c.p. lamps at present at 30 cents.

Another source of revenue which the city has in contemplation is the establishment of a power service during the day, the conditions being exceptionally favourable for this, on account of the

* Abstract of an article by C. Kammeyer, in the *Electrical Engineer* of New York.

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ease with which the combined power and lighting load, so troublesome in ordinary stations in the early evening hours, especially on dark winter days, can be taken care of in a plant such as described above.

THE ELECTRICAL MEASUREMENT OF STARLIGHT.*

BY G. M. MINCHIN.

The method employed in these experiments for measuring the intensity of the light which reaches the earth from the stars and planets consists in the determination of the E.M.F. generated by such light in certain photo-electric cells, the square of this E.M.F. being proportional to the energy of the incident light.

In these cells the surface on which the incident light is received is formed by depositing a thin layer of selenium on a surface of clean aluminium, and immersing the sensitive layer in a glass cell filled with œnanthol.

The seat of the E.M.F. is the surface of contact of the liquid and the selenium, the selenium receiving a positive and the liquid a negative charge.

An examination of a seleno-aluminium cell with the various portions of the spectrum of lime-light shows that the cell is sensitive to all the rays from the end of the red, and below it, to beyond the violet, the maximum E.M.F. being produced in the yellow; but the magnitude of the E.M.F. does not vary very greatly until the violet is reached. In this respect the seleno-aluminium cell differs from all other photo-electric cells, for the sensitiveness of most of the latter is almost wholly confined to the blue. It may be mentioned, however, that a cell formed by immersing clean silver plates in a solution of eosine gives electromotive forces of opposite signs for the red and the blue rays.

The energy incident on a photo-electric cell has been found to be proportional to the square of the electromotive force generated. If one candle held at a certain distance from the cell gives a difference, E, of potential between the poles, two candles close together will be found to give a difference $E\sqrt{2}$. Or, if a candle be tried at different distances from the cell, the difference of potential will be found to vary inversely as the distance.

If I is the total amount of energy radiated into space in any time by a star at the distance r from the earth, the quantity received on any given surface on the earth will be proportional to I/r^2; and if E is the E.M.F. which this generates in a given cell, we have

$$I/r^2 = kE^2 \quad \ldots\ldots\ldots \quad (1)$$

where k is some constant. Hence, if I′ is the intrinsic energy of another star at the distance r', and E′ the corresponding E.M.F.,

$$I'/r'^2 = kE'^2, \quad \ldots\ldots\ldots \quad (2)$$

from which we have

$$\frac{I}{I'} = \frac{E^2 r^2}{E'^2 r'^2}. \quad \ldots\ldots\ldots \quad (3)$$

Hence, if the parallaxes of the two stars are known, say p and p' respectively, we have

$$\frac{I}{I'} = \left(\frac{Ep'}{E'p}\right)^2. \quad \ldots\ldots\ldots \quad (4)$$

When it is desired to compare the energy of a star with that of the sun, we must know the area of the sensitive layer of selenium in the cell. Let this be a, and let A be the area of the aperture of the telescope.

Then, since it is not desirable to concentrate on the selenium the amount of solar light which falls on the large area A, we must turn the cell to the sun without the aid of the telescope. Let E be the E.M.F. observed, S the intrinsic energy of the sun, and r the distance of the sun from the earth. Then

$$a\frac{S}{r^2} = kE^2, \quad \ldots\ldots\ldots \quad (5)$$

while, for any star whose distance is R, giving an E.M.F. equal to e,

$$A\frac{I}{R^2} = ke^2. \quad \ldots\ldots\ldots \quad (6)$$

$$\therefore \frac{I}{S} = \frac{a}{A}\left(\frac{eR}{Er}\right)^2. \quad \ldots\ldots\ldots \quad (7)$$

As the E.M.F. produced by the light of the sun falling directly on the cell is probably too large, it will be desirable to diminish its intensity by taking it through a small measured aperture and placing the cell at a known distance behind.

The instrument employed for measuring the E.M.F.'s generated by the light of different stars is a quadrant electrometer differing from the forms in ordinary use in having its quadrants made of aluminium, two of these being supported on brass pillars connected with the case of the electrometer and always earthed, while the other two are supported on pillars of melted quartz.

It had been intended to use with the electrometer an air condenser consisting chiefly of two gilt brass plates, each about 15cm. in diameter, to multiply the potentials indicated by the electrometer; but at present there are difficulties in the way of its employment, and the measures made on this occasion were made by the electrometer alone. Both instruments were constructed with the aid of the Government grant dispensed by a Committee of the Royal Society and were made by Mr. Paul, of Hatton Garden.

The telescope was Mr. Wilson's 2ft. reflector, which was at first used as a Cassegrain instrument, and subsequently as a Newtonian, the cell-carrier being in each case fixed to the telescope in place of the eye-piece.

One pole (the insensitive) of the cell was connected with earth by a wire attached to a gas pipe, while the other (that of the sensitive surface) was attached to a fine uncovered copper wire, carefully insulated throughout, which passed down through a shellac plug in the floor of the observation room to the electrometer in the room below.

The readings of the electrometer deflections caused by the light of the stars were made in the lower room by Prof. Fitzgerald, while Mr. Wilson and I attended to matters upstairs. But in this part of the work the services of my two colleagues were of very much greater use than mine.

Regulus was the first star taken, and only two observations of the deflection on the electrometer scale produced by its light were made before proceeding to an examination of Arcturus for comparison. It is thought desirable to show in tabular form a few of the results obtained. A Leclanché cell produced on the scale a deflection of 530mm., the scale being about 7ft. from the electrometer.

Experiment.	Scale reading, star off cell.	Scale reading, star on cell.	Scale reading, star off cell.	Difference from mean.
1	150	146·5	151	4·0
2	151	146·0	150	4·5

Every photo-electric cell of the type previously described, and of maximum sensitiveness, has a certain native or disturbing E.M.F., which is always opposed to the E.M.F. generated by light. In this case it was represented by 11·2mm. The second column of this table contains the number on the scale at which the spot stood when the cell was in the dark, *i.e.*, when the only E.M.F. in it was its disturbing E.M.F.; the second column contains the number to which the spot moved when the light of the star was allowed to fall on the sensitive surface in the cell. It will thus be seen that the E.M.F. due to Regulus in these two experiments was represented by the number 4·25, or about 4·25/530 of a Leclanché.

Arcturus when tried gave the following results, after a few preliminary observations (which were tried in the case of Regulus also, and which are rendered necessary after the disturbances caused in shifting the telescope, &c.):—

Experiment.	Reading, star off.	Reading, star on.	Reading, star off.	Difference from mean.
1	135·5	128·0	135·5	7·5
2	135·5	Clouds	came	up.
3	145·0	138·0	143	6·0
4	143·0	Clouds	came	up.
5	136·0	137·0	Found star	off the wires.
6	189·0	132·5	139	6·5
7	139·0	130·0	135	7·0
8	135·0	127·0	134	7·5

These observations were somewhat irregular, because the sky was not quite clear during most of the observations, but was getting clearer as they proceeded.

The last was probably the best observation, and in that case Arcturus produced a voltage of about 0·02.

An experiment was made to try whether, if the cell were exposed to the sky in the neighbourhood of the star, but not to the star itself, any effect was produced, and a deflection of about 0·5mm. in the direction *opposed* to that of the deflection caused by light was constantly observed.

If we take this effect into account, we have as the deflections due to

Regulus .... 4·75
Arcturus .... 8·00

Assuming now the latest determinations of the parallaxes of these stars to be

Regulus .... 0·093″
Arcturus .... 0·018″

* Observations made at the Observatory of Daramona House, co. Westmeath, in April, 1895. Abstract of Preliminary Report, read before the Royal Society.

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we have from equation (4) the ratio of their respective intrinsic energies, I, I′, the result

$$I'/I = 75{\cdot}72,$$

showing that Arcturus radiates into space about 75¾ times as much energy as Regulus in a given time.

The telescope was next turned to the star η Bootis. If the radiation to the sky is added, the star's deflection amounts to 1mm., *i.e.*, a voltage of 0·0028. This observation is, however, recorded merely for the purpose of showing that a comparatively faint star is able to give an unmistakable E.M.F.

The telescope was next turned on Saturn, whose image was so large that the ends of his rings were probably off the sensitive surface in the cell. The observation was :—

Experiment.	Reading, star off.	Reading, star on.	Reading, star off.	Difference from mean.
1	129	125·5	129	3·5
2	129	125·0	129	4·0
3	129	122·5	126	3·75

Between the second and third of these experiments the cell had been slightly disturbed, so that the last is not very satisfactory, although it gives the mean result. The glare from the moon was now very distinctly apparent, and its effect seemed to be a deflection of about 0·5mm., which must be deducted from Saturn's effect. This latter would, then, be represented by about 3·25mm., or a voltage of 0·009.

Comparison with the Photometric Method.—In the ordinary method of comparison of "magnitudes," if B and B′ are the brightnesses of two stars whose magnitudes are *m* and *m′*, respectively, we have, by definition,

$$\log \frac{B}{B'} = \tfrac{4}{10}(m' - m). \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Now, taking Arcturus and Regulus as of the magnitudes 0·3 and *m′*, respectively, and the E.M.F.'s of their lights as 8 and 4·75 (determination of April 11th, previously cited), we have

$$\log \left(\frac{8}{4{\cdot}75}\right)^2 = \tfrac{4}{10}(m' - 0{\cdot}3),$$

$$\therefore m' = 1{\cdot}43.$$

The magnitude of Regulus, as a matter of fact, is variously cited as from 1·42 to 1·7 ; thus the amount of correspondence between the photo-electric and photometric methods is seen.

Concluding Remarks.—It is hoped that these measurements will be resumed about the end of next September, at Daramona, by the same obervers ; and, in the meantime, some improvements will be effected in the cell-holder which will facilitate observation. An endeavour will also be made to improve the cell itself in the directions indicated at the beginning of this report.

The experiments prove conclusively that there is little difficulty in obtaining fairly accurate measurements of the light of stars of the first and second "magnitudes," even without the employment of a multiplying condenser or a larger telescope. A telescope with an aperture of 5ft. or 6ft. would certainly annex a very great number of stars to the list.

It is right to put on record the fact that the first photo-electric observations of planets and stars were made by Mr. Monck, in Dublin, in the year 1892, in conjunction with Prof. Fitzgerald. My cells were at that time much less sensitive that the present ones ; and, for reasons set forth in this Paper, their sensitiveness fell off after about six hours. The liquid in those cells was acetone, and the aluminium on which the selenium was deposited was not insulated from the liquid. Nevertheless, Mr. Monck and Prof. Fitzgerald were able to observe electromotive forces due to the light of Venus, Jupiter, and, I think, Mars. Mr. Monck's telescope is a refractor of 9in. aperture, so that large results were not to be expected. These observers were not quite certain whether Vega and Capella produced measurable effects or not ; but their observations were much interfered with by draught of air, and other things, in their observatory.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *May 25, 1895.*

Electric Railway Litigation.—After some years of preparation the suit involving the street railway trolley is about to be brought to a hearing. This appears to be another of the causes from which only the lawyers will derive profit, which, by the way, seems to be characteristic of electric street railway suits, none of the "broad" patents relating to this branch having thus far been sustained. In the present instance the defence is based upon prior invention, and numerous patents are cited granted for trolleys for use with systems for telegraphing to and from moving trains. Shortly after the introduction of the practical telegraph, the problem of train telegraphy became a favourite one with inventors, and during the 20 years previous to 1870, numerous patents were issued on this subject involving the use of the trolley. Many forms of the latter were invented, including over-running, under-running, and lateral trolleys, applied to overhead wires, side wires and underneath rail conductors. The question at issue would, therefore, seem to be whether a trolley transmitting a large current to an electric motor is a different invention from a trolley transmitting a small current to a telegraph instrument, and a well-established principle in patent law indicates the probability of an answer in the negative.

The Berliner Telephone Transmitter Patent.—The recent decision of a United States Court of Appeals, reversing Judge Carpenter's decision nullifying the Berliner microphone patent, was a great surprise, and has spread consternation in telephone circles. It had been taken for granted that there was no probability of a reversal, and several hundred telephone exchanges in competition with those of the American Telephone licences had been started in various parts of the United States, while many firms had commenced the manufacture of telephone apparatus. There were two questions involved in the appeal: the illegality of the Patent Office proceedings, which delayed the issue of the patent for 14 years, and the point whether the 1880 Berliner patent included the invention claimed in the 1891 patent. The judges hurriedly delivered their decision immediately after it had been determined in order to avoid any possibility of a "leak" that would cause stock speculation, and the opinion sustaining it will not be ready for publication for several weeks yet. In the meantime there is much interest as to the reasons assigned for the reversal, there being some hope that it will leave grounds for a more successful issue under another method of legal procedure. The litigation thus far will result in some good even should the monopoly of the Bell Company be extended to 1908, for competition during the last several months has caused that Company to grant large reductions in telephone rentals throughout the United States in the smaller cities, and any attempt to increase to former rates would be undoubtedly prevented by legislation.

The New Westinghouse Works.—The new works of the Westinghouse Company at East Pittsburgh, Pennsylvania, are now in operation, about 3,500 men being employed at present. The great manufacturing district in which the works are situated owes much of its fame and prosperity to the economy in which manufacturing operations are conducted, labour-saving processes and workshop organisation having there been brought to a remarkable state of efficiency. We may remark in this connection that Mr. Carnegie ascribes the enormous profits made by his firm to this cause rather than to the favourable situation of his works with respect to other manufacturing conditions. Mr. Westinghouse has been a recognised expert in this department of the art of manufacturing, and has had a wide field for practice in connection with the many enterprises with which he is connected—notably with respect to the immense shops of the Westinghouse Air Brake Company—and the new electric works have received the benefit of his long experience and study in its equipment and organisation. The claim made, therefore, that the new works at East Pittsburgh form the finest example in existence of an electrical manufacturing establishment is one having a reasonable basis, and those who have visited the establishment are enthusiastic in praise of what they have seen.

BOOKS RECEIVED.

"Dictionnaire d'Électricité." By M. E. Bouty. (Paris : J. B. Baillière et Fils.)

Transactions of the North East Coast Institution of Engineers and Shipbuilders. Session 1894-5. Vol. XI., part 6. (London : Andrew Reid and Co.)

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CORRESPONDENCE.

PRESSURE CURVES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to Mr. T. Cooper's letter on this subject in your current issue, I regret to find that, through an unfortunate error, the St. Pancras curve given in your issue for May 24th actually represents the electrical pressure variations in Fitzroy-square for the 24 hours from noon May 2nd to noon May 3rd, instead of for the complete day of May 2nd as was intended.

I have also to express my regret, having regard to what is mentioned in Mr. A. P. Trotter's letter, that the curve of the Kensington and Knightsbridge Company for March 20th was inadvertently given in place of that for March 19th.

I should at the same time like to be allowed to acknowledge my indebtedness to Messrs. Drake and Gorham—the owners of the Cardew patent under which all these voltmeters are made—for having kindly lent to me the very sensitive instrument with which all these records were taken.—Yours, &c.,

66, Victoria-street, Westminster, A. A. C. SWINTON.
June 1, 1895.

VACUUM TUBE AFTER-GLOW.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In his communication on "Curious Vacuum Tube Phenomena" in *The Electrician* of May 10th, Mr. W. Lomas has broached a subject which seems to merit greater attention than it has as yet received.

Mr. Lomas will find a brief description of the phenomena referred to, as observed by Mr. H. M. Martin and myself, in the *Electrical World* (N.Y.) of January 20, 1894, and in a later issue of the same paper the method of obtaining the effect by means of a small incandescent lamp and a Ruhmkorff's coil is detailed (*see* "The After-glow in Exhausted Bulbs," the *Electrical World*, January 20, 1894, and "Tesla Effects with Simple Apparatus," the *Electrical World*, September 1, 1894).

I have in addition collected the following data, which may be of assistance to Mr. Lomas in suggesting lines for further investigation.

While the use of the Ruhmkorff's coil in producing this effect is interesting in some connections, the influence machine is better adapted to a study of the after-glow proper, and most of the results following were obtained by its aid.

If an ordinary 16 c.p. glow lamp be held in the hand by the bulb and the base brought near the collector of an influence machine, sparks will pass, the base and filament will become charged, and the interior of the bulb will glow.

If the charging be continued the filament will bend and gradually approach the side of the bulb, and when the charge is sufficiently intense, and the filament quite near the glass, the crackling discharge which Mr. Lomas mentions takes place, and the filament regains its normal position. But if the lamp be withdrawn before the discharge occurs, the after-glow is established and continues for several minutes, as Mr. Lomas describes.

Experiments were made with a bulb containing some loose pieces of carbon in addition to the sealed-in filament. This arrangement possessed great capacity, and when charged and laid upon a table at a distance from any other objects of capacity sustained the after-glow for eight minutes.

These and other experiments seem to warrant the conclusion that if a charged body be surrounded by a rarefied gas, the molecules of the gas will be attracted, and coming in contact with the body, receive charges and be thrown off. When there is but one charged body these movements will cease when the molecules have all received charges, but if there be two or more bodies with charges of different signs or intensity, molecular journeyings will go on between the bodies until equilibrium of charge has been established, the action being that exhibited by the well-known "electric chimes."

It appears, also, that a relatively small difference of electrostatic potential may give rise to molecular collisions and bombardments sufficiently energetic to produce a visible glow. Indeed, so little charge is required that the glow is often observed without apparent cause.

On two different occasions I have grasped a perfectly dead lamp in a dark room, and been astonished at seeing a glow caused by the charge excited in my body by walking across the carpeted floor; and I have frequently produced the glow in a lamp by simply rubbing the base briskly with a silk cloth.

At first sight the foregoing theory seems inadequate to account for the continued maintenance of the glow in a bulb having only a single terminal capable of taking a charge, and the possibility of stimulating and apparently controlling the glow through the glass of the bulb by rubbing with the hand, &c., but a consideration of the extreme minuteness of the individual molecular charges may afford an explanation.

The molecules and their charges must be so infinitesimal that it is reasonable to believe that they are discharged by contact with even so poor a conductor as the glass bulb, and that the proximity of the hand simply assists in the accumulation of a charge on the interior surface of the bulb, which, aided by the condensing power thus obtained, may become sufficiently intense to discharge through the thin glass, so causing the crackling sound heard by Mr. Lomas.

Probably but comparatively little energy is expended in supplying the molecular charges, the capacity required to sustain the glow for the maximum time observed (eight to ten minutes on a single charge) being necessary because of the great losses by dissipation, surface leakage, &c.

The difference between this method of obtaining vibration of the gas molecules, and that with which the name of Mr. Tesla is associated, has been pointed out.—Yours, &c,

May 27, 1895. W. H. PALMER, JR.

LEGAL INTELLIGENCE.

Bryson v. The Town Commissioners of Crieff.

An action was recently brought in the Sheriff's Court by Mr. W. A. Bryson, consulting electrical engineer of Glasgow, against the Commissioners of Crieff and others for the sum of £26. 5s. in respect of professional work alleged to have been done on the defenders' behalf in connection with the proposed introduction of electric lighting into Crieff. Having heard the evidence, the Sheriff found that the pursuer had failed to prove his employment by the defenders, either as individuals or collectively, and dismissed the action with costs against the pursuer. The Sheriff stated that in considering the pursuer's claim no question arose as regarded his having performed the work for which he charged or the fairness of the charges made. The sole question was one of employment, and with reference to this the pursuer was entitled to the benefit of the fact that the work in question was, in the first instance, undertaken by him on the suggestion of the defender Veitch, whom he had some reason to believe was acting with the knowledge and approval of the burgh authorities, and in view of the same anticipated action on their part for the introduction of electric lighting into the burgh, and that this was a matter in which the defender Adie, as Provost of the burgh, took special interest. In so far, therefore, the circumstances of the case may be held to be favourable to the pursuer, but they do not afford evidence either of actual or implied employment to perform the services he has rendered. It was clear that the Burgh Commissioners in their corporate body did not authorise his employment, nor were the communications, written or verbal, which passed between him and the defenders Adie and Veitch, such as to establish that, as acting on behalf of the Commissioners and with their authority, they employed the pursuer to perform the work in question.

Acetylene.—According to the *Gas World*, the Neuhausen Aluminium Company is making calcium carbide for 6d. a kilogramme, or £25. 7s. a ton, and holds out hopes that if there be a sufficient demand it may be able to reduce the price materially for large orders. At the present moment, it is said, that calcium carbide is being sold in London in two shillings 2lb. tins. Herr Wedding, says the same authority, has found that there is a great difference between the acetylene yield of various samples of calcium carbide. One sample, from Pintsch's, gave 64·5 litres per kilogramme; another gave 115·7; one from the Neuhausen works gave 96·8; one made by himself gave 254·3; while the theoretical is 348.

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

LABORATORY NOTES AND FORMS.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett (*now ready*). Strong portfolios can be had, price 1s. each. A full prospectus can be obtained post free.

"THE ELECTRICIAN."—A special notice concerning certain changes in the price, &c., of this journal will be found on page 190.

TENDERS INVITED.—The Electric Lighting Committee of the Corporation of St. Helens (Lancs.) invite tenders for the supply and erection of boiler and engine-house plant, switchboard and instruments, underground work (including cables, boxes, culverts, &c.), transformers and fittings, meters, and overhead crane for their electric lighting station. Specifications, plans, &c., can be obtained from Mr. Robert Hammond, the consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., after the 11th inst., and tenders are to be sent in to Mr. W. J. Jeeves, Town Clerk, Town Hall, St. Helens, not later than Tuesday, July 2nd. Some further particulars appear in our advertisement columns.

——— The Italian military authorities at Pavia are inviting tenders for the supply of 105,600 metres of rubber-covered telegraph wire 1·6mm. in diameter. Tenders must be sent to the Direz. Offic. di Construz. Mat. Genio Milit., Pavia.

——— Tenders are invited by the General Direction of the Roumanian Posts and Telegraphs at Bucharest until June 15th for the supply of 4,000 Callaud cells for telegraphic purposes."

——— The Municipal Authorities of Medina del Campo (Valladolid, Spain) are inviting tenders until the 27th inst. for the concession for the electric lighting of the town during a period of 20 years, the Municipal Authorities reserving the right to annul the concession at the end of eight years. Tenders are to be sent to the Ayuntamiento de Medina del Campo (Valladolid).

——— Tenders are invited by the Municipal Authorities of Astorga (Province of Leon, Spain) for the concession for the electric lighting of the town during a period of 20 years. Tenders are to be addressed to the Ayuntamiento de Astorga (Leon).

TENDERS ACCEPTED.—The Burton-on-Trent Town Council have accepted the tender of the Telegraph Manufacturing Company, Helsby, near Warrington, for high and low-pressure cables for their electric light extensions, and they have also accepted the tender of the Stanton Ironworks Company for cast-iron pipes.

——— The Gas, Electricity and Street Lighting Committee of the Bolton Corporation have accepted the tender of the British Insulated Wire Company for supplying and laying down the mains required for their electric lighting extensions.

——— The Electric Lighting Committe of the Brighton Town Council have received the following tenders for the 80 cast iron and drawn steel bracket posts arc lamps:—

Peirson and Co., London	£3,680
Newton, Chambers and Co., Sheffield	2,640
Hart, Son, Peard and Co, Birmingham	2,600

Informal tenders were received from Messrs. MacFarlane and Co., Messrs. Reed and Co., Messrs. G. Smith an Co., Messrs. Mackenzie Bros., Messrs. Baird, Son and Thompson, and the Alloa Iron Company. The Committee recommend that the tender of Messrs. Hart, Son, Qeard and Co. be occepted.

The tenders received for the supply of 45 cast-iron upright posts, wlth bracketed canopies, for arc lamps, need further consideration, and the Committee deferred their recommendations on these tenders till the 20th inst.

SALE BY AUCTION.—Messrs. Wheatley Kirk, Price and Goulty will sell by public auction at the Mart, Tokenhouse-yard, London, E.C., on Thursday next, June 13th, at 12:30 for 1 o'clock, the entire valuable property of the Val d'Aosta Syndicate, Limited (in liquidation), consisting of freehold works, mines, &c., with engines, boilers, plant, railways, water rights, &c., of which particulars are given in our advertisement columns. The plant is in first-class condition, and is especially suitable for carrying on the trade of copper depositing, refining, and smelting. This sale offers an exceptional opportunity for capitalists, as the works, plant and patent rights are practically sold as a going concern. The auctioneers, Messrs. Wheatley Kirk, Price and Goulty, of 49, Queen Victoria-street, London, E.C., and Albert-square, Manchester, will supply plans and descriptive particulars gratis, as will also the liquidator, Mr. F. R. Reeves, Mansion House-buildings, E.C., the solicitors, Messrs. Deacon, Gibson and Medcalf, 9, Great St. Helen's, E.C., and Messrs. Mackrell, Maton, Godlee and Quincey, 21, Cannon-street, E.C.

SALE BY AUCTION—Under an order of the High Court of Justice Mr. William Izard (Messrs. Izard and Izard), of 52, Gracechurch-street, London, E.C., will sell by auction on Tuesday, June 18th, at 12 o'clock, the valuable and extensive stock, plant, and machinery of the Ford-Lloyd Manufacturing Company (Limited) at Phœnix-place, Mount-pleasant, Clerkenwell, E.C. Some further particulars are given in our advertisement columns.

APPOINTMENT VACANT.—The Governors of the Merchant Venturers' Technical College, Bristol, invite applications for the post of junior assistant master in the boys' school, at a salary of from £100 to £120 per annum. Applications have to be in by June 22nd. Our advertisement columns contain some further particulars.

——— A gas and electricity manager is required by a gas company in West Australia. Salary £250 per annum. Apply to Box 61, Post Office, Oldham.

——— The Liverpool Salvage Association require a practical engineer to act as superintendent of steam pumps, electrical installatoins, &c. Salary, £150 to £200 per annum. Applications to the Chairman, A 20, Exchange-buildings, Liverpool, by June 10th.

BUSINESS FOR SALE.—Mr. John M. Macleod, C.A., of 101, St. Vincent-street, Glasgow, has for disposal the old-established business of electrical engineers, bell hangers, &c., carried on by Mr. J. Scott, under the style of D. and G. Graham, at 130 and 140, Douglas-street, and Byars-road, Glasgow, together with the whole of the stock-in-trade, plant, machinery, &c. Offers must be sent in to Mr. Macleod by June 14th. Some further particulars appear in our advertisement pages.

DISSOLUTION OF PARTNERSHIP.—Messrs. Kiesow and Wendt, globe and shade manufacturers, of 25, Fore-street-avenue, London, E.C., have dissolved partnership. Mr. Wendt continues the business in his own name.

——— Messrs. J. A., F. J. and A. H. Lea, who have hitherto carried on business as electrical and general engineers at Pengwerne Works, Shrewsbury, under the style of Lea, Sons and Co., have dissolved partnership. Debts by Messrs. J. A. and F. J. Lea, who continue the business as Lea, Son and Co.

LIQUIDATION.—At a meeting on May 22nd it was resolved that Sarsons (Limited), electric light globe and shade manufacturers, of Birmingham, be wound up. Mr. J. Squiers, C.A., 21, Bennett's-hill, Birmingham, has been appointed liquidator.

BANKRUPTCIES.—Loftus John Barnacle, formerly carrying on business as Hall and Co., electrical engineers, South John-street, Liverpool, passed his adjourned examination in bankruptcy last week.

AGENCY.—Messrs. Francis and Spilsbury announce that they have taken up an agency for the well-known manufactures of Mr. A. P. Lundberg.

G. KYNOCH AND CO. (LIMITED).—At the meeting of this Company, on Wednesday, the Chairman (Mr. Arthur Chamberlain) announced that their new works at Arklow were lighted throughout by electricity, gas-engine power being used. They had laid down gas-producing plant, and the engine drove a large dynamo which distributed light and power through the 170 acres covered by the Company's works.

BELL'S ASBESTOS COMPANY (LIMITED).—Mr. W. Claude Johnson, M.I.C.E., of the firm of Johnson and Phillips, has been elected a Director of this Company.

ELECTRO-PLATING OF SHIPS' HULLS.—Mr. J. H. Cox, engineer, of Greenock, is stated to have invented and patented a rapid method of electro-plating the hulls of iron and steel ships. The largest of vessels can be operated upon in dry dock in about a week. The chief object of the invention is the preservation of ships' bottoms from corrosion and fouling, and an experiment upon the floats of a large passenger steamer are said to have showed, after a trial of three months, that the copper was clean and free from fouling, while those parts unplated were found to be very foul.

ARC LAMPS.—We are informed that Messrs. Drake and Gorham will, in a few weeks, put on the market the "Jandus" arc lamp, which, the makers state, will burn for 200 hours with one pair of carbons.

MESSRS. CLARKE, CHAPMAN AND CO. (LIMITED).—This firm report that they are very busy in their electrical department. They have several orders for ship-lighting plants in hand, including one from the Admiralty for the complete installation for three of H.M. cruisers. This firm have also erected at the shipbuilding yard of Messrs. C. S. Swan and Hunter, Wallsend, an overhead traveller and jib crane, worked electrically, which serves to deal with all

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the lifts required in building steamers, under an overhead erection of girders, &c.

A New Wire-Wound Steam Pipe.—A wire-wound steam pipe, consisting of an inner thin shell of steel or wrought iron, overwound with tough wire, one-eighth of an inch or less in thickness, has been patented by Mr. D. R. Smillie, of Glasgow. Tests of this pipe were recently carried out in the presence of Prof. Forbes, Mr. Harding, of the Admiralty, and several other gentlemen, at the works of Messrs. Mechan and Sons, of Elliot-street, Glasgow. These pipes are claimed to be stronger, lighter, and less costly than the pipes in general use.

The "Trusty" Oil Engine.—We hear that this engine, which has several times been favourably referred to and described in this journal, is now being made for greatly increased horse-powers, and that the prices have been reduced. The great convenience of the oil engine as a small motive power for isolated electric light and other installations is now fully recognised; and it is not less certain that, with oil even at its present somewhat high price, electric current can be obtained very cheaply by this means. One of the merits of the "Trusty" engine is that it will work with either Russian, American, or Scotch burning oils, and that the highly explosive petroleum spirits are not required in it. It seems that the engine gives better results with Scotch or American burning oils than with "Russolene," but as the former are far more commonly met with in this country, especially in the rural districts, where oil power is mostly required, there is more advantage than disadvantage in this fact.

Catalogue.—Messrs. R. Hornsby and Sons (Limited), of Grantham, have sent us a copy of the catalogue of their new Type B water-tube boiler. The general appearance and arrangement of this steam generator is not altogether unlike the type of water-tube boiler with which electrical engineers are now so familiar; but there are some very important modifications. The chief of these latter will be found in the arrangement of the mud-drum and return tube from the steam drum. The return-tube is carried vertically down from the back of the steam drum to a point below the level of the bottom of the lowest of the sloping water tubes. At this point it communicates with the bottom tube, as well as with the mud drum. The effect is to carry the circulating water to the bottom of the water-tube stack, instead of discharging it from the return tube into the top of the back header, as in some well-known boilers.

Ayr.—At the last meeting of the Town Council, on the recommendation of the Lighting and Hall Letting Committees, it was resolved to wire for the electric light the Town and Council Halls and Committee Room, together with the other municipal and police offices. The Committees further recommended that the expense of wiring the municipal offices be borne by the Common Good, provided the cost of the wires and fittings for the police offices be paid by the Police Commissioners. A long discussion on this part of the Committees' recommendation ensued, and Mr. Beveridge said that, although the matter was not a large one, there was a most important principle involved in it, namely, that tenants were to be expected to introduce the electric light into their landlord's premises, and he therefore moved that the latter part of the recommendation be not approved of. In reply, Bailie Ure said they were going to wire other buildings in the town, and he did not see why the Police Commissioners should be put on a different footing to others. It was also announced that two letters had been received, stating that the correspondents would take electric current if the Commissioners were willing to wire the buildings and supply the necessary fittings, they paying 5 per cent. on the cost of the fittings. A motion embodying this principle was finally adopted.

Bangor.—At the meeting of the Town Council, on Wednesday, on the recommendation of the Electric Light Committee, Mr. F. H. Medhurst was appointed consulting engineer to prepare a preliminary report and advise the Committee generally on the electric lighting question, at a fee of 25 guineas.

Belfast.—At the last meeting of the Electric Light Committee it was reported that applications for the supply of electric current had been received from the Northern Counties Railway Company and the Ulster Hall Company, and as an extension of the present mains to those districts would be necessary before the Committee could comply with the demands, the electrical engineer (Mr. V. A. McCowen) was instructed to make inquiries as to the probable demand for lighting and to report thereon at the next meeting.

Bolton.—Mr. W. J. G. Clerk, Local Government Inspector, held an inquiry this week on the application of the Corporation to borrow a further sum of £17,300 for electric lighting purposes.

Bray.—Notice of opposition to the Improvement Bill has been given by the Dublin, Wicklow and Wexford Railway. The Town Commissioners consider the opposition vexatious and unreasonable.

Brighton.—The pier or jetty erected by the Brighton and Rottingdean Seashore Electric Railway Company as one of the termini of the new electric line was opened on Saturday last, and it is expected that the line will be completed in August next.

Chelmsford.—At the last meeting of the Town Council the Lighting Committee recommended that the sanction of the Council be given to the transfer of the Provisional Electric Lighting Order from Crompton and Co. (Limited) to the Chelmsford Electric Lighting Company (Limited), and after a rather acrimonious discussion the recommendation was adopted.

Cheltenham.—A very satisfactory report is made of the working of the electric light machinery, and it has already been found necessary to extend the mains in order to meet the demands for current. An additional main is to be put down to a portion of the town outside the compulsory area at an estimated outlay of £1,300.

Church and Chapel Lighting.—St. Agatha's, Portsmouth, is to be lighted by electricity, and the success of the installation at the chapel at Elm-grove has led to the desirability of its general use in ecclesiastical buildings throughout the Portsmouth district being recognised.

Coventry.—At the last meeting of the City Council a report of the Electric Lighting Committee was discussed, which contained detailed instructions for the management of the electric light undertaking. After some discussion a clause providing for an annual financial return was added to the report, and in this amended form it was finally adopted.

Croydon.—Gen. Carey, Local Government Board Inspector, held an official inquiry on Wednesday into the application of the Corporation to borrow £27,500 for electric lighting purposes.

Dover.—The Town Council have accepted the offer of the Electricity Supply Company to light Snargate-street by electricity. Ten lamps are to be provided at a charge of £300 per annum.

Electric Light at the Military Tournament.—In reference to a note on this subject in our last issue, we have received communications from Messrs. Crompton and Co. (Limited), and Messrs. F. A. Glover and Co., both claiming a share in the electric lighting at the Agricultural Hall. Messrs. Bergtheil and Young were responsible for the matter of our note last week, and they write us that the information supplied is quite correct, and that they have authority "to advertise as contractors to the Royal Military Tournament." Messrs. Crompton and Co. claim to have carried out the permanent installation at the Agricultural Hall, and Messrs. Glover to have made some alterations thereto.

Electric Organs.—The fine organ at St. Margaret's, Westminster, London, has recently been overhauled, and electric motors similar to those in use at the Royal College of Music have been adopted for blowing the instrument.

Fire Prevention.—The Chelsea Electricity Supply Company, in order to provide against danger of fire at their Draycott-place station, have fitted a number of Merryweather's improved terminal hydrants, which are connected with the water mains. Similar apparatus and accessories have been supplied by Messrs. Merryweather to the Metropolitan Company, the Brush Company, the Edison-Swan Company, and other electrical firms.

Fermoy.—Representatives from Mr. H. Simon, of Manchester, attended the last meeting of the Town Commissioners, and explained the terms upon which he was prepared to carry out the electric lighting of the town. Mr. Simon submits two schemes, one to carry out the work at his own expense, and the other for the carrying out the scheme on a system of deferred payment by the Commissioners. The Board consider these propositions fair and reasonable, and a decision in the matter is to be come to on an early day.

Fulham (London, S.W.).—The Vestry Clerk has been requested to invite three electrical engineers (to be selected by the Electric Lighting Committee) to state their fees for preparing reports on, and estimates of the cost of, the installation and maintenance of the electric light for the parish, in conjunction with a refuse destructor scheme. The Committee have asked Prof. W. Garnett to advise them on the selection of an expert.

Gas Pipes.—It is said that Chicago is so grid-ironed with gas pipes that no more can be laid in the middle of the streets. The side-walks will be requisitioned in the event of more pipes having to be laid.

Halifax.—Mr. T. P. Wilmshurst, the Corporation electrical engineer, is reporting upon the proposed extension of the electric lighting mains to the Skircoat district. It is also under consideration to extend the electric light to the Halifax New Infirmary.

Hammersmith (London, W.).—At the last meeting of the Hammersmith Vestry the Electric Lighting Committee reported that the sub-committee which was recently appointed had visited the electric lighting installations at Chelsea, Ealing, St. Pancras and Portsmouth, and had carefully considered the various systems in use at those and other places, but they could not at present advise the adoption of the report presented by Messrs. Morgan Williams and King. The sub-committee recommend the Vestry to advertise

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for complete schemes and tenders for the necessary plant for lighting the compulsory area, and that when such tenders and schemes are received the Vestry consult one or more engineers to advise them. This recommendation was agreed to.

Holbeach.—At their meeting on Tuesday the Urban District Council had under consideration the tenders recently received for lighting the streets of the district (by oil, gas, or electricity). The oil tender amounted to £140, the gas tender to about £165 (£2. 3s. per lamp, or 4s. 2d. per 1,000ft. consumed), while the electric lighting tender was £210 per year for a period of seven years. It was finally decided to adopt a penny wise and pound foolish policy by accepting the gas tender.

Hull.—The Electric Lighting Committee having considered the new Board of Trade Regulations, think that there are many objectionable points to be raised, and in this view are supported by the Electric Lighting Committee of the Borough of Lancaster. Exception is taken by both bodies to the distance limit of the supply area, which is considered to act detrimentally upon the application of electricity to tramway purposes, and upon this question the Hull folks feel strongly, as complaints are general of the parlous condition to which the present tramway system has drifted.

Ilfracombe.—The District Ccuncil have received a letter from Messrs. F. W. Ball and Co., of Bristol, asking if the Council had any objection to the starting of an electric lighting station, but the Council have replied to the effect that they wish to retain the electric lighting powers in their own hands.

Lancaster.—At the last meeting of the Electricity Supply Committee of the Town Council it was decided to extend the electric light mains in several districts at a total estimated cost of £2,035.

Medical Electrical Institute (Limited).—The official report of Mr. J. C. Stewart, official receiver and liquidator in this failure, is issued, and shows liabilities of £11,614, with an estimated deficiency of £5,472. The report enters into a lengthy review of the formation of the Company on the ashes of Harness's Medical Battery Company, which concludes as follows :—"Upon the commencement of business by the new Company advertisements seem to have been inserted in various newspapers upon a considerable scale, in the hope that, as a result thereof, the demand by the public for the medical and electrical appliances sold by the Company would greatly increase, it appearing that the former prosperity of the old Company was in a large measure due to a system of extensive advertising. In this hope, however, the Board were disappointed—the secretary states that the advertisements did not produce sufficient business to pay expenses." While it is satisfactory to find that this attempt to resuscitate a concern which was proved in court to be a gigantic fraud upon the public was unsuccessful, it shows clearly that influential organs of the press are not above inserting advertisements which can only serve as a snare for the unwary. In this case the public had been put upon their guard ; little thanks for this is, however, due to the principal organs of public opinion.

Middlesborough.—At a meeting of the Electric Lighting Committee of the Corporation on Wednesday, it was agreed to recommend the Council to light the town by electricity at an initial estimated cost of £25,000, for which borrowing powers are likely shortly to be sought.

Newcastle-on-Tyne.—The Electric Light Committee of the Town Council have considered the report of Prof. A. B. W. Kennedy (abstracted in our issue of the 17th ult.) on the proposed purchase by the Corporation of the undertakings of the two local electric light companies, and they recommend the Council not to purchase the rights of the companies on the terms set out in the report. Although the Committee have come to this conclusion, they have instructed the Town Clerk to make inquiries concerning the best means of providing an independent electrical supply, and the Committee will afterwards consider the advisability of obtaining powers therefor.

Obituary.—We have to announce the death of Mr. W. C. Deeley, Chairman of the Electric Light Committee of the Chester City Council. The deceased was Managing Director of the Dee Oil Works (Limited).

Oldham.—The Electric Lighting Committee have prepared their statement of accounts for the year ended March 25th last, which shows that the expenditure on capital account during the year to have been £608. 2s. 1d. The total capital expenditure to date was £25,380. 1s. The gross revenue for the year amounted to £1,915. 16s. 4d., and gross expenditure to £1,271. 18s. 3d., or a balance of £643. 18s. 1d. The interest on loans was £643. 3s. 9d., and the amount set aside for sinking fund was £153. 6s. 9d., thus making a deficiency on the year's working of £152. 12s. 5d. The price for electric current had been 6d. per unit to all consumers. The amount sold to 55 consumers has been 66.998 units, and the number of meters fixed on March 25th was 62. The number of equivalent 8-c.p. lamps supplied was 8,940, an increase of 5,021 over the previous year. During the year the supply mains at the Bottom-o'-th'-Moor were extended 180 yards. The total length of mains is now 4,576 yards. The Chairman and other members of the Committee have expressed their great satisfaction at the report, and have complimented the officials of the electric light works upon the success of their efforts. The Committee have decided to apply for powers to borrow a further sum of £15,000 for extensions.

Portsmouth.—In this town and the surrounding district the electric light is rapidly overtaking gas, and is coming into quite general use. The Asylum Committee have resolved to introduce electric light into the huge establishment at Milton, where the gas bill is £700 per annum, and the electric light fittings for which are estimated to cost £550. The Clarence Esplanade pier is to be lighted electrically, and throughout the municipal buildings gas is being superseded wherever possible. The many advantages of the electric light over gas are obtaining full appreciation in this town.

Provisional Orders.—The Stirling Electric Lighting Provisional Order has been passed by both Houses of Parliament. The Bill promoted by the Southampton Town Council has been read a second time by the House of Lords and referred to a Select Committee.

South African Telegraphs.—In his speech on the opening of the Transvaal Volksraad last month, President Kruger said the Government proposed to lay before the Volksraad a contract entered into between representatives of the Eastern and South African Telegraph Company and the Transvaal Government, whereby, by granting an annual subsidy to the Company, a considerable reduction in the charges for cable messages would be effected. Since this measure would be of great benefit to the population, the Government hoped the Raad would approve of its action.

St. Pancras (London, N.W.).—At the last meeting of the Works Committee of the Vestry it was stated that an application from the London Hydraulic Power Company for leave to lay mains for the service of business premises in Charlotte-street, to extend along Tottenham Court-road, Windmill-street, and across Charlotte-street, had been received. Mr. Matthews said that as the Electricity Department could supply motive power, it was unwise to give permission to a private company to tear up the streets merely for one customer, and it was resolved to forward the letter to the Electricity Committee for their consideration and report.

Telegraph Clerks' Grievances.—At a meeting of the Edinburgh Telegraph Clerks' Association, held last week to consider the recent decision of the Postmaster-General in regard to the appointment of a committee to inquire into their grievances, resolutions were passed expressing regret that the Postmaster-General has not seen his way to grant an inquiry into their case by a Parliamentary Committee, as was done in the other branches of the Civil Service ; and that with a view to mitigate the entire want of confidence which a departmental committee inspires, this meeting urges that both in the interests of the public and of the service the inquiry be public, and that while the telegraph case is being considered at least one working telegraph clerk be placed upon the committee.

The Telephone in Dublin.—A meeting of the members of the Mercantile Association who are subscribers to the telephone was held last week to discuss the grievances of the subscribers. The meeting, which was influentially attended, was presided over by Mr. Councillor Graham, who said they were aware that a serious breakdown had taken place in their telephonic communication, which lasted for 10 or 12 weeks, and had caused a serious loss to the mercantile community of the city. They complained that the National Company had disregarded their protests, and had bound them to the letter of their contract to pay for the telephone whether it was in usable order or not. He considered this an unreasonable position for the Company to take up, and he thought they should not demand the whole year's rental. Subscribers did not claim compensation, and were willing to say nothing about the serious loss they had sustained, but they did complain that, in addition to this loss, they were compelled to pay the Company for a thing they were not in a position to supply. This was a view of the question which deeply concerned telephone subscribers throughout the country, and perhaps this was the reason the Company had met their request with a *non possumus*. Their complaint was that when the breakdown occurred the National Company did not act with expedition, which they considered was a serious breach of contract on the part of the Company, who should use reasonable care, first to preserve the wire, and next, if a breakdown did occur, to have them repaired and put into working order immediately. There were other grievances, including the inattention of the operators and the contact of the subscribers' wires, which cause serious delay. Mr. T. Edmondson proposed a resolution embodying the complaints enumerated by the Chairman, and urging all subscribers to pay only for the time during which their telephones had been in working order. He said there was no desire

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to oppose the Company in any way, as it was to the subscribers' interest to work amicably with them ; but the unreasonable conditions of the National Company necessitated their taking steps to protect the subscribers' interests. Mr. Malcolm Inglis proposed that a guarantee fund should be established to fight a test case, and this proposal met with the sanction of the meeting, which at once subscribed upwards of £100, on the understanding that, if the Company met the Association in a reasonable manner, no necessity would exist for further proceedings.

TUNBRIDGE WELLS.—The Electric Lighting Committee have adopted Mr. Preece's recommendation that the electric light mains should be extended along Mount Ephraim, Monson and Calverley-roads, at an estimated cost of £630. 10s. The Committee have also resolved to engage Mr. Preece to prepare plans and estimates, and to do all work required from the electrical engineer up to the obtaining of the sanction of the Local Government Board to the additional loan of £12,000, which the Town Council recently decided to borrow for electric lighting extensions, including attendance at the public inquiry, and that he be paid for these services 2½ per cent. upon the amount of his estimate, it being understood that in the event of the Council desiring Mr. Preece to undertake the superintendence of the carrying out of the works covered by the new loan he will give the same services as he has done in respect of the present works for an additional 2½ per cent. on the amount expended.

WANDSWORTH (LONDON, S.W.).—The General Purposes Committee of the District Board of Works have passed resolutions approving of the proposed laying of conduits for electrical conductors by the County of London Company, subject to certain conditions as to the work being executed to the satisfaction of the Board's Surveyor, &c. Mr. Dunkley, in discussing the Committee's recommendations, said that the residents in the district were earnestly awaiting the introduction of the electric light, and the opposition would prove futile.

WAREHOUSE LIGHTING.—The *Drapery World* points out that the use of the electric light in wholesale and retail drapery houses has been much increased during the past 12 months, owing to its having been found both healthier and cleaner than gas, as well as more convenient. The extensive range of warehouses of Messrs. John Howell and Co. (Limited), which have large basement spaces to be lighted, have recently been installed with the electric light, a complete plant having been put down under the supervision of Mr. Albion T. Snell, of Suffolk House, Cannon-street, E.C. The motive power is supplied by a 12 nom. H.P. Crossley gas engine, which drives a 12-unit dynamo, and the plant includes a battery of accumulators. At present 200 incandescents are used.

YORK.—The Streets and Building Committee, in reply to a letter sent to Prof. Kennedy, have received a reply to the effect that, as their request involves a deliberate opinion from Prof. Kennedy of the best system of lighting the city by electricity, he is unable to give this opinion without a special examination of the city and its requirements. A special meeting of the Council is to be called for June 17th to further consider the tenders sent in for the electric lighting of the city.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

May 13, 1895.

9,406. G. HILL. Manchester. Improvements in electric switches.

9,429. H. GUTHRIE. London. Improvements in apparatus for electrolytical purposes.

9,433. R. BURN and L. G. TATE. London. Improvements in electrically signalling on locomotives and apparatus for that purpose.

9,442. G. G. M. HARDINGHAM. London. Improvements in means for insulating electric conductors. (The firm of Felten and Guilleaume, Germany.)

9,445. A. PELOUX. London. Improvements in electric meters.

May 14, 1895.

9,478. G. S. RAM. Coventry. Improvements in heating and cooking by means of electricity.

9,504. A. A. BARRATT and THE ARTISTIC LETTER COMPANY (LIMITED). London. Improvements in shades or reflectors for incandescent, electric and other lamps.

9.513. W. H. SHEPPARD. London. Improvement in electric lamps.*

9.515. R. D. CASSELS and G. DOWIE. London. Thermo-chemical processes for generating electricity.

9.521. J. IMRAY. London. A photographic telegraph recorder (Ader's system). (La Société Industrielle des Telephones and C. Ader, France.)

9,546. E. LACHMANN. London. Improvements in or relating to conduits for electric railways.

9,547. H. H. LAKE. London. Improvements in and relating to the attachment of an electric lamp to a cap or the like. (A. Rodriquez and E. D. Rockwell, United States.)*

May 15, 1895.

9,582. E. G. PULFORD. Liverpool. Improvements in electrical apparatus for transmitting signals between points or stations, such as street fire-alarm apparatus.

9,636. SIEMENS BROS. AND CO. (LIMITED) and F. BOOKER. London. Improvements in electric arc lamps.

May 16, 1895.

9,683. R. BELL. Glasgow. Improvements in apparatus for lighting railway carriages by electricity.

9,684. W. J. HARLING. Manchester. An improved commutator.

9,685. W. J. HARLING. Manchester. An improved brush-holder for dynamo electric machines and motors.

9,695. J. S. RICHARDSON and S. JEVONS. Birmingham. A new or improved hand electric gas lighter.

9,698. C. B. CRAWSHAW and R. KENNEDY. Bradford. Improvements in electrically-driven pumps and in apparatus therefor.

9,704. J. Y. PORTER. London. Improvements in electric track switches.

9,703. J. H. DELANEY. London. Improvements in electric heaters or rheostats. [Date applied for under Patents, &c., Act, 1883, sec. 103, November 23, 1894, being date of application in United States.]*

9,727. Sir C. S. FORBES, Bart. London. Improvements in and relating to telephones.

9,730. J. T. ARMSTRONG. London. Improvements in electric lighting apparatus for gas and oil lamps and burners

May 17, 1895.

9,779. W. MATHER. London. An improvement in secondary batteries.

9,784. F. LE ROY. Liverpool. Improvements in electrodes, pencils, filaments, or the like, for electric lamps of all kinds.

9,795. J. BONTHRON, W. HART and J. S. LUCAS. London. Improvement in conduits for electric cables.

9,805. R. COMBOUL. London. Improvements in diaphragms for use in electrolytical apparatus.

May 18, 1895.

9,864. R. C. QUIN and G. J. PHILPOTT. Brighton. An improved automatic safety clutch applicable to the suspension of electric arc lamps and for other purposes.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

1,542. COX and CROWLEY. Telegraphy.
6,458. DE FERRANTI. Dynamo-electric machines.
8,412. FRAZER. Controlling electric currents.
8,730. FROGGATT. Electric batteries for vehicles, &c.
8,825. ELECTRICAL INSTALLATION COMPANY (LIMITED) and O'BRIEN. Conducting electricity through table-cloths, &c.
9.605. MORDEY. Electric motors.
9,368. BRAIN. Electric fuzes.
10,140. HARTNELL. Electric current regulators.
10,353. MORRISS. Electric lamp, &c., fittings.
10.487. SULLIVAN. Electrical measuring and signalling instruments.
10,952. HOEPFNER. Electrodes.
11,160. RAVENSHAW and OTHERS. Starting electric motors.
11,452. CROMPTON and DOWSING. Electric conductors.
12,140. SWINTON. Electric igniters.
12,221. JOHNSON (Serve). Electrical furnaces.
12,650. DRAKE and GORHAM. Storage battery plates.
12,982. BROCKIE. Arc lamps.
13,267. HOPKINSON. Galvanometers.
14,691. LAKE (Cie de l'Industrie Electrique). Motors.
17,741. THOMPSON (Lessing). Galvanic batteries.
24,588. ROBINSON. Phonographs.

1895.

60. STEVENS. Arc lamps.
2,025. BRAHAM. Gas and electric light standards.
2,913. DEVONSHIRE (Priest). Controlling electromotors.
4,551. CLAREMONT. Electrical cut-outs.
4,939. ANDREOLI. Electrolysis.
5,500. LUCCHESINI. Incandescent electric lamps.
5,509. MARCUS. Incandescence lamps.

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COMPANIES' MEETINGS AND REPORTS.

Consolidated Telephone Construction and Maintenance Company (Limited).

The fourteenth annual ordinary general meeting of this Company was held at Winchester House, Old Broad-street, yesterday (Thursday), under the presidency of Mr. C. L. W. FitzGerald.

The SECRETARY (Mr. Charles Curtoys) having read the notice calling the meeting, the report of the Directors was taken as read.

The CHAIRMAN said: The report which we present to you to-day commences by showing you the operations of the past year, the manufacturing profit being the sum of £1,403, and the amount available for disposal—bringing into account the money we brought forward—is £2,866, from which we propose to pay you a dividend of £1. 10s. per cent., leaving a balance of £1,236 to carry forward. Now, gentlemen, we always have to refer to one subject—competition—which becomes more and more severe. What I discover is this—that our wages come to pretty much the same, and the amount we expend on materials to very much the same, but somehow or other, at the end of the year, we always have less profit. The amount we sell in gross means the same quantity of stuff pretty well, but its value is less. The year before last it was £17,000, last year it was £15,000, and this year it is £13,000; that is roughly speaking, of course. What I personally consider is that we are the victims of free trade, foreign competition, and high workmen's wages. There is no getting away from that. The telephone business is not a business which you can, as I may call it, ram down people's throats. The people who purchase the telephone are limited in numbers, and you cannot keep trying to sell telephones to people who have no use for them. A gentleman who buys a telephone cannot put it up for himself. In fact, your customers are, and always will be, limited, and that is one of the difficulties of this business. As to wages, however, we find that the lease of the factory is up at the end of the year, and we propose to move away from London, if we can get a suitable place, where wages are lower, where we hope to get coal cheaper, and where, possibly, steadily holding our own manufactures, we shall be able to make more profit for you. In addition, we have entered into an agreement which may turn out very valuable. It is in connection with a novel form of electrical battery, and we have entered into this agreement with the patentees of the capsule battery. The invention being new, it will, of course, require a very considerable amount of pushing to sell to the various people who are likely to use it; but with that we have nothing to do. We have to manufacture for the Capsule Battery Company, they doing the canvassing and getting the orders, but being bound to give us any order they receive for the next 14 years, or, I should say, for the term of the patent. I can see in that the possibility of this Company reaping a large profit. It is a very ingenious little article, and will do all sorts of things. It will fire a mine; it can be used for medical batteries, for ringing bells, and for electrical brushes. It can, in fact, be applied to a great many things where electricity is used. The next matter, which I will not go fully into now, is the question of our being able to manufacture things other than electrical, but that will come up at our extraordinary general meeting afterwards. I now come to what I consider the most important point in this report—namely, the lawsuit in Belgium, undertaken in conjunction with the Edison Gower-Bell Telephone Company, against infringers of the patent held by the Company, which resulted in a successful appeal against the previous decision, and the Court now has ordered a claim to be sent in for damages. Now, gentlemen, I think it would be well if I were to give you a slight history of this action; perhaps there are a good many shareholders who do not know anything about it. When my colleagues and myself in 1884 came into the management of this business we found that we—or rather the Edison Gower-Bell Telephone Company—had got a patent in Belgium, and that some people in that country were using our patent. I went to Belgium in 1886 to examine into this question, and I thought—and we all thought—that as our patent was extremely good, the people who were using it ought to pay us a royalty. I remember that at one of our meetings you passed a resolution authorising us to go into the actions, which commenced in December, 1886—nine years ago. After several failures at law we resolved to appeal, and in January, 1894, appeal proceedings commenced at Liège. In June, 1894, the Zurich company against whom proceedings were taken were found in damages and costs, which we have since been trying to get assessed. That means that we have finally won against this particular company, and we were ordered to send into the Court our claim for damages. Of course we did that as quickly as we possibly could, and since then—it is another year—we have been trying to force these legal gentlemen on either side to say that we have got no damages or that our damages are substantial, as the case may be. We have done the very utmost to expedite this lawsuit, and one can hardly believe it was possible for it to last so long. We do not know what we can do, but we keep on worrying the people over there. What damages we may ultimately get I cannot say. All that I can hope with regard to this particular point—which is really an important one to us—is that we may have something definite to tell you by the next time we meet. I now come to a paragraph which I hope will please the shareholders, namely, that the Directors have resolved, although our fees are charged in the accounts, to defer the payment of them. The remaining subsidiary company which we are interested in has again shown satisfactory progress, and when I come to the figures I will show you that it has perhaps done more satisfactorily even than it looks. Our trading account, as I have already told you, shows a profit of £1,403, which is considerably less than it was last year, when it amounted to over £3,000. The interest from our investments is about the same, with this exception that we received a large sum of money from the Austrian Company. On the other side there is not much difference to call attention to. The travelling expenses are slightly more than they were last year, and the income-tax is less. The legal expenses, I regret to say, are higher, but that is on account of the new business—the matters arising through the agreement and examining those things which had to be inquired into. The amount carried down is £606, to which we add the £1,301 balance of the revenue account from March last year, less the dividend passed by the shareholders at their meeting on May 31st following; the unclaimed dividends forfeited, £77, and the legal expenses *re* the Belgian patents £1,015. This sum represents the disbursements made in the lawsuit and charged against the profit in previous years, but now held up as recoverable. In respect to the sum we have charged our accounts with from time to time in connection with the Belgian lawsuit, we have decided, with the consent of our auditor, to write back that amount as profit taken from the shareholders at various times, the sum being now fairly recoverable in the lawsuit. With that amount we are enabled to carry down the sum of £2,866. We have made a little alteration in the accounts, for we have put the Edison Gower-Bell dividend, which has not been paid, to a revenue suspense account, instead of putting it up in the revenue account as so much due to us. That appears also on the *contra* side. The item of plant and machinery stands at £5,642 against £5,479. The next item is the cost of the installation of private lines. We spent this year in putting lines for subscribers to our private wire system £385, as against £399 last year. Our stock of instruments on hand is £7,296, against £7,422. Of our subsidiary companies, the Anglo-Portuguese Company last year owed us £5,170, but this year this Company owes us only £3,094. In other words, it has paid over £2,000 to us for back money that was owing. By other companies and persons we are owed £2,506, as against last year £2,165. The expenses connected with the patents represent the total expenditure on the lawsuit in Belgium—£1,691, and that, ranging over nine years, is not a very large amount. I do not think there is any other item to refer to except the loans. Last year we had £600 loaned to the Edison Gower-Bell Company, and this year that has been raised to £1,080, and we have also loaned the Capsule Battery Company £1,000 to take out foreign patents, of which we shall probably get the benefit by manufacturing the apparatus. On the other side of the balance sheet there is a very gratifying item. This year our creditors only amount to £757, while last year the amount was £2,194. The balance of net profits to March 31st was £2,866, as against £3,484 last year. In our valuation of securities there is an item of £500 for our shares in the United River Plate Telephone Company. Those shares in the market do not stand at that value, or anything like it; but when I tell you that but for the premium on gold in the Argentine Republic that Company would be paying us 13 per cent., I do not see that there is any harm in letting this item stand in the balance-sheet at £5,000, although it may only be worth £2,000. As I have always said, if we write down we must write up. I now propose the adoption of the report and accounts, and the payment of the dividend.

Sir ALEXANDER ARMSTRONG, K.C.B., seconded the motion.

Mr. BUCK said that to his mind the Company was in an unsatisfactory condition. He thought the Chairman had been most explicit with them, and that he and his colleagues on the Board had done all they could for the shareholders. He would like to know the opinion of the Board with reference to the actual value of their holdings in the subsidiary companies.

Mr. C. WOOLLEY said he felt indebted to the Board for looking elsewhere with the object of making profits in the face of existing difficulties. There was a great agitation at the present time with regard to the telephone, and their Company might come in for a share of the good things which, it was expected, would be going. As regarded the value of their goodwill and their interest in subsidiary companies, he understood that the Chairman had spoken with great care. With reference to the lawsuit, there were possibilities which might make the expenditure which had been incurred of £1,600 extremely valuable. Time after time they saw those who infringed patents brought to book and have to pay very handsome sums in the shape of royalties. As regarded the question of Directors' fees, he had been associated with a great many companies, and he always regretted where good suit and service was rendered that it was not properly compensated. He deplored the necessity which the Board had most manfully recognised in taking up the position they had done with respect to their fees. He wished to know, with respect to the £3,750 due to them from the Edison Gower-Bell Telephone Company, how did that sum come to appear in the accounts on the credit side, whether it was cumulative dividends, whether the amount represented a dividend payable, and, further, whether it was likely to be paid within a reasonable date. They held an enormous number of Ordinary shares in the Edison Gower-Bell Company and 20,000 Preference shares, but he saw no credit in respect of either for dividend.

The CHAIRMAN, in reply, said that the Directors felt that the report was not satisfactory, but they could not do more. As regarded the value of their holdings in subsidiary companies, they had £10,500 in 8 per cent. debentures of the Anglo-Portuguese Telephone Company. That was an asset which was worth a good deal of money if they could only get any one to buy it. Then there were their 6 per cent. debentures in the same Company to the amount of £1,700. That was a security paying the interest regularly, but they could not sell it, and that was their difficulty. The shares held by them in the National Telephone Company they could sell. The value of their shares in the Edison Gower-Bell Company, which figured at £11,000 in the balance-sheet, was rather a difficult matter. He would like to say when a dividend on these shares might be paid, but if he were to do so he would be only telling something to people on the other side of the water. It

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was not the cost of their factory that they complained of, but the cost of wages, coal, and raw materials generally. They undoubtedly paid far more wages in London than would be paid in Birmingham.

The resolution was then carried unanimously.

On the motion of Sir A. ARMSTRONG, seconded by Mr. HENRY GREWING, Mr. FitzGerald was re-elected to his seat at the Board.

Mr. J. G. Griffiths was re-elected as auditor at a remuneration of 60 guineas.

An extraordinary general meeting was subsequently held for the purpose of considering resolutions modifying and adding to the Articles of Association to enable the Company to manufacture, buy, sell, and deal in articles, apparatus and inventions in connection with the production, storage, transmission, or use of electricity, or to which electric power may be applied; to manufacture, buy, sell, and deal in mechanical apparatus, appliances and inventions, or parts thereof, whether connected with electricity or not, and to acquire and work letters patent and patent rights relating to such apparatus, appliances, and inventions; and also to sanction the alteration of the name of the Company to "The Consolidated Telephone Construction and Manufacturing Company (Limited)."

The CHAIRMAN stated that they found that the telephone business was too limited to enable them to make a profit, and they hoped the business they were going into would bring them better results. Of course they could not be sure of that, but as regarded the capsule battery, he felt pretty confident that it would prove advantageous to them. Anyhow, it seemed to the Directors that it was advisable to try and manufacture other articles, and make a profit out of them.

The resolutions were carried unanimously.

West Coast of America Telegraph Company (Limited).

The report of the Directors of this Company for the year ended December 31st last, to be presented at the eighteenth ordinary general meeting at Winchester House, London, E.C., on Tuesday, 11th inst., states:—

The gross income for the year 1894 was £21,753. 12s. 2d., as against £15,096. 4s. 3d. in 1893, and in order to provide for the payment of the debenture coupons, it was necessary this year to take £10,400. 12s. 9d. from the reserve. The total expenses were £20,154. 4s. 11d., against £19,632. 16s. 6d. in 1893. The sterling value of the local traffic for 1894 was again most seriously affected by the low rates of exchange, both in Peru and Chile, the value of the dollar in Chile having fallen as low as 10⅝d., and the average rate for the year was 12d., as against 14d. in 1893.

In view of the recent legislation in Chile, by which the paper currency of the Republic is to be replaced from June 1st by gold, on the basis of 18d. to the dollar, it may fairly be hoped that exchange in the future will not greatly fluctuate from that figure. It may also be anticipated that the use of the telegraph for commercial purposes will continue to increase.

The Company's cables and landlines, as well as the repairing steamer "Retriever," continue to be maintained in a state of efficiency, consistently with which every possible economy is practised with regard to the expenditure. The direct service between the Company's stations and Europe, via Madeira, appears to have afforded every satisfaction to the public. Mr. J. Denison Pender and Mr. Frederick Walters both offer themselves for re-election as Directors, and Mr. John Francis Clarke, the auditor, also seeks re-election at the meeting.

Hobart Electric Tramway Company (Limited).

The following is the report of the Directors of this Company for the year ended December 31st last to be submitted at the general meeting of shareholders to be held at College Hill Chambers, Cannon-street, London, E.C., on Tuesday next, at 12 o'clock:—

The Company entered upon the working of the line themselves as from April 1, 1894, and a great saving was thereby effected. Further economies, including costs of administration, are being carried out. The revenue, though not equal to the expectations formed at the formation of the Company, has been well maintained, notwithstanding the great depression that has prevailed throughout the Australian Colonies, and for the months of January, February and March of the current year shows a monthly increase over that of the corresponding period of last year.

A further issue of £5,000 Second Mortgage Debentures has been authorised, raising the total of Second Mortgage Debentures to £20,000.

The number of passengers carried by the tramway since the opening of the line in September, 1893, to March 31st last is 2,346,972, and the total number of car miles run is 554,316. Careful and exhaustive reports have been submitted by the Company's General Manager in Hobart, Mr. A. C. Parker.

The retiring Director (Mr. J. G. Bellamy) offers himself for re-election, as do the auditors, Messrs. G. N. Read, Son and Co.

NEW COMPANIES, STATUTORY RETURNS, &c.

VAL D'AOSTA ELECTRIC POWER COMPANY (LIMITED).—This Company was registered on May 27, 1895, with a capital of £80,000, in £10 shares, to carry on in any part of the world the business of suppliers of electric light and power in all its branches; to produce and accumulate electricity and other forces by the utilisation of water and other power; to make experiments in and public exhibitions of electric power and lighting, and electrical machinery and appliances; to carry on the business of electricians, electrical and mechanical engineers, and manufacturers of and dealers in every description of electrical apparatus, and to acquire the right to manufacture, put up and sell telephones, telegraphs, phonographs, and electrical apparatus. The subscribers, with 25 shares each, are:—Oswald Brown, civil engineer; Frederick A. G. Brown, merchant; Antonio Bigio, merchant; Niccolo Bruno, engineer; Philip Bright, engineer; R. F. Austin, solicitor; J. Hunter Jones, contractor; and Walter G. Kent, engineer.

ELECTRICAL OIL REFINING COMPANY (LIMITED).—An agreement has been made with F. B. Aspinall, electrical engineer, R. W. Hoar, G. H. Wise, J. Cecil Bull, and David Cook (vendors), which provides for the transfer to the Company of the vendors' interest in Patent No. 18,767 (1893) for improvements in bleaching, sweetening and purifying oils, provisional specification No. 11,324 (1894), for an improved process of refining cotton oil and separating colouring matter therefrom, and provisional specification No. 24,095 (1894) for improvements in obtaining coloring matters from cotton seed oil, and other like oils, in consideration for the allotment as fully paid to them of 1,493 £1 shares in the Company.

"ELECTRICAL PLANT" (LIMITED).—The annual return of this Company, made up to March 7, 1894, is filed. The nominal capital is £10,000, in £10 shares, of which 575 have been taken up. Of these 500 have been considered as fully paid, and the full amount of £750 has been called and paid on the remainder. Mr. H. Cuthbert Hall, consulting engineer, is Managing Director, and holds 515 shares.

ELIESON ELECTRICAL SWITCH (LIMITED).—The statutory return to October 9, 1894, is filed. The nominal capital is £5,000, in £1 shares, of which 3,506 have been taken up. Of these 2,500 have been issued as fully paid to C. P. Elieson, electrical engineer. The full amount has been called on the remaining shares.

CITY NOTES.

BELGRANO (BUENOS AYRES) GAS COMPANY (LIMITED).—Mr. C. P. Ogilvie, who presided at a meeting of this Company on Tuesday, said the consumption of gas in their district had increased 15 per cent. during the past year. The Company had incurred £500 expense in obtaining an Act of Parliament in order to preserve itself in Belgrano against the advent of electric light companies, but he did not think that at present the shareholders had anything to fear from electric light competition. The satisfying dividend of 1 per cent. was declared.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended June 2nd were £929 against £869 in the corresponding period of 1894, being an increase of £60. The total receipts for the half-year amount to £20,533, against £20,013 for the corresponding period of 1894, an increase of £520.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—This Company's estimated traffic receipts for the month of May were £2,017, against £1,594 in the corresponding period of last year.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of May, 1895, amounted to £68,382, against £54,846 in the corresponding period last year, being an increase of £13,436.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of May, 1895, amounted to £44,620, and to £43,960 in the corresponding period of last year, being an increase of £660.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL COMPANY (LIMITED).—The report of the Directors of this Company for the year ended December 31st last states that the second debentures have been reduced from £49,480 to £25,980 by redemption at a small cost in Preference shares. The accounts of the Metall Aktiengesellschaft show that additions and improvements to buildings, machinery and plant, increase in materials and stores in hand, and increase in the amount due from sundry debtors are the chief features. The amount due to sundry creditors is large, owing to the amounts payable to contractors on account of new plant. Although the new plant was not completed until the end of 1894, the sales had increased from £3,194 in 1893 to £8,131 in 1894, and the loss on factory account was practically nil. The working of the Company was greatly restricted by want of capital during the early part of the year, but with regard to the general work of the factory to date the Directors report satisfactory progress. Owing to various causes the rate of progress has not been so rapid as the Directors would desire, but the sales are over three times as great as for the same period last year. The report states that the Company are in receipt of an abundance of good paying orders, amongst which is the supply of copper tubes to the German Imperial State railways.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this Company for the week ended 2nd inst. amounted to £1,146, as against £830 in the corresponding week of last year, being an increase of £316.

REDUCTION OF CAPITAL.—Notice is given that a petition is to be heard by Mr. Justice Kekewich, on Saturday, the 15th inst., to confirm the resolution to reduce the capital of the British Electro-Medical Agency from £75,000 to £50,000, divided into 2,500 Founders' shares of £10 each and 5,000 Ordinary shares of £5 each. Mr. S. G. Spreat, 27, Nicholas-lane, London, E.C., is solicitor in the proceedings.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the week ended May 31st, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,659.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the half-month ended May 31st are £2,600, as compared with £2,412 in the corresponding period of 1894. The January receipts, estimated at £4,693, realised £4,756.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, May 29.		Price Wednesday, June 5.		Rate per Cent. Yielded.	Dividend Due.	Business Done during Week ending June 5.	
			TELEGRAPHS					£ s. d.		Highest	Lowest
£1,012,880	Stock	10 0	Anglo-American	46	48	46	48	4 3 4	Jan., Apr., July, Oct.	47	46
£2,993,560	Stock	20 0	Do. Preferred	84½	85½	84½	85½	4 14 2	" "	85½	85½
£2,993,560	Stock	5/0	Do. Deferred	8¼	8¾	8¼	8¾	..	.. ..	..	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 17 6	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	12¾	13¼	13	13¼	4 16 4	Mar., June, Oct., Dec.	13⅜	13
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 8 8	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	154	158	154	158	4 8 7	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	3½	4½	3½	4½	4 8 11	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10½	9¾	10½	4 7 7	" "	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	105%	108%	105%	108%	4 3 4	.. ..	..	..
60,710	20	2/0	Direct United States Cable, 1877	9¼	9¾	9¼	9¾	4 0 5	Jan., Apr., July, Oct.	9¾	9½
400,000	10	2/6	Eastern	16¼	16½	16¼	16½	3 18 9	" "	16½	16¼
70,000	10	6%	Do. 6 per Cent. Preference	17¼	17¾	17¼	17¾	3 7 7	" "	17 7/16	..
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	123	126	123	126	3 3 6	May and November	125	123½
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	109	106	109	4 18 3	February & August	..	..
250,000	10	6/6	Eastern Extension	16⅞	17⅜	16⅞	17⅜	4 7 7	Jan., Apr., July, Oct.	17 1/16	16 15/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	124	127	124	127	3 3 0	February & August	..	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	104	108	104	108	4 14 7	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	104	108	104	108	4 14 7	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	107	110	107	110	3 13 7	February & August	107½	107
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	111%	114%	111%	114%	3 10 4	May and November	..	..
180,227	10	2/3	Globe Telegraph and Trust	10	10¼	10	10¼	3 12 0	Jan., Apr., July, Oct.	10 3/16	10 1/16
180,042	10	6%	Do. 6 per Cent. Preference	16¾	17⅛	16¾	17	3 0 7	" "	17⅛	16⅞
150,000	10	7/2	Great Northern	21¾	22¼	21¾	22¼	3 11 1	Jan., April, and July	22¼	22
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	..	..
17,000	25	37/6	Indo-European	44	47	44	47	5 6 5	May and November	46	45
37,548	10	2/6	London Platino-Brazilian	5	7	5	7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	106	110	106	110	5 10 1	March & September	..	—
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	105	109	106	109	3 14 7		..	—
11,839	8	4/0	Reuter's	3½	4½	3½	4½		April and October	..	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	124	129	124	129	4 13 0	" "	126	..
15,609	10	5/0	West African Telegraph	4½	5½	4½	5½	..	January and July	..	—
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	102	105	102	105	4 16 5	March & September	..	—
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	2 5/16	1⅞
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	100	105	100	105	7 12 5	June and December	..	—
88,321	10	6d.	West India and Panama	¾	1	¾	1¼	..	.. ..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10	10½	9¾	10½	5 6 8	May and November	10	9¾
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	6 6 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110	113	110	113	4 10 4	June and December	..	..
64,242	15	6/0	Western and Brazilian	10¼	10¾	10¼	10¾	4 17 11	May and November	10⅝	10½
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	—	6½	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4¼	4¾	4¼	4¾	..	..	4⅝	4⅜
£171,200	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	103	107	103	107	5 14 3	February & August	..	—
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	103	107	103	107	5 14 3	" "	..	—
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	5 19 2	May and November	..	—
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	101	103	101	103	5 18 10	March & September	..	—
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	—	..	3 9/16	3½
224,850	10/0	2¾d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	—
171,504	£1	8·215d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	..	..
484,597	5	2/6	National	5⅜	5⅝	5⅜	5⅝	4 5 1	June and December	5¾	5⅝
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15½	16½	15½	16½	3 12 9	" "	16½	16
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½	15½	14½	15½	3 17 5	" "	15⅜	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅜	6⅛	5⅜	6⅛	4 1 8		5⅞	..
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	104	106	3 6 0	January and July	104¾	..
58,000	5	1/0	United River Plate	1	2	1½	2½	..	" "	..	—
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	85	90	87	92	5 8 8	" "	89	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	14	15	14	15	1 13 4	—	14⅞	..
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15½	16	15½	16	3 15 0		15 15/16	15 9/16
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	—	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	—
8,322	£5	..	House-to-House Electric	..		..		..	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		..	..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	—	—
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7¼	7⅞	7¼	7⅞	..	—	..	—
111,000	5	..	London Electric Supply	..		..		..	..	..	—
49,900	£10	6/0	Metropolitan Electric Supply (fully paid) xd	10¾	11¼	10¾	11¼	2 13 4	..	..	..
£150,000	Stock	4½%	* Do. 4½% Debs.	117	119	117	119	3 16 11	June and December	119	117
6,452	£10	2/0	Notting Hill Electric	8	8½	8	8½	..	..	..	..
19,980	£5	4/6	St. James and Pall Mall	8¼	8¾	8¼	8¾	..	—	..	..
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9¼	8¾	9¼	3 15 8	—	..	..
59,900	5	5%	Westminster Electric Supply (fully paid)	7¾	8¼	7¾	8¼	3 2 6	..	..	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅜	2⅝	2⅜	2⅝	5 14 3	—	2 9/16	2 7/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2¼	2½	4 16 0		2 9/16	2 3/16
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	113	116	112	115	3 18 11	March & September	113¾	113
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2½	3	2½	3	—	January and July	..	—
12,139	5	—	Edison and Swan United	1¾	2¼	1¾	2¼	—	..	—	—
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		—		—	..	—	—
120,000	2	..	Electric Construction	½	¾	½	¾	..	..	—	..
12,845	2	2/9¾	Do. 7 per Cent. Cumulative Pref.	1½	2	1½	2	—	..	..	—
91,195	2	10/0	Elmore's Patent Copper Depositing	1	1¼	1	1¼	..	..	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	—	..	1⅛	1
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	February & August	22⅜	22
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 7 2	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..		..	..
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	⅛	⅜	⅛	⅜	..	..	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	42	44	43	45	5 6 8	March and July	44½	43¾
£150,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4 11 9	January and July	..	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,870	10	12/0	W. T. Henley's Telegraph Works Ordinary	10	11	10	11	5 8 1	..	..	..
£30,000	10	7%	Do. 7 per Cent. Preference	13½	14½	14	15	4 13 4	..	..	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1¼%	City and South London Railway	44	46	44	46	2 14 4	May and November	..	..
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	14¾	—
£67,130	Stock	4%	Do. 4% Perpetual Debenture xd	131	133	131	133	3 0 2	May and November	..	..
37,500	£10	2%	Liverpool Overhead Railway	9⅝	9⅞	9⅞	10	2 0 0	..	..	..
6,295	10	5%	Do. 5% Preference	14¾	15¼	14¾	15¼	3 5 7	..	..	..
125,000	Stock	4%	Do. 4% Debenture	111	113	111	113	3 10 2	January and July ..	..	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 891. [No. 7. Vol. XXXV.] FRIDAY, JUNE 14, 1895. PRICE SIXPENCE.

NOTES.

THOSE who are accustomed to compare the exhibits of scientific and artistic interest at the soirées given by the Royal Society from time to time will have observed that, as a general rule, the exhibits are more of artistic and less of technical interest on the occasions of the ladies' soirées, and last Wednesday's function formed no exception to the rule. Artistic exhibits abounded; but the number of electrical exhibits was noticeably small. Yet, what there were of the latter were intrinsically interesting; even though the majority of them had been on show in May. Undoubtedly the most attractive of the electrical exhibits was the POSTMASTER-GENERAL's demonstration of the new telephone trunk-line system connecting Edinburgh, Glasgow, Leeds, Belfast, Dublin, and Cardiff, all of which places were duly and successfully "called up." There had been the official inauguration of this telephone trunk system at the General Post Office earlier in the same day, and on both occasions speaking with each of these towns was remarkably distinct and loud, and singing, laughing, and even Scotch humour came through without any appreciable "distortion." Nor did inductance or capacity seem to be too formidable for the droning of the melancholy bagpipe.

OF the other exhibits, we may mention the collections of drawings of the electric arc, by Mrs. AYRTON, together with a number of carbons used in the researches to which these drawings relate. A 8-dimensional model, showing the surface which is the *locus* of the curves obtained by Mrs. AYRTON in these arc investigations, was shown by Mr. A. P. TROTTER. The electric furnace exhibited by Prof. ROBERTS-AUSTEN demonstrated the practical applicability of the electric arc in the metallurgy of highly refractory metals. Other electrical exhibits were made by Sir DAVID SALOMONS, Prof. RAMSAY—who showed spectra of argon and helium—Prof. EWING and Miss ALICE LEE. The last-named exhibitor showed a set of curves demonstrating the development, propagation, and and dying-away of Hertzian waves, and it is intended, when the set is complete, to have the curves photographically reduced and placed in a zoetrope, so that the phenomena may be optically demonstrated.

SINCE the meeting of the Electrical Trade Section, which was held on Tuesday to discuss the revised Board of Trade Rules for securing the public safety, wisely resolved itself into a Committee, a proceeding which was not inconvenienced by an over large attendance, we are only at liberty to state that the rules were gone through one by one, and received careful consideration; the treatment, however, was not sufficiently drastic to suit one gentleman present, evidently a lineal descendant of the inventor of "Pride's purge." We may add that the Board of Trade has courteously extended the time for sending in suggestions to the 15th inst., and that efforts are being made to ensure that the emendations proposed by the Institution of Electrical Engineers, the Electrical Trade Section, and the Borough Electrical Engineers assembled in council shall all be on the same lines. In any case the Board of Trade will be difficult to move. Without some common agreement as to the modifications to be proposed, the Department may very possibly afford the electrical industry an opportunity of solving the well-known problem of the immovable body and the irresistible force, with the latter factor left out.

As suggestions are the order of the day in this connection, we may be forgiven for hazarding one ourselves. A good modification of Rule 4, the idea of which is apparently to limit the magnitude of the disturbance caused by the breakdown of a long-distance feeder, would be to forbid any single line to carry more than a certain percentage of the total output of a station, a special exemption being accorded to stations with specially small outputs. To rigidly fix a certain maximum for all cases is both unnecessarily hampering future and irritating present central station engineers.

GENERALLY speaking, the Board of Trade, in its anxiety about the public safety, seems to have entirely lost sight of the public convenience. The automatic cutting out of every line and machine which may happen to be momentarily behaving abnormally, would conduce rather to an increased demand for gas than to safety. The first duty of a central station engineer is to maintain the supply. In the performance of this duty the Board of Trade do not appear disposed to afford him any assistance, except of an academic order. We have most of us at one time or another experienced the calm frame of mind which is brought about by the airy advice of a fashionable physician to a busy man to take a three month's complete rest at an expensive and far-distant health resort; beyond his purse and beyond his reach. Something of the same chastened mood may be expected to

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follow on the cheery advice which the Board of Trade by implication gives to central station engineers, namely, to duplicate and triplicate everything, and thus set eccentric automatic cut-outs, *et hoc genus omne*, at defiance. It can be done, of course, if the public will only foolishly find the money.

THE old A. T. *v.* B. T. controversy, which was so fiercely fought out seven years ago at the Society of Telegraph Engineers and Electricians, and which has since burst forth at irregular intervals in semi-extinct volcano fashion, had one of its remittent eruptions last month at the Northern Society of Electrical Engineers, the occasion being the reading by Mr. J. C. HOWELL of an able and interesting Paper on "Uses of Accumulators." There were not quite so many polemics and hypothetical statistics last month as was the case in April, 1888, but what was lost in excitement and prophecy was more than gained in knowledge. So long as human nature remains what it is, it will probably continue to find a vent for its superfluous loquacity in controversy, and had the A. T. *v.* B. T. question not cropped up, probably the sine curve or some other such battle would have been more deadly. That there has been any controversy at all is, perhaps, due as much to the excessive ardour of the secondary batteries advocates as to the not unreasonable aversion of the average electrical engineer to filling up his station with imposing rows of glass vats filled with acid. Even in the pre-central station era of seven years ago, the advantages of storage were sufficiently obvious. But to-day, what with elaborate costs analyses, peaky load-curves, and ugly coal bills, even the most obdurate would hail a genuine means of storage as a relief. One can scarcely imagine our good friends the gas engineers throwing heretical doubts on the utility of the gasometer, but that is simply because its utility is so absolutely beyond dispute. When the advocates of accumulators are able to bring forth an electrical equivalent of the gasometer, the A. T. and B. T. controversy will become an extinct volcano. Meanwhile, the B. T. men must expect to see their claims very closely scrutinised. It may be quite possible to reduce one's generating expenses, say to 1½d., by the judicious use of accumulators, but with accumulators as we now know them, central station engineers have ever to be on their guard lest in effecting this economy they sink so much capital in acid-holding vats that the extra profit which thereby accrues is insufficient to pay the increased sum required for interest.

THE point raised by Mr. COWAN in the discussion on Mr. HOWELL'S Paper, a point which he elaborates in an article appearing elsewhere in the present issue, was, we think, effectually disposed of by Mr. HOWELL in his reply. Mr. COWAN argues that the only saving which accumulators can effect must be made on the units actually taken out of the batteries, and as these units are usually but a small percentage of the total units generated, therefore the saving on the cost of the total output must be very small. Leaving out of consideration the fact that the judicious use of accumulators enables, in some instances, an entire shift, or even more, as at Belfast, to be dispensed with, and that in all cases it tends to reduce the number of men required at a central station, it is obvious, we think that accumulators, if properly made use of, enable *all* the units generated to be generated by engines running at a tolerably close approximation to full load, an approximation which can only be secured otherwise by a very minute subdivision of plant; an expedient which in its turn introduces many fresh difficulties and sources of loss.

As is so often the case with the Northern Society, the discussion was of a thoroughly practical nature, the speakers being in every case actual or potential users of accumulators. We have of late heard much about high-rate-of-discharge accumulators; but, as Mr. RIDER pointed out, these would be still more valuable were they also capable of being charged at a high rate.

IN our "Correspondence" columns this week will be found a letter from Prof. ZICKLER concerning his electro-dynamometer, which we recently described. We are glad to note that Prof. ZICKLER has turned his attention specially to the elimination of the induction variation. The equalisation of the turns on the fixed and moving coils would reduce the self-induction of the instrument from its present value of 2·76 henrys to about 0·07 henry, if the same product of turns were retained. As this value of the self-induction, however, makes the induction variation practically *nil*, it would be possible to increase the turns, and thus reduce the current, without an undue self-induction. If Prof. ZICKLER finds it practicable, by the use of the aluminium coil, to approach equality in the turns of the fixed and moving coils without seriously affecting the accuracy of the watt readings, or increasing the weight of the suspended system, the value of his instrument will be very greatly enhanced.

IT will be seen from our "Legal Intelligence" this week that the Parsons turbine has again been invoked to stay vibration, the City of London Electric Lighting Company having, on Mr. FRANK BAILEY'S advice, decided to replace four of its vertical engines by steam turbines. The Company's appeal to the House of Lords in the action brought against it by Mr. SHELFER has, in consequence, been withdrawn. An engineering victory is always to be preferred to a legal one; it is often cheaper in first cost and always so in the long run.

IN our "Correspondence" column this week will be found an interesting letter from Mr. H. F. PARSHALL referring to our recent comments on Prof. H. J. RYAN'S Paper on "Improvements in Armature Ventilation." Mr. PARSHALL says that his own experience confirms our criticisms and statements; and his letter is a very instructive amplification of the views which we had previously advanced.

Conversazione of the Institution of Electrical Engineers.—The annual conversazione of the Institution of Electrical Engineers will be held in the Galleries of the Royal Institute of Painters in Water Colours, 191, Piccadilly, on Wednesday evening, July 3rd, from 9 till 12 o'clock.

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University College, London.—Particulars are given elsewhere of the courses of instruction in mechanical, civil, and electrical engineering, which commence on October 1st, and are arranged to cover periods of two and three years.

Cable Interruptions:

	Date of Interruption.	Date of Repair.
Chorillos—Iquique	June 4th, 1895.	June 5th, 1895.
Mollendo—Arica	June 4th, 1895.	—
Laurenço Marques—Mozambique	June 9th, 1895.	—

Royal Institution.—At a general monthly meeting of the members of the Royal Institution, held on Monday last, the special thanks of the members were returned to Lord Playfair for his donation to the Fund for the Promotion of Experimental Research at Low Temperatures.

Damage by Lightning.—At Ardgay, last week, a gamekeeper was killed by lightning.——At Beauly, some people working on a farm were overtaken by a thunderstorm, and took shelter under some trees. Three of them were injured by lightning; their faces were burned, and all of them were more or less stunned.

The Chicago Lamp Tests.—Certain of the ancients believed in the existence of an ever-burning lamp. The *Electrical Review* of New York asks whether "it is possible the lamps submitted for test two years ago (at the Chicago Exhibition) are burning yet?" For no publication of these tests has yet been made.

Cambridge Engineering Laboratory.—Prof. Ewing announces that Mr. W. Mather, M.P., has promised to present to the engineering laboratory a 20-H.P. combined steam engine and dynamo of a modern high-speed type, specially adapted for experimental work. The engine is now in process of construction by Messrs. Mather and Platt.

Engineering Training.—A writer in the *Electrical World*, of New York, says that "the truth is that a first-class constructive engineer can be turned out in a year or two." In our opinion this is very far indeed from the truth; and the sooner young men realise the fact the better will it be for the future of the profession.

Royal College of Science (Ireland).—The next session will commence on October 7th, and entrance examinations for intending associates will be held on Monday, 17th inst., and on Monday, October 7th; the subjects are mathematics and elementary practical geometry. Some further particulars will be found in our advertisement pages.

A Mercury Rail Bond.—A novel form of electric rail bond has been proposed in America. The ends of the abutting rails are united by strips terminating in holes in the rail containing mercury. The holes are drilled in the side of the rail head with a downward and sideward inclination. Mercury is then placed in them to a suitable depth and the strips are driven in so as to enter the mercury and tightly close the holes.

Electric Tramway Competition.—While in New Haven, U.S.A., the effect of the electric tramway has been to reduce the number of licenced public omnibuses by 50 per cent. and the hacks by 30 per cent.; in Denver the electric tramway receipts have been terribly reduced by the 10,000 bicycles which are estimated to be used in that city, and the tramway company has had to reduce its expenses—otherwise, its servants' wages—to balance this loss.

Meeting of the German Electro-Chemical Society.—The annual meeting of the Deutsche Electro-Chemische Gesellschaft was held at Frankfort on the 6th, 7th, and 8th inst. Among the Papers read at the meeting were the following:—"Electrical Transmission of Power," by Prof. Ostwald; "Charging Accumulators by means of an Alternating Current," by Herr Pollak; "Calcium Carbide," with experiments, by Dr. Borchers; "On a New Electrolytic Analysis Method," by Dr. Jordes. Visits were also paid to the Pollak Accumulator Works and to the Gold and Silver Separating Works.

The Chicago and St. Louis Electric Railway.—But little, says the *Street Railway Gazette*, has been heard for the last year and a-half of the Chicago and St. Louis Electric Railway. Mr. Washington Adams, the projector, is quoted as saying that for the last few months the Company has been busily engaged in endeavouring to find a market for the bonds which the Company needs to sell before beginning the construction of the road. According to Mr. Adams, arrangements have now been made with Chicago bankers for placing $9,000,000 of the $10,000,000 worth of bonds to be issued.

The Light of the Future.—An American contemporary expresses its contemplation of the "light of the future" in the following extravagant rhapsody:—

> "When the sun's rays weaken, when the decay of a colossal planet is heralded to us, how shall we prepare for the inevitable darkness, or drive away the iciness of interplanetary space? The glow-worm has taught us its lesson; the will-o'-the-wisp is no longer a delusion. With a whip that science alone can control we will lash the ether until it gives to us the quivering light of dawn—the effulgence of the rising sun."

We really think the attention of the Royal Society for the Prevention of Cruelty to Animals should be called to this proposed wanton infliction of corporeal punishment.

The Ganz Company's Alternate-Current Patents.—Messrs. Ganz some years ago sued the local electric lighting company at Tours for infringment of their alternate-current system of parallelled transformers. The Court of Appeal at Orleans decided in favour of Messrs. Ganz, but the Tours Company carried the matter before the Court of Cassation, the highest tribunal in France, which has now given its decision, and confirmed the judgment of the Court below. A similar lawsuit, as we reported some time ago, was brought in Italy against Messrs. Siemens and Halske; this also has been decided in favour of Messrs. Ganz.

Atlantic Submarine Telegraphy.—On the 23rd ult. about 350 members of the New York Chamber of Commerce attended a special meeting of that body to witness the ceremony of the presentation to the Chamber of a picture commemorative of the work of the late Mr. Cyrus Field and his American associates in laying the first Atlantic cable. The picture represents a meeting of the Atlantic cable projectors in the house of Mr. Cyrus Field in Gramercy Park. The picture is life-size, the canvas being 9ft. by 7ft. The list of donors includes the Gould Brothers, Western Union Company, Mr. Cornelius Vanderbilt, Mr. J. Morgan, and about 50 others.

A Commercial Electric Furnace.—According to the *Canadian Electrical News*, the Montreal Electric Company have recently put up an electric furnace at the works of Messrs. Peck, Barry and Co. for heating bar iron intended to be converted into horse nails. The current at a potential of 1,040 volts is taken from the mains of the lighting company and is reduced to 20 volts by a Siemens transformer. The furnace itself consists of a carbon tube 2ft. 6in. long and 2in. in diameter. The bar of iron is slid through the tube, which is covered with sand. On a current being passed through the carbon, the iron is rapidly heated, 5ft. of the bar being brought to the proper temperature per minute.

Semi-Municipalised Tramways.—The London County Council have completed an arrangement with the London Street Tramways Company to lease to them the part of their undertaking which the Council has acquired for five years from August 1st, but determinable at any earlier day before 1898 by giving three months' notice, for a yearly rental of £5,729 and insurance against fire; the lessees to pay all rents and outgoings, and to work the tramways continually and efficiently. One clause of the agreement lays down that the Company is not "to employ any servant more than 60 hours in any one week, or for more than 10 hours per day upon an average of any two consecutive days, and to pay to the lessors £50 damages for every breach of this covenant."

Obituary.—Señor Don José Aparicio, who has represented the Direct Spanish Telegraph Company in Spain since its formation (more than 22 years ago), died at Madrid on the 6th inst. from heart disease. Señor Aparicio was for nearly 15 years in the Spanish Government Telegraph service before joining the Direct Spanish Company, of which he was one of the representatives at the International Telegraph Conference of Paris in 1890. He was also hon. secretary and treasurer for Spain of the Institution of Electrical Engineers. He was a man of remarkable business capacity, and was much esteemed by those with whom he had dealings, as was proved by the imposing

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procession which followed his remains to the Cementerio del Este, at Madrid, nearly all the officials of the Telegraph Corps in Spain being present.

Electric Parcel Delivery.—A novel application of electricity has been made at Victoria Station, Manchester. For some time the necessity has been felt of increasing the facilities for dealing with the parcels business at the station, and an overhead tramway, extending from the old parcels office on No. 3 platform to No. 8 platform, where the new parcels department is now situated, has been constructed. This miniature tramway is suspended from the girders of the roof. Along the rails runs an electric traveller, capable of lifting and conveying a ton, but which is not used for more than half that weight. When parcels have to be transferred to or from the office they are placed in a hamper, and it is then lifted up to its place under the motor cab, which is under the control of a workman, who is able to stop it and let down or pick up a hamper at any point. At present only one set of rails is in use, but the Company are fixing a second pair to run alongside the first.

Light Railways Bill.—On Tuesday evening last Mr. Bryce formally moved the second reading of this Bill in the House of Commons. Mr. Strachey moved, "That, so long as light railways are constructed and maintained by Imperial subventions in Scotland and Ireland, no bill for the construction of light railways in England will be satisfactory which does not provide for like assistance from the Treasury." The agriculturists of the country strongly approved of the amendment he proposed. Mr. Grant Lawson seconded the amendment On Wednesday evening the debate was resumed by Mr. Grant Lawson, who said that the obstacle to the creation of light railways was not the expense of obtaining Parliamentary sanction to their construction, but the difficulty of raising capital for them. If private companies were to be started to construct and carry on these railways profitably, it would be necessary that they should have State aid. But if the House would not give State aid to light railways in England, would they face the only possible alternative? Would they grant the Directors of those railways power to charge rather higher rates than were charged by the great trunk lines which, with their big organised staffs, could naturally work much more cheaply than the small lines? Mr. Parker Smith said that, in his judgment, there should be a much greater power in the Bill in the direction of empowering the Board of Trade to relax the requirements. The hon. member was speaking at midnight, when the debate stood adjourned.

The Electrical Standardising, Testing and Training Institution.—We have received from the secretary of this Institution some particulars of the latest developments of its many-sided activity. In the standardising and testing departments the Institution undertakes to examine instruments and supplies, on behalf of manufacturers and users, as well as to inspect outside machinery and works. A useful adjunct to these departments is the suite of private testing rooms, where for a truly moderate fee anyone can pursue original or any other form of experimental work under the most favourable conditions. Another branch of the same class of usefulness is the lending out of sets of testing apparatus, so that the occasional or needy inspecting electrician is under no necessity to purchase expensive apparatus, but can hire it hot from the calibration room. Besides catering in these useful ways for existing members of the electrical profession, the Institution is also taking care that its ranks shall not become thinned, by providing a well-equipped and systematically managed training college. The motto here is "*γνῶσις καὶ πρᾶξις*," and to all appearances it is acted upon. The student receives three classes of instruction: (1) theoretical instruction in the lectures and class-rooms, (2) laboratory work, and (3) actual experience in workshops and electric supply stations. This is probably as far as any institution, other than a manufacturing engineering concern itself, can go in the direction of training up a young engineer in the way he should go. There are nowadays so many young engineers, so-called, who are far from being trained up in the way they should go, with the result that long before they are old they happily depart from our ranks. But the Faraday House Institution claims to have secured appointments for over 80 per cent. of its fully qualified students, which is a good record, even with the assistance of "affiliated companies."

Technical Instruction Conference.—The following letter has been addressed by the Secretary of the Society of Arts to representatives of Technical Education Committees, and others interested in the subject:—"Sir: It has been suggested to the Council of this Society that a useful purpose would be served if the Society were to afford to those who are interested in Technical Education in different parts of the country an opportunity of meeting together, and discussing the measures which the Society might take with a view to enlarge the scope of its present action in this matter, and thus aid local authorities in giving effect to recent legislation on the subject. There appears to be a lack of central organisation which might deal especially with such questions as the examination and inspection of classes. In spite of the valuable work which has been done by the City and Guilds of London Institute, and by other bodies, it is only in a portion of the subjects sanctioned as subjects of technical instruction that examinations are held. The wide field of agriculture and home industries is untouched; while no means are provided for anything like a general system of inspection which local authorities may call to their aid should they desire to do so. There are also other points with regard to which common action would be desirable, and the Council of the Society have, therefore, determined to hold a Conference of Representatives of the Technical Instruction Committees of the various County Councils and others, with the view of eliciting their views on the subject. It is proposed to hold this Conference on June 20th next, and to invite to it the Chairmen of the Technical Instruction Committees, or other representatives who may be delegated by such committees, and their directors or organising secretaries. I shall be glad if you will let me know whether you can yourself attend the meeting, and also whether your County Council will depute any members of its Technical Instruction Committee to attend."

Electric Lighting of the Side Streets of the City.—At the last meeting of the Commissioners of Sewers the Streets Committee presented the following report:—

"From time to time we have had under consideration the question of lighting the minor streets of the City under the electric lighting contracts entered into by your honourable Court in the years 1890 and 1891. These contracts provide, *inter alia*, that all streets, lanes and courts, other than those described as main thoroughfares, shall be lighted by means of 906 glow lamps, the prices being fixed at £10 per annum for lamps of 200 watts power and £5 per annum for those of 100 watts, the right being reserved to the Commissioner to change or alter any specified lamps as they may direct. With a view to determine the best method of lighting narrow thoroughfares, experiments were made in Aldermanbury and Basinghall-street with incandescent lamps of these capacities, but the result was by no means favourable to this mode of illumination, and a subsequent trial with alternating arc lamps in the latter thoroughfare proved of no practical value. We thereupon instructed Mr. Preece and your electrical inspector to formulate a scheme for lighting the minor streets where possible by arc instead of glow lamps, and a survey of the thoroughfares in question was made, and plans were prepared by Mr. Voysey with that object. The City of London Electric Lighting Company, however, having intimated their inability to furnish us with any reliable estimate as to the cost of giving effect to the proposal until further experience has been gained on the subject, we submit a report from the electric inspector, suggesting that certain experiments should be made to illustrate side by side three different methods of illumination, whilst every facility will be afforded to Mr. Voysey by the Company to check the actual cost of each system. It is proposed to light Bow-lane and the court leading out of it to Bow-churchyard by means of six "Sunbeam" incandescent bracket lamps, so arraged as to be capable of being switched on and off by the police. Watling-street, Bread-street, Friday-street, and Old Change are to be lighted by means of 11 centrally-hung arc lamps. The thoroughfares selected for the experiments being contiguous will afford the opportunity of practically testing the comparative efficiency and value of the alternating and continuous-current systems of arc lighting, as well as of the method of illumination by means of "Sunbeam" incandescent lamps, and of obtaining information as to the respective costs of running the same, the City of London Electric Lighting Company having agreed to charge only the actual cost to them of the work, which they estimate at about £386, independently of the charge for running the lamps, which your electrical inspector is of opinion will be about £1 per night. We beg to recommend that the proposed experiments be agreed to, and that the report be referred back to us to have the same carried out accordingly."

As the hour was late and several members had left the Court, the report was ordered to be printed and circulated and its consideration adjourned.

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MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(*Continued from page 149.*)

Steam Engine Testing.

It is impossible, within the compass of the small space which can be devoted to the subject of steam engine testing, to do more than briefly describe some of the more important and common tests, and to indicate the chief points to be observed in making them, leaving the reader to consult more special works on the subject for fuller information. In testing a steam engine, the principal points which usually require to be determined are: the indicated and brake horse-power, or, if the engine is directly coupled to a dynamo, the electrical horse-power; the steam consumption of the whole engine at various conditions of load; and the quality of the steam supplied. As subsidiary points, it will be necessary sometimes to test the condition of the valve setting, to determine the amount of steam used in the jacket, and to examine the working of the condenser. If the steam is superheated, a separate trial of the superheater will be necessary.

Besides these tests, which from time to time may be made upon the engine, there are the continual tests which must be made in every well-regulated station. A properly managed electric supply station will be under a ceaseless condition of being tested. Careful check will be made upon the performance on the one hand, and upon the consumption on the other hand. The output of the dynamos driven by the engines will furnish some guide to the useful power developed by the engines themselves; and recording instruments, such as electrical energy meters and revolution counters, &c., will enable the amount of duty and performance of each set to be noted and recorded. A similar check will be made upon all those supplies, such as fuel, water, oil waste, &c., which have to be expended in keeping the machinery going. In this way the long-period efficiency of the steam plant and of its coupled machinery will always be easy of inspection, while the careful tabulation of the separate items will enable any incipient fault to be detected or the locality of any abnormally heavy waste to be discovered. The occurrence of such a fault will often give occasion to some special test, such as one or other of those which will now briefly be described.

Test I.

To Determine I.H.P.—In making a direct test of the indicated horse-power of a steam engine, it will be necessary to measure the following quantities: (1) the length of stroke, (2) the nett area of the piston, (3) the speed of revolution, and (4) the indicator card. If there are more than one cylinder on the engine, the test virtually becomes a measurement of the I.H.P. of each separate cylinder, care being taken to see that the indicator cards of the several cylinders are taken simultaneously, or else that the load and steam pressure are kept quite constant.

The length of stroke and the area of the piston, if not known, can easily be measured when the engine is not running. The former is best measured by noting the linear movement of a mark on the piston rod past a fixed point, such as a scribing point, when the engine is turned from the inside to the outside dead centre. If accurate measurement is desired, care must be taken to see that the engine does not shift over from one brass to the other at the crosshead and crank pin bearings while this is being done. The nett area of the piston is found by deducting the sectional area of the piston rod from the total area of the piston, if the engine has a tail rod or prolongation of the piston rod; but half of the area of the piston rod only must be deducted if there is no tail rod. Simple a matter as it may seem to measure the speed, there is generally a liability of introducing greater error by this factor than by any of the others. Where the engine is making only, say, one hundred or less revolutions per minute, an error of one revolution in the speed measurement causes an error of one per cent. or more in the final result. To reduce this error in the speed the counting may be carried on for longer than one minute; but there is then introduced the liability of the speed having changed during the count. During indicator tests the speed may be estimated in one of two ways: either by counting the revolutions or by noting the indication on a speed indicator or tachometer. The former can only be relied on if the conditions permit of a long count; the latter only if the indicator is well calibrated and if there is no belt gear to introduce a chance of slipping. On the whole, it is probable that indicator tests are far more frequently vitiated by want of accuracy in speed measurement than by even the errors of the indicator card.

The steam engine indicator usually consists of a small cylinder in which there is a freely-moving piston, the movements of which are accurately magnified by linkage and imparted to a vertically-moving pencil. The pencil moves over the surface of a vertical drum, mounted on the same frame as the instrument cylinder; and this drum receives a reciprocating motion on its vertical axis by means of an inextensible cord attached, by suitable reducing gear, to the piston rod. Thus, the horizontal linear movement of the drum past the pencil is an exact reproduction, on a small scale, of the movement of the engine piston. By connecting

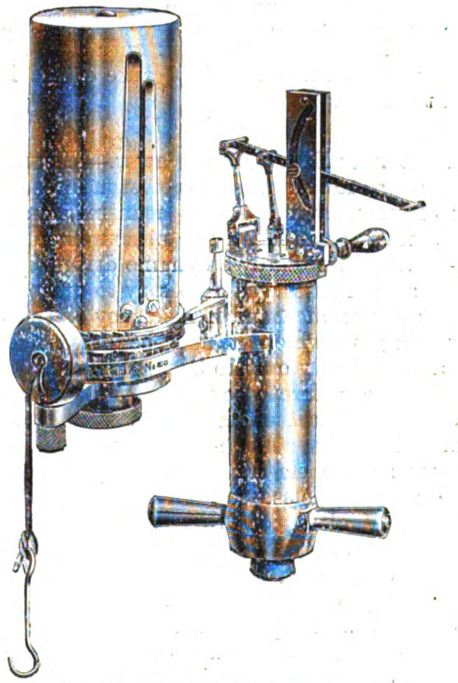

Fig. 70.—The Tabor Indicator.

the lower part of the instrument cylinder to the engine cylinder, and by placing a steel spiral spring of sufficiently perfect elasticity in the upper part of the former cylinder so as to cause it to press downward on the piston, it is evident that the movement of the indicator piston will reproduce the variations in steam pressure within the engine. A sheet of white paper clipped over the surface of the drum will be marked by the pencil in a continuous line, the shape of which will be the indicator diagram required; *i.e.*, the ordinates of the diagram will represent the steam pressure on the engine piston, and the abscissæ will represent the stroke. One form of instrument, known as the Tabor indicator, is manufactured by Messrs. Musgrave and Sons, and is illustrated in Fig. 70. The pencil linkage of this instrument is caused to produce a straight line motion by means of a curved slot and pin, as will be seen by the illustration. For descriptions of other forms of indicators, the reader is referred to "A Practical Treatise on the Steam Engine Indicator and Indicator Diagrams," by Mr. W. Worby Beaumont.

When the object of indicator rigging is once grasped, namely, that it has to transmit the motion of the piston in reduced facsimile to the drum, there will be no difficulty in contriving a form of rigging to suit any particular kind of engine and

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arrangement of engine room. Generally speaking, the points to be remembered are: that the theory of the rigging shall be approximately (it need not be absolutely) correct; that the joints shall be free from excessive looseness or back-lash; and that the members shall be rigid and strong enough to resist flexure and change of length. With these conditions fulfilled, the simpler the rigging the better; and it may be added that one way to eliminate forces which lead to flexure or distortion of the rigging is to have as little friction as possible.

Attention must be paid to the scale of the reduction of the piston motion, and to the scale on which the steam pressures are drawn by the pencil. The former is principally determined by the speed of the engine. It will, in general, be sought to obtain as long a diagram as practicable, in order to minimise the errors in estimating the area of the diagram, &c.; but if the length is too great in proportion to the speed, the movement of the drum will set up a reaction which will slacken the cord, thus distorting the diagram. With very slow-speed engines a full diagram, just clearing the drum stops, may be taken; but with high-speed engines the length of the diagram may have to be reduced to half, or even less than half, this amount. The latter is determined by several considerations, into which it is impossible here to enter; but it may generally be taken that a diagram of greater height than is fixed by the limits of pressure marked on the spring will be liable to error from imperfect elasticity of the spring. Again, with high-speed engines it is necessary to work with a lower diagram than with engines of lower speed, because of the inertia reactions within the indicator.

Test II.

To Determine Brake Horse-Power.—Electric power engines may be tested for brake horse-power in three ways, in general: either directly, by means of a transmission or an absorption dynamometer, or indirectly by measurement of the electrical horse-power given off by a dynamo driven by the engine. In the last-named case, it is necessary to make a separate determination of the mechanical efficiency of the dynamo, and of any gearing by which it may be driven. The last-named method is generally only to be recommended where the engine and dynamo are directly coupled without intermediate gearing, and the mechanical efficiency of the dynamo may be determined by Hopkinson's two-dynamo method.

A very serviceable transmission dynamometer is described in the early articles, so there is no need to enter into further particulars of this class of test. Absorption dynamometers, or brakes, require some further consideration, however, as they are more commonly adopted in engine testing. It has already been pointed out that unless the brake is suitably designed and rigged on the engine there will be set up frictional resistances which do not occur when the engine is doing its ordinary work. Thus the engine will be unfairly tested. A form of brake which imposes the very minimum of side pressure on the pulley is the strap brake, so arranged as to envelop the pulley almost completely by a strap or set of ropes, and to oppose the tight and slack tensions in the strap in very nearly the same straight line. The side thrust is then reduced to merely the difference between the tight and slack tensions. For small amounts of power, such as in testing gas engines or small steam engines, two or three ropes braced together on the pulley face will serve the purpose; but for large amounts of power a leather belt is better, or a considerable number of large ropes may be used.

If a belt is used, it should be cut into a length slightly less than the circumference of the pulley, and the ends should be fastened securely to lengths of stout cord or wire, according to the stress likely to arise, in the manner shown in Fig. 71. It will be seen that one end is connected to two outer cords, which support a heavy weight from below, while the other end is fastened to the ends of a Y-shaped cord, the upper end of which is secured to a spring balance. It is convenient to fix the spring balance vertically over the pulley to a hook in the roof, or to support it by a cord passing over a fixed pulley. It is usual to arrange that the direction of motion of the engine pulley shall tend to lessen the pull on the spring balance, in which case the reading on this instrument gives the slack tension in the strap, and the pendant weight represents the tight tension. The force of friction resisting the turning of the pulley will, of course, be the difference between these tensions, and the power absorbed will be the product of this resisting force into the linear velocity of the pulley rim. Thus, calling T_2 the tight tension and T_1 the slack tension, and r, N and V the radius in feet, the speed in revolutions per minute and the linear velocity in feet per minute of the pulley, respectively; then we have.

$$\text{B.H.P.} = \frac{(T_2 - T_1)\,V}{33{,}000} = \frac{2\pi r N (T_2 - T_1)}{33{,}000} \quad \ldots . (94)$$

The speed is measured simultaneously with the adjustment of the two tensions, this latter adjustment usually being made by adding or removing weights at the end of the lower cord. It will, of course, be necessary to so adjust matters that the speed is normal.

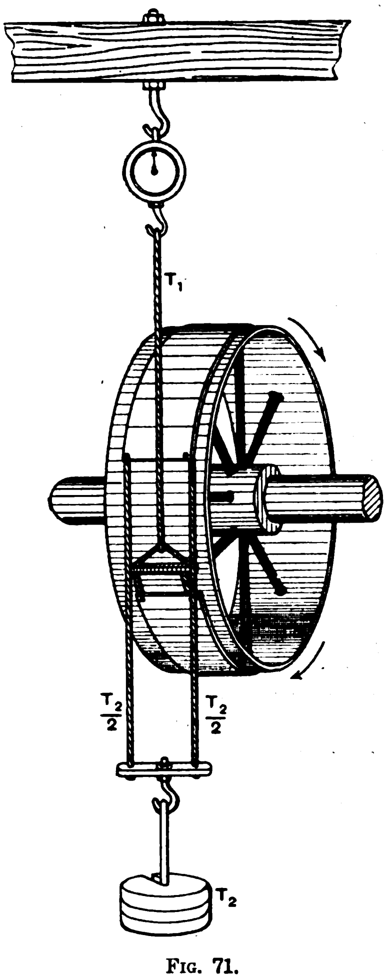

Fig. 71.

As the whole of the power is expended in heating the strap and pulley, it will generally be found necessary to prevent a great rise in temperature by keeping a jet of clean or soapy water playing against the pulley rim and over the strap. This has the further effect of producing a more steady motion, and enables a better adjustment to be obtained; as, if the strap is run quite dry, it is apt to jerk and move irregularly. The use of soapy water, however, often makes these brake tests anything but clean and pleasant.

The brake horse-power and the indicated horse-power of the engine having been determined under the same conditions of working, the mechanical efficiency of the engine will be found by taking the ratio of the former to the latter, and the engine friction by taking their difference.

Test III.

To Determine Steam Consumption when Condensing.—The line of testing which will be adopted in attempting to measure the steam consumption of an engine will depend on whether

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or no the engine is, or can be, fitted with a surface condenser. We will, in the present case, assume that such a condenser is available. The alternative method is to measure the feed water supplied to the boilers. The chief advantage of the condenser method lies in the fact that the results are not vitiated by the escape of steam, either by condensation or leakage, between the boilers and the engine. The condenser measures the actual steam and water passed into the engine from the steam pipe. It must be observed that it does not distinguish between water supplied as water and water supplied as steam, a distinction which can, however, be made by Test V.

The method of making the test is as follows:—An ample surface condenser, which can be supplied with a copious stream of cold water, is fitted to the engine exhaust, and a pipe leading from the condenser is arranged to convey the condensed steam to a tank which is placed upon a carefully calibrated weighing machine. Care must be taken to see that all the joints are tight, and the condensed steam must be sufficiently cooled by the time it arrives at the weighing tank to prevent any appreciable evaporation or steaming. This done, provision must be made for measuring the steam used in the jackets, if any exist. A short length of glass tube, to act as a gauge glass, is inserted in the end of the jacket drain, and the other end of this glass is connected to a small pipe in which there is a throttle valve. Beyond the throttle valve the pipe passes in a short coil through a cooling tank, and finally discharges the condensed jacket steam into a weighing tank. If a separate determination of the jacket steam is to be made, this weighing tank must be distinct from the main weighing tank.

These preparations completed, the engine must be run for a considerable time under normal conditions, until everything is at a steady condition, before the actual test can be commenced. Steam in the boilers must be kept steady, the supply of condenser circulating water must be regulated, and the throttle valve on the jacket drain must be adjusted until the level of water in the gauge glass is constant. It will take a considerable time to arrive at a sufficiently steady state of affairs; but not until the condensed steam runs into the weighing tank sufficiently cool, and not until the level in the jacket gauge is fairly constant, must any measurement be taken. Keeping the engine on steady load and the steam pressure constant, the test may be commenced at a moment when the tanks are empty, and must be carried on for from half to three-quarters of an hour. The moment of starting the test is noted, and each time the weighing tanks "kick the beam" is also be noted. If the engine is a large one, duplicate tanks may be placed on the weighing machine, and the flow switched alternately to each, thus allowing time to empty the tanks; but in a small test it is sufficient to collect the flow for a moment or two in any convenient small vessel while the tank is being emptied, the small amount collected being afterwards thrown into the tank.

If the steam consumption per horse-power is to be determined, Test I. or II. must be carried on simultaneously with Test III.

(To be continued.)

THE GARE DE SCEAUX CENTRAL STATION.

BY ÉMILE DIEUDONNÉ.

In order to show the important part played by electricity in the working of the extension of the Sceaux line to the Luxembourg, it is necessary to refer to the nature of this extension. The Sceaux railway, which is worked by the Compagnie d'Orleans, penetrates into one of the most densely-populated southern suburbs of Paris. It used to terminate at the Gare de Sceaux, that is to say, about two kilometres from its new terminus. The extension now carried out may be put down as a serious beginning to the long-talked-of metropolitan railway, the various proposals for which have miserably failed and have caused serious injury to Paris. The extension will certainly be carried further, and pushed underground along the Boulevard St. Michel to the Place St. Michel. Further, the Moulineaux line, worked by the Compagnie de l'Ouest—the work upon which is at present being carried out—will be carried past the Champs de Mars to the Invalides, the new terminus being in front of this building. It is, however, permissible to think that things will not long remain in this state, and it will not be long before the line will be continued underground either along the banks of the Seine or along the Boulevard St. Germain, joining the Sceaux extension at the intersection of this boulevard with that of St. Michel or at the Place St. Michel. A few words as to the carrying out of this line. Some 300 metres of the total of 2,000 metres is an open cutting, the remainder being run underground under the public thoroughfare. To carry out this latter work an excavation was first of all opened on one side of the road and one of the abutments was constructed, then the road was opened up and the soil cut away into an arch and bricked over. The abutment on the other side of the street was then constructed, and lastly, the soil was cut away from beneath the brick casing. The distance between the level of the rails and the roadway is approximately 12 metres. The line is run through a part of Paris, the subsoil of which is honeycombed by a network of galleries known as the "catacombs," the tops of which are about 15 metres below the rail level. The trains are worked by means of steam locomotives of a peculiar construction rendered inevitable by the necessity for diminishing smoke and steam as much as possible. The tunnels are well ventilated by means of shafts, and in addition a ventilating tube runs along the top of the roof, terminating in a powerful ventilator worked electrically. The electric plant is particularly interesting, showing as it does the flexibility with which electricity adapts itself to various railway purposes. Besides the electric lighting of the stations at the Luxembourg, Port Royal, and Denfert, and of the Mont Rouge goods yard, which is carried out by 96 arc lamps and 500 glow lamps, there are numerous apparatus worked electrically, such as a ventilator exhausting 180,000 cubic metres of air per hour, a pump, two turn-tables, one turn-bridge, five lifts, and in addition the signals are lit by glow lamps. The Compagnie de l'Ouest asked for tenders from all the best-known electrical concerns of Paris, and the work was given out to the firm of Sautter, Harlé et Cie.

The central station is situated at the side of the Gare Denfert. The boiler plant comprises two Roser multitubular boilers, having 90 square metres (968 sq. ft.) heating surface each, and working at 12 atmospheres (170lb. per square inch) pressure. These boilers are in a well-lit house opening on to the rails, so that the coal is discharged at the foot of the furnaces, thus reducing the manipulation of the fuel to a minimum. The engine room is airy, spacious, and well lit. At present it contains two 120-H P. machines, with room for a third. The engines were made by Chaligny et Cie. These engines, a view of one of which is given in Fig. 1, are compound condensing, driving direct on to the dynamo by means of a belt. The bed-plate is of peculiar construction, with a view to avoiding the necessity of a brickwork foundation. The steam, after leaving the high-pressure cylinder, passes into an intermediate receiver, where it is sensibly heated, and then into the low-pressure cylinder. The steam distribution is effected by means of a simple three-port slide valve, the high-pressure cylinder being regulated by hand, by means of a slide acting on the eccentric. The indicator and steam consumption diagrams of these engines are very interesting and instructive, and it is to be regretted that lack of space does not permit of their publication. These machines have a very workmanlike appearance, and their details seem likely to make them suitable for central station work. The condensers are of the injector type, and are worked by means of an extension of the piston rod of the low-pressure cylinder.

The station being above the catacombs, the sinking of a well for the purpose of obtaining condenser water was out of the question, and water had to be taken from the town mains. The condensing water is cooled by means of the Chaligny cooler, shown in Fig. 2. The cooler consists of a sheet-iron tank erected on a brickwork cement foundation. As will be seen by the illustration, it is provided on one side with a belt-

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driven air-fan. The tank contains several rows of fascines. The hot water coming from the condenser is forced up by the air-pump to the top of the tank, and distributed over its surface. The water then sinks to the bottom through the fascines, and is thus brought into close contact with the air forced through by the fan. A small portion of this water is evaporated, and in evaporating robs the water of a large amount of heat. The cooled water drains into a masonry tank, and is passed through first a coke and then a sponge filter. The water, thus cooled and purified, is once more ready for condensing purposes. The amount of water evaporating in the cooler is about 8 kilogrammes (17½lb.) per horse-power-hour. About this quantity is furnished by the condensation of the steam, so that it may be said that the consumption of water for condensing purposes is nothing at all. With an apparatus of this kind condensing is no longer limited to places where large quantities of water, amounting to 200 to 300 litres (7 to 10⅓ cubic ft.) per horse-power-hour are available. The dimensions of a cooler of this kind, capable of dealing with an engine of 110 to 170 H.P., are—height, 3·32 metres; breadth, 2·5 metres; depth, 3·95 metres.

the instruments controlling the working of the dynamos, the other dealing with the distribution of the current. The two groups of instruments are mounted on contiguous slate panels, but from the electrical point of view are completely independent. In the diagramatic sketch shown in Fig. 3, I have, with a view of facilitating the understanding of my description, brought the two panels close together, and to the same end I have shown in the same sketch the distributing boards at the Denfert, Port Royal, and Luxembourg stations. At the bottom of the switchboard proper are the + and − bars, on the top the neutral ± bar. An ammeter is placed in the circuit of each dynamo. There are three voltmeters, two of which are constantly in circuit, across each arm of the three-wire circuit; the third, which is a dead-beat instrument, is intended by means of a switch to enable the engineer to ascertain the pressure on the mains and that between the terminals of the dynamo which it is proposed to switch into use.

The electromagnetic circuit cut-outs I *m* play an important part in switching the dynamos in and out of circuit; they are so arranged that it is impossible to switch into circuit a dynamo which is not at the same pressure as those already at

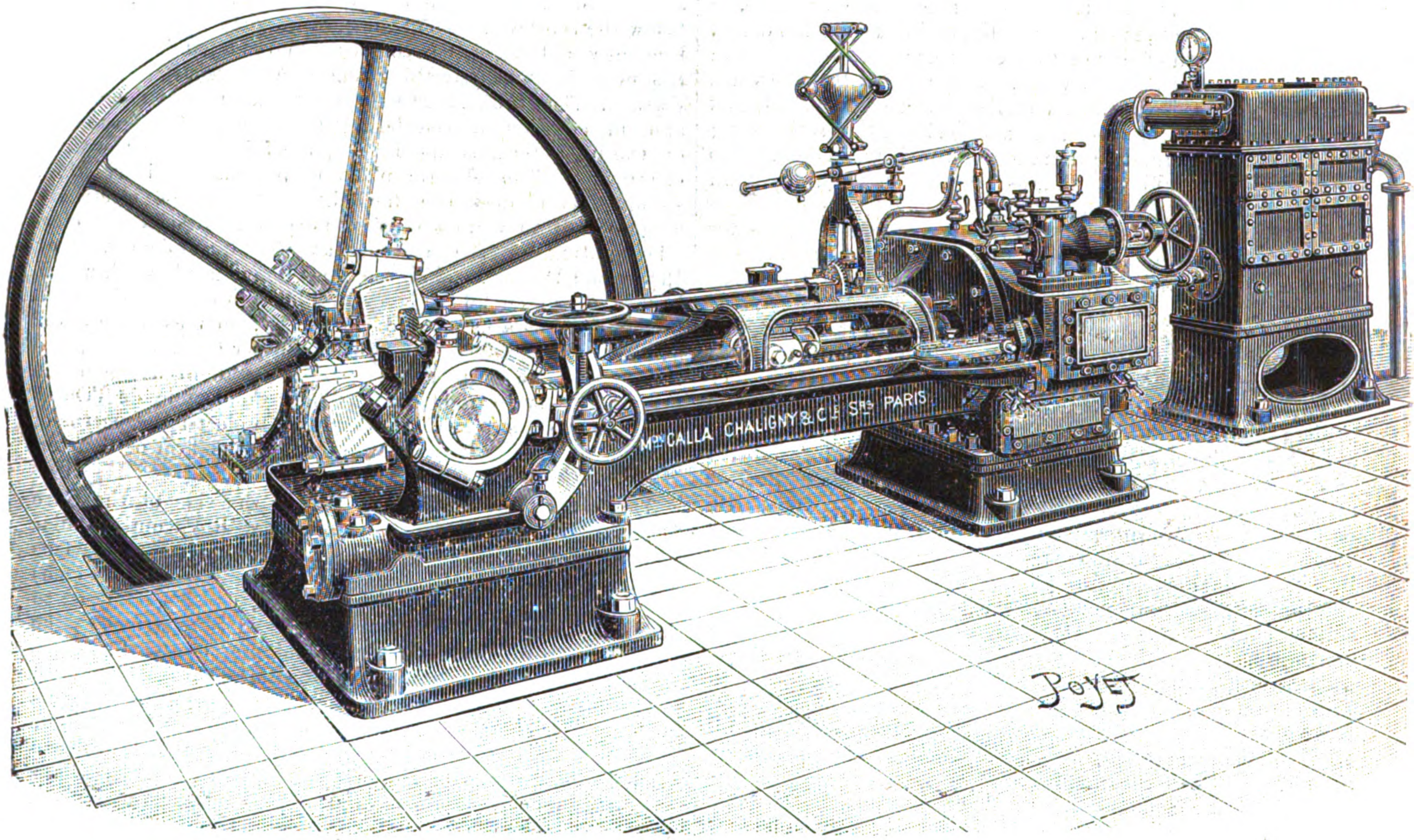

FIG. 1.—Chaligny Compound Condensing 120 H.P. Engine.

The dynamos are double-armature machines, with two distinct fields, and revolve at 420 revolutions per minute. Each armature at full load supplies 160 amperes at 270 volts. The dynamo pulley is keyed on to the dynamo shaft midway between the two armatures. The distribution takes place on the three-wire system at a pressure of 220 volts on each arm, arc lamps being run four in series and glow lamps two in series. Two batteries of accumulators—one at the central station and the other at the Gare du Luxembourg—supply the current to the electric motors driving the turn-tables and lifts; these batteries also supply the current to the glow lamps during the hours when the station is shut down. The arrangement of the plant contemplates the use of parallel running, but at present the dynamos are only paralleled at the moment of switching in or out of circuit; but later on, when the line has been extended, parallel running will be the normal order of proceeding. The apparatus on the station switchboard is divided into two distinct groups, one comprising

work, and they automatically switch the dynamo out of circuit when its current falls below a certain figure. The apparatus, which is shown in Fig. 4, consists of a lever L capable of completing the circuit between the jaws M and M_1, and of an arrangement of coils actuating the interlocking mechanism. Knowing by the dead-beat voltmeter the pressure on the mains and the voltage of the dynamo to be switched in, one knows in what direction it is necessary to alter the field-magnet resistance to bring the two to an equality. When this has been done the two sets of electro-magnets, E E and F F, the pull of which is exerted in opposite directions, liberate the arm m_1, which locks the lever L. It will be seen that the coils E E and F F are circuited between the neutral wire, to which the thin bar, shown dotted in the sketch, is connected, and the + pole of the machine which is to be switched in, whilst the coils F F are between the + pole of the network and the neutral wire, the terminal B being connected to the corresponding pole of the dynamo and the terminal B_1 to the general posi-

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tive bar. One can see that when the two pressures are equal the actions of the electro-magnets E E and F F neutralise each other and liberate the bar m_1. The circuit can then be closed the bar *m* clutches the lever L. When, owing to some cause or other, the current of the dynamo is reduced to a certain amount, it is necessary that it should be put out of circuit. This

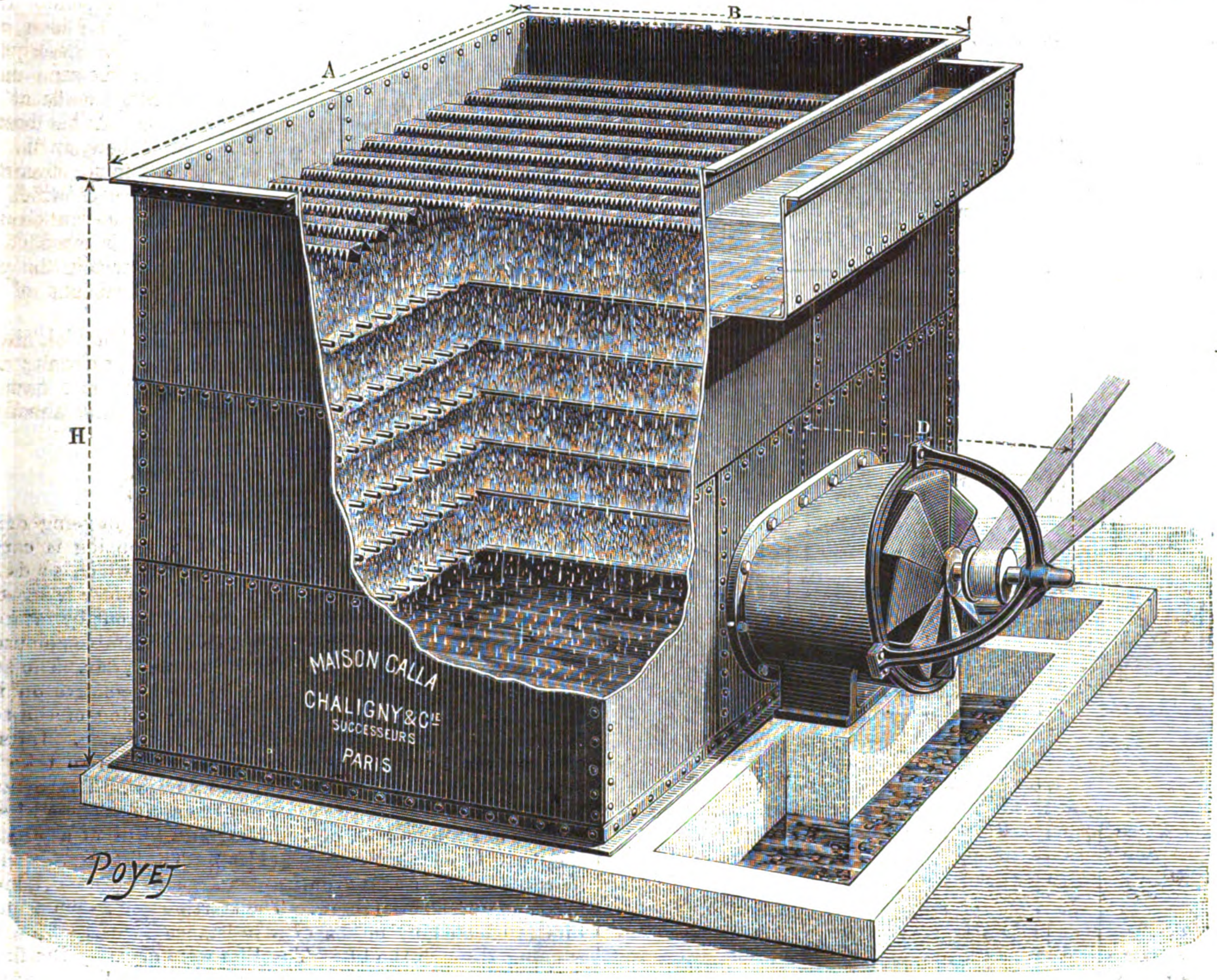

Fig. 2.—Chaligny Condensing Water Cooler.

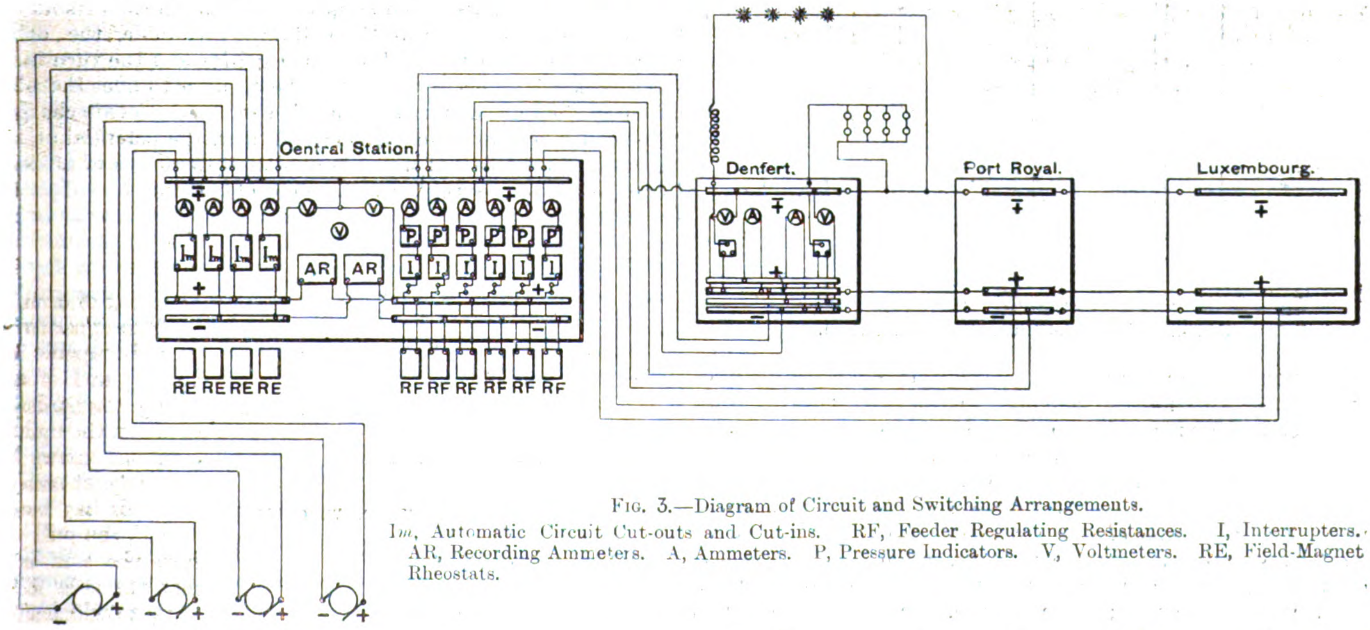

Fig. 3.—Diagram of Circuit and Switching Arrangements.

Im, Automatic Circuit Cut-outs and Cut-ins. RF, Feeder Regulating Resistances. I, Interrupters. AR, Recording Ammeters. A, Ammeters. P, Pressure Indicators. V, Voltmeters. RE, Field-Magnet Rheostats.

by means of the lever L. The current then passes through the coils of the electro-magnets C C, and the pendulum *p* polarised by the electro-magnet A is diverted from its vertical position, the circuit of the electro-magnet D is broken, and is accomplished automatically. The magnetism of the electro-magnets C C decreasing with the current, the pendulum *p* tends to resume its vertical position, and at a certain point it makes contact with the terminal *b*. The circuit of the coils

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D D is completed, the arm *m* is attracted, and the lever L is free, and is shot away from M M_1 by the action of a powerful spring, and the dynamo is switched out of circuit.

The distribution board is next to the switchboard, properly speaking, and from it run the circuits to the various stations on the line and to the signal lamps. The omnibus bars on the distributing board are connected to those on the switchboard, through recording ammeters. As will be seen from the sketch, this board is provided with pressure indicators, P; these give warning to the central station engineer, acoustically and optically, whenever the pressure at the various stations is not at its normal value. This is done without pilot wires, by using compound-wound instruments. The boards at the various stations, as will be seen from Fig. 3, are provided with switches

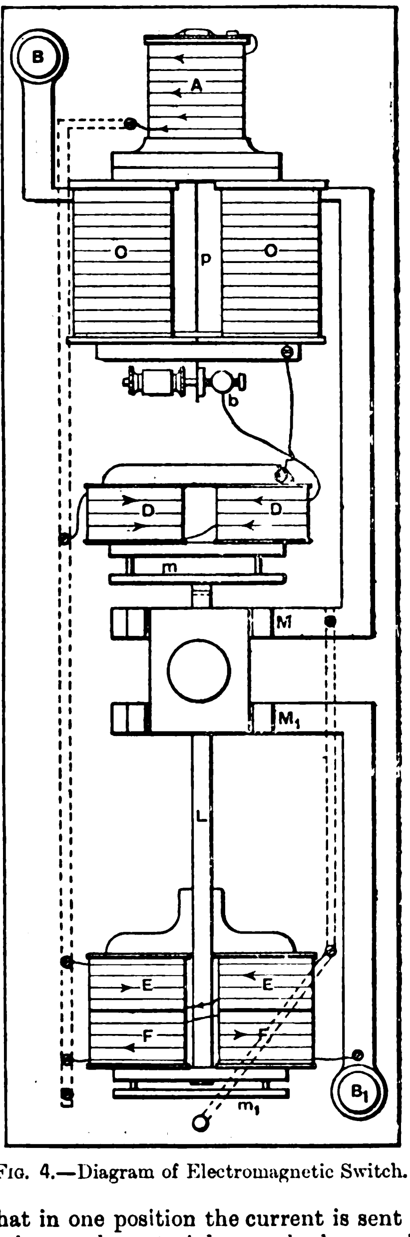

Fig. 4.—Diagram of Electromagnetic Switch.

so arranged that in one position the current is sent through an ammeter, and in another straight to the lamps; in the third the circuit is broken. The voltmeters are always in circuit.

The circuits connecting the distributing board with the different stations are in some places of bare copper on porcelain insulators, and in other places they are of insulated cable running under the platforms of the stations. All the distributing circuits, whether for light or power, when they leave the distributing boards at the various railway stations are run along the spring of the roof; these circuits, like the main circuits, are run on porcelain insulators. Wood-casing has only been employed in rare cases and dry places. As an instance of the amount of light required, it may be remarked here that the Luxembourg station requires light for 21 hours out of the 24, and that the entire electric lighting plant is looked after by one electrician and one machinist, the switching in and out of the lamps at the various stations being done by the regular employés of the railway company. In order to avoid the necessity of employing men at the time when the light is not required, the carboning of the lamps is carried out whilst they are in circuit, each lamp being provided with a short-circuit switch to permit of this, the current through the remaining three lamps in the series being temporarily increased thereby.

A few details with regard to the electrically-driven apparatus will be interesting. First of all comes the ventilator devoted to the ventilation of the Luxembourg station, and the tunnel between this station and the Port Royal station. This ventilator has to run continually, and the current is supplied to it straight from the machines; it runs at 70 revolutions per minute, and is belt-driven by a 15-H.P. series motor running at 260 revolutions. The motor is started by means of a switch at the switchboard which operates a liquid resistance, the apparatus being arranged so as to short-circuit the rheostat, whilst its electrodes are completely within the solution, an arrangement which is preferable to the one which acts by making the short circuit occur inside the vessel itself. Another electrically-driven apparatus is a centrifugal drainage pump which is situated at the Luxembourg station. The motor driving this pump also receives its current straight from the dynamos. The turn-tables at the Luxembourg station are driven by an endless chain, the chain being driven by an electric motor. The starting and stopping is carried out by means of a pedal acting on a relay which sends the current through a resistance; as soon as the motor has got up speed the resistance is automatically switched out by means of a second relay. These turn-tables do a considerable amount of work, one of them being used about 80 times a day. The semi-rotation of the turn-table with a 50-ton locomotive on it is carried out in less than 30sec. Quick working of the turn-tables is very important at the Luxembourg station. Lifts are used at the Luxembourg and Denfert stations to take the passengers and their luggage to the surface. The arrangements in each of these two cases are the same. These lifts are capable of lifting a load of 700 kilograms ($\frac{3}{4}$ths of a ton) at a speed of 0·45 metres per second ($1\frac{1}{2}$ft.). The lifts are suspended by ropes taken round drums which are electrically driven by means of a tangential screw. The starting and stopping of the lifts is effected by means of a resistance actuated by a cord running through the lift. The lifts were made by the firm of Edoux. The lifts and turn-tables are supplied with current from two batteries of accumulators, one of which is placed on either branch of the three-wire system, one battery being at the generating station and supplying current to the lifts at the Denfert station and the Mont Rouge turn-table, the other supplying current to the Luxembourg lifts and the turn-table at that station, this latter battery being placed under the platform of the Luxembourg station. The accumulators are charged through a continuous-current transformer, the potential at the secondary terminals of which is regulated by means of a resistance in the primary circuit. The use of batteries for supplying the current to the lifts and turn-tables prevents injurious shocks to the generating machinery. The application of electricity which has been made at the Luxembourg station only remains to be mentioned. The walls of the underground portion are decorated with ornamental white porcelain panels, which give the place quite an artistic appearance and serue to reflect the light of the arc lamps.

ECONOMY AND ACCUMULATORS.

BY ED. W. COWAN.

Mr. Howell, in his Paper on "The Uses of Accumulators" (*see* p. 224), read before the Northern Society of Electrical Engineers on May 13th, claimed to be able to effect a saving of £13 per day on the coal bill by the installation of a battery of accumulators in a certain American electricity supply station. In the discussion which followed an endeavour was made to challenge this figure, but the criticisms did not convince either Mr. Howell or Mr. Crompton. It is proposed in

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this article to examine the question rather more fully, in the hope that it may be definitely settled. The use of accumulators in an electricity supply station has become a very important matter, and it is therefore well worth careful consideration.

Below are given the two load diagrams (Figs. 1 and 2) which Mr. Howell used to illustrate his Paper. Fig. 1 shows the actual load diagram for June 23rd of the American station, and how that load was dealt with by the steam dynamos installed. Fig. 2 shows the load diagram transformed by the same steam dynamos, working in conjunction with a battery having a total output of 14,000 ampere-hours. Between these diagrams Mr. Howell estimates a difference of £13 worth of coal, taking it at 20s. per ton, in favour of the use of accumulators. This contention is not disputed; Mr. Howell has evidently very carefully worked out the steam consumption for each engine, based upon Mr. Willans' curves of steam economy in relation to load. But the important point is this: is the saving of fuel due to the installation of the battery of accumulators? In order to test this point let us remind ourselves what quality it is which an accumulator possesses which adapts it to being used as a means of economy in an electric supply station. It is this: that it is a reservoir into which electrical energy can be stored when it can be generated at a low fuel cost, and from which a supply can be obtained when its generation first hand would be expensive. We are therefore brought to this point—that all the saving effected must be made upon the electricity which passes into and out of the battery.

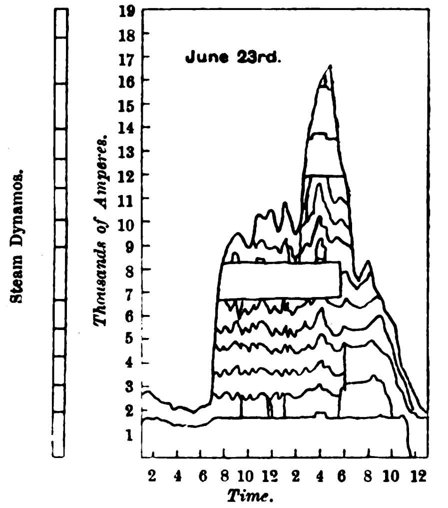


Fig. 1.—Without Accumulators.

Measuring the diagram it will be found that the battery only deals with about 1,520 units. The coal cost of this output of units under the conditions of load obtaining in this station could hardly amount to more than 1d. per unit, or a total of £6. 6s. 8d. if supplied direct to the circuits. Where, then, is the saving of £13 to be made? Mr. Crompton and Mr. Howell both replied that it was made partly on the electricity dealt with by the battery, but chiefly on the electricity supplied by the steam dynamos which went direct to the circuits, pointing out that as the steam dynamos were run always at full load the consumption of steam per unit was reduced not only on the units which went to charge the cells, but on the whole output of the plant.

This sounds plausible, but it is contended that it is not and cannot be true. For the purpose of considering the question, the steam consumption of each unit of plant should be divided into three parts (Fig. 3). The area of A represents the steam consumed in overcoming the standing losses of the engine and dynamo, the area of B, the steam consumed in generating the units which are supplied direct to the circuits, and the area of C the steam consumed in generating the units which are stored in the battery. Now, this diagram is properly divisible into two parts, in order to ascertain whether the addition of the battery can effect any economy on the electricity supplied direct to the circuits. The first part is A + B, which represents the steam consumed for the output to the circuits direct, and which would be the same whether an additional output represented by C is shunted into a battery or not, and C the output to the battery. The fallacy of the contention is now apparent. How can the steam consumed for the output A + B be reduced by adding the output C to the plant? If by increasing the load of an engine we can reduce the total steam consumption, the reduction would be made if we shunted the part of the output necessary to bring it to full load into resistances, which is, of course, an absurdity.

It is true that the steam consumed for the electricity supplied for charging the cells is very low, perhaps not more than 14lb. or 15lb. per unit, but it cannot be obtained for nothing, or for less than nothing! There is no doubt that some saving might be made by a better manipulation of the plant on account of the confidence which a knowledge of a reserve must give to the engineer in charge. But this will not amount to much, and it is not claimed that the saving is made in this way. What, then, is the cause of the large saving being shown between the two diagrams? It would seem to be this: Fig. 1 is a diagram taken from actual practice, while Fig. 2 is an ideal diagram, where everything is done in the way it ought to be done. If we make an ideal diagram for this load curve without the use of accumulators, we shall find that we can effect nearly as great a saving. The difference will not pay the standing charges to which a battery of accumulators is subject.

Mr. Howell says that a saving of more than 10 per cent. has actually been made by the use of accumulators in this American station, and it is not a matter of surprise that such a

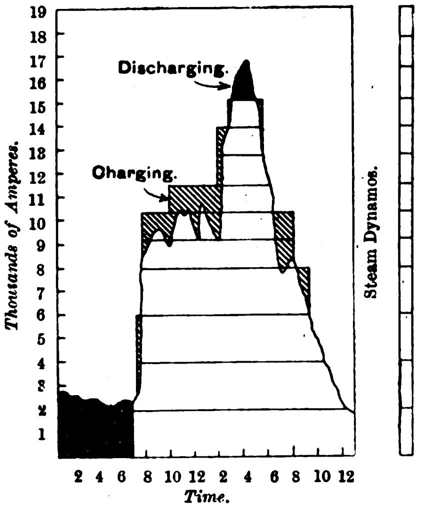
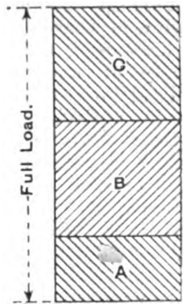


Fig. 2.—With Accumulators.



C Battery. **B** Circuits. **A** Standing Losses.

Fig. 3.—Diagram of Steam Consumption.

saving should have been realised; but the accumulators were not necessary for this saving. Mr. Howell says that the steam dynamos were run as near to full load as was considered safe in American practice. But the plants should be run not only at full load, but well above full load. A steam dynamo which will not stand running 20 per cent. above full load (that is load of maximum economy) is not fit for an electricity supply station. Had the units of plant been run in this way in the American station, the intermittent fluctuation in load, and the fluctuation which has a relation to the hour of the day, might have been dealt with with a variation of load factor of steam dynamos which would not have the steam consumption for the day more than about 3 per cent.

In a generating station the units should be so designed that their mean load factors represent the load of maximum economy, generally called full load, and if this is done in a station having a large output and large minimum load, accumulators will be of no economical service.

There are undoubtedly many generating stations where accumulators can effect economy—their advantages as a reserve and as a means of allowing of shutting down the steam plant are of course well known and appreciated by everyone; but it is very important that their function should be clearly understood, and if economy is to be effected by their use upon the coal cost of the generation of electricity which does not pass through the battery it will be of great advantage if Mr. Howell or Mr. Crompton will further explain.

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USES OF ACCUMULATORS.*

BY J. C. HOWELL.

After a few introductory remarks with reference to the history of accumulators, the author went on to say that the first uses to which accumulators were practically put was for maintaining continuity of supply in country house electric lighting work. Although the capital cost of the early accumulators was exceedingly high, it was speedily found that the annual saving effected by their use was sufficiently large to recompense the purchaser for his outlay, except in cases where water power was available. In gas-engine work, and with steam engines, the accumulators were found to be working at their best efficiency at a time when, had the motorial plant been in operation, it would have been working at its worst efficiency, and instances are recorded where, by the adoption of accumulators, the gas bill had been reduced to 50 per cent. of what it was when the supply of electricity for household service was obtained from the dynamo driven directly by the engine, and this difference in a case where the former supply had not been in constant service.

The construction of the first accumulators was defective, and for a while accumulators became discredited, owing to the frequent breakdown of the plates of which they were composed, and the falling away of the active material. By slow degrees these faults in construction were discovered and remedied. Then a more abstruse series of faults developed, viz., those due to the chemical actions which were going on in the cell, and which required time to show themselves. These, too, in turn were carefully investigated. During this period the electric light had become so popularised that central stations were established for the supply of electricity. Had the public been content to maintain their demand for lighting at a normal rate whenever they required it, it would have been easy for the central stations to supply electricity in an economical manner. Although it had struck many long-sighted engineers that the public supply of electricity would have to be dealt with finally in much the same fashion as the public supply of water or gas had been dealt with, no one had realised how greatly the demand for lighting at different times of the day varied, and the ordinary engineer greeted the publication of the first load curve of a central station that was published with a smile of wondering bewilderment. In time it became more and more evident that, unless some satisfactory means of providing for this inequality of demand was discovered, electric lighting would for ever remain a luxury.

After reference to the Colchester installation the author remarks that this scheme had shown that accumulators, to be of real service in central station work, had to be capable of meeting for short periods demands considerably in excess of their normal capacity. This fact being properly appreciated speedily led to the development of accumulators, which could, on being called upon, discharge at very rapid rates, and, although these accumulators were costly, it was discovered that their freedom from breakdown in trying circumstances was such as to warrant a trial being made on a sufficiently large scale to see whether this new form would be fully equal to all the requirements of central station practice. Reliable statistics, too, were at this time available, so that engineers could fully realise the costs of working under the peculiar conditions which the public demanded, and it was found that the cost of fuel was from four to six times what had been expected from the results obtained when working an engine and dynamo under test. To make this matter clearer the author exhibited a Table (I.) and curves of the efficiency of a steam-driven dynamo at various loads.

Table I.—*Non-Condensing Willans Set.*

Engine load factor. Per cent.	Lb. of coal per unit.	Cost of coal per unit. Coal at 20s. per ton.
20	7·3	0·78d.
30	5·4	0·57d.
40	4·75	0·5d.
50	4·3	0·46d.
60	4·0	0·43d.
70	3·75	0·4d.
80	3·5	0·37d.
90	3·4	0·36d.
100	3·3	0·35d.

Similar engines, when dealing with the business of supply, had, the author said, been tested by Prof. Kennedy at actual work. These results the author has embodied and amplified in Table II.

Taking as an example of the use of Table I. that there is 100 unit, steam dynamo running at maximum efficiency, the author

Table II.—*Kennedy Table of Consumption on Variable Loads.*

—	11 a.m. to 6 p.m.	6 p.m. to midnight.	Midnight to 11 a.m.	Whole day.
Time	7hrs	6hrs.	11hrs.	24hrs.
Total I.H.P. hours	562	1,366	407	2,335
Total E.H.P. hours	400	979	260	1,639
Units generated	293	731	193	1,217
Coal consumed	3,838lb.	4,459	2,547	10,844
Coal per unit	13·1lb.	6·1	13·2	7·33
Coal at 20s. per ton	1·4d.	0·65d.	1·41d.	0·8d.

points out that it will need under the most perfect conditions of running 3·3lb. of coal per unit, or 330lb. per hour. Increase the load 20 per cent. and another similar set has to be started, so that the load is divided between them; each set is now working at 60 per cent. load factor, the amount of coal consumed is 4lb. per unit, or 480lb. Thus an increase of 20 per cent. in the load involves an increase of 45 per cent. in the coal consumption, and the actual loss owing to the decrease in efficiency is 9½d. per hour in the coal bill alone as long as the 20 per cent. extra load is maintained. That these losses are real, and are actually found to exist in practice, is at once discovered by reference to the Kennedy table, where we find that there was less coal burned during the period of heavy load than during the period of lighter load—that, in fact, 63 per cent. of the total amount of fuel consumed was used to provide 33 per cent. of the output. The day on which these tests were taken was divided into three parts closely corresponding with the times as shown on a load curve where there is a minimum demand, a moderate demand, and a maximum demand. It will be noticed that the amount of coal required for the moderate demand approaches very closely to the total amount required for the maximum demand, and that during the period of minimum demand, when only some 20 per cent. of the maximum output was delivered, the coal bill reached the respectable figure of 57 per cent. Further, it will be seen that during the period of lighter load an amount of coal was consumed sufficient, working at the rate shown during the period of maximum demand, to produce 1,050 units, or very nearly the *total daily output required*. Had some suitable means of storage been provided, enabling the engine to run at a fair rate of economy, there was a possible chance on that day's output of effecting a saving of two tons of coal during the run.

As an example of the sort of problem with which the central station engineer has to deal the author then gave some particulars with reference to an American station. The plant was capable of dealing with a maximum output of some 18,800 amperes made up in four sets of 2,000 amperes each, and nine sets of 1,200 amperes. From the marginal scale at the side it will be noted that at no time during the day did the station touch an engine load factor of 80 per cent. except for a few minutes at the peak of the diagram.* Starting at one o'clock in the morning set No. 15 was kept running nearly the whole 24 hours; set No. 11 ran from one o'clock till half-past nine, and, if the level that No. 11 set combined with No. 15 would have taken be carefully noted, it will be observed that during the whole period of minimum demand the engine load factor did not reach even 60 per cent. as an average. At seven o'clock, when the load commenced to rise, the additional load had to be dealt with by adding small set after small set, and it was only when the load was rising so rapidly near the peak were they able to fully utilise the larger sets, which ought *à priori* to be more economical to run than the smaller sets. The same criticism will apply on the down grade when the demand is decreasing. The coal consumption at this station on the day on which the curve was taken was 80 tons. On further reference to this curve, it will be seen that the two larger engine sets were kept going at as near their maximum output as in American practice is considered safe, taking the sudden abnormal changes of load into account, and that the balance of the load was equally divided over all the other sets that were at the time running. The result of this complicated system is that although by the number of engines running the efficiency of each is somewhat increased, the regulation of the pressure on the mains is more difficult, as the adjustment to standard is only really effected when the current from the last machine is properly adjusted. That the labour involved in this adjustment is considerable is easily understood on reference to the diagram.

The author then stated that there were now methods very fully described by which the use of accumulators would relieve the central-station engineer from all anxiety as to his variable demand. He had prepared a chart showing how the methods described would deal with the load curve which he had put before the meeting. The first thing to ascertain is the output for the period of minimum demand, and for what time the minimum demand lasts. These

* Abstract of a Paper read before the Northern Society of Electrical Engineers.

* [Reference should be made to the diagrams illustrating Mr. Cowan's article, p. 223.—Ed. *E.*]

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figures enable the capacity of the accumulators required to be ascertained. This period of minimum demand is very clearly defined on the load curve in question as lying between 1 a.m. and 7 a.m., a period of six hours. During this time an average of 2,100 amperes have been delivered to the circuit, or, in round figures, a total of 13,000 ampere-hours. To provide for this output and allow a margin for contingencies, a set of accumulators having a capacity of 14,000 ampere hours will be required. An inquiry addressed to modern accumulator manufacturers brought the information that such a battery would cost, delivered and erected, £7,000.

On adding this battery to the equipment of the station the result upon the working of the motorial part of the machinery is that whenever an engine is started it can be kept at full load from the moment it starts to the moment it ceases running, thus bringing up the efficiency of the station to 100 per cent. engine load factor at once. The result may be observed on the load diagram. Instead of the patchwork jumble of in and out engine loads, each set is working steadily at full output as long as it is required; the hours of running have been shortened from 24 to 18, thereby lessening the number of men employed. More than this, it has been possible to commence running with three of the large sets at full load from the moment of starting up to 7 a.m., and that these engines run steadily throughout the day. It is also to be noticed that when the load increases the accumulators, although discharging during the early morning hours, have already received sufficient charge to permit a discharge until three more engine sets can be started simultaneously, pointing out the advisableness of employing fewer sets of larger plant for this station. The only regulation required is the steam pressure at the boilers, which must be kept constant, and a slight increase in the speed of the engines as the load creeps up to compensate for the slight additional loss in potential in the feeders leading the current away from the station.

The author thinks that he will very probably be told that, owing to the variation in the E.M.F. of the battery during charge, the regulation of the charging current will be an exceedingly difficult matter. This can be dealt with by making one of the steam dynamo sets expressly to give just the current necessary for properly charging the battery, and no more. It is the first to be started up, and it is the last to leave off, and is, during the whole day, prepared to charge the battery except at the time when the output called for is in excess of the current generated by all the sets in combination. It is kept permanently attached to the regulating ends of the battery. An adjustable switch is so arranged that the terminals of the machine can be attached to any cell in the regulators, so that as the end cells get charged up the switch may be moved down until it reaches the cell, which is in connection on the discharge side with the terminals of the other sets and with the circuit. The loss in charging the accumulators is very slight, as it is only felt by one unit of the plant, and is really in the load diagram in question only 1 per cent. of the total load delivered to circuit, as the proportion between the load dealt with by the accumulators and the total output is just slightly over 8 per cent.

Even the most casual glance will show how immensely simplified the station work has become, a certain number of engines running, a certain amount of steam required, the engineer in charge directing everything with quiet confidence, knowing full well that he has a big reserve always behind him capable of dealing with an extraordinary demand, or with any little accidental occurrence. Further, a comparison made between the two curves will at once show that the labour bill will be considerably reduced by the employment of accumulators, the amount of the saving being worked out by the author for the case in question at £1. 15s. 6d. a day. The coal bill will also shrink as engines have ceased running during the period when using coal most wastefully, and moreover engines are able to run at full load whenever they are running. Working out the amount of coal required for each engine, the author brings down the amount from 80 tons to 67. The total saving is worked out at £15. To effect this saving there has been an outlay of £7,000 in a class of plant which, the author remarks, in the minds of most engineers should submit to a heavy charge for depreciation. The author then sets aside a sum sufficient to meet the views of these engineers by putting on the other side of the account an amount of £2 per day for depreciation and £1 per day for interest on the outlay. The net saving, therefore, is reduced to £12 per day, or, say, £4,380 per annum, an amount sufficient to wipe off the whole capital cost of the accumulators in two years, and still leave a margin to go to the profit and loss account.

The author, after suggesting the use of accumulators in factory and mining and electric tramway installations, asserts that wherever there exists an intermittent demand for a supply of electricity an electrical storage system is a necessity, unless the cost of the initial power is so abnormally low that the interest charges on the accumulator outlay amount to more than the annual saving to be effected. Such causes do sometimes occur when an abundant supply of water is available close at hand.

DISCUSSION.

Mr. WORDINGHAM said Mr. Howell's Paper bristled with what he (Mr. Wordingham) believed to be facts. He thought, looking at it broadly, that it would be very difficult to assail Mr. Howell's position. To his mind there was no doubt that storage to a certain extent was essential to the economical working of a station. In Manchester they had put down a very large battery of 400 H.P. for 2½ hours' supply; this they had put within a mile of the station for the double purpose of effecting the economy Mr. Howell had spoken of, and to save putting down more conductors. He hoped they would introduce considerable economy by the use of this battery. One thing always occurred in dealing with these secondary batteries: they were so useful for a light load, and so useful at full load, that the difficulty was to know when to charge them.

Mr. RIDER said that, while he thoroughly agreed with Mr. Howell on most of the points raised so far as they concerned the generating station, he could hardly at that stage enter into the reasons why a high-tension system could still be of service. Unlike most men who put down high-tension stations, he had such faith in accumulators that he put them down wherever he could find a use for them, such as for exciting the alternators. His experience of cells was that the Crompton-Howell cells were very good; they had the fault, however, which, he thought, all cells had, that although one could take a very high discharge from them for a short time, they could not be charged at a high rate: that, he thought, was a point which some makers would do well to look at in the future. If the cells were discharged at a high rate, they wanted to be charged at a high rate.

Mr. CLIREHUGH said Mr. Howell had alarmed them very much by using the Kennedy table of coal consumption, but he did not think he (Mr. Howell) meant it to represent the actual working of a central station; they would see, by referring to the two tables, that when he had consumed 13·2lb. of coal per unit he had reduced his engine to 20 per cent. therefore the difference of 13lb. of coal, as against the 6lb., would, he thought, never be sustained in practice.

Mr. FAWCUS said it had given him great pleasure to listen to Mr. Howell's most able Paper, although personally he could not agree with much that he had said. The saving of £13 a day in coal looked very nice on paper, but he was disposed to doubt its accuracy. It was almost impossible for any one of them to-night who had merely listened to the Paper without having any opportunity of studying the figures, to discuss the matter properly; if they had time for reflection perhaps some of them would be able to put Mr. Howell right. Mr. Howell might have given them some little information as to the actual results in pounds of coal consumed per unit in the most modern battery stations. If such a large saving could be effected by the use of accumulators, why was it they saw an alternate-current high-tension station beating the figures of all continuous-current stations?

MONDAY, MAY 27TH.

Mr. COWAN said that at the last meeting he felt anxious to check Mr. Howell's claim of a saving of £13 per day in coal by using accumulators in the American station, of which diagrams were before them. Since then he had gone carefully into the matter, and could not see that such a saving or anything like it was possible with so small a battery. The only way in which economy could be realised by the use of a battery was by storing electrical energy when it cost little to generate, and taking it out for the circuits when its generation first hand would be expensive. It therefore followed that the only saving which could be effected must be made upon the electrical energy which passed through the battery. How was a saving of £13 per day to be made by the use of a battery which only dealt with £5 or £6 worth of electricity, taking its fuel cost at 1d. per unit? He thought that under the conditions of load at the American station 1d. per unit for coal was an ample allowance. It might be claimed that a saving would be effected on the whole output of the station, as the load factor of the engines was raised to 100 per cent.; but a little consideration would show that this was a fallacy. The only further saving which could be made would be due to the better management of the plant on account of the reserve allowing of its better manipulation; but this was a small matter. It seemed to him that Mr. Howell obtained his result by comparing an actual diagram taken from practice with an ideal diagram where everything was done in a perfect way. If they looked carefully at the actual load diagram they would see that it was peculiar in many respects. The "in and out running" of the engine load line suggested that the man who was jockeying that plant had heavily backed accumulators. Mr. Howell said that the engines were run as nearly at full load as was considered safe in American practice, but they ought to be run not only at full load but above full load. A steam dynamo which could not be run, at any rate for limited periods, 10 to 20 per cent. in excess of its full load (that is, load of maximum economy), was not fit for an electricity supply station. If, instead of spending £7,000 on a battery, they engaged the services of an engineer who understood better the principles of the economical management of an electricity supply station, they might effect an equal saving without the heavy charge to which a battery was subject.

Mr. RIDER said he believed that cells were a good thing to have in a station, for the reasons Mr. Howell had stated in his Paper, for bringing up the engine load factor to 100 per cent., and because the shifts could be reduced at a certain part of the day. He did not see that there was very much in the use of accumulators as a stand-by against breakdowns, because if the station was properly arranged he would as soon have a good engine and alternator to fall back upon as a set of cells. Cells could be as readily used in an alternating-current station as in a direct-current station. Let the day-load alternator be fitted with a rectifier, and let them transform down to 150 volts or so such power as was not being used for the circuits. Let them send this transformed current through the rectifier, and charge a set of cells. The engine load factor could thus be brought to

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100 per cent. throughout the day, and the cells could be used to run a motor alternator whenever desired, and particularly after midnight and on Sundays. The whole steam plant could be shut down on those occasions. Although accumulators would enable to do many good things, they would have to be very much improved before they would be highly satisfactory, because, as he remarked at the last meeting, cells could not be charged at a high rate, but it would take from eight to ten hours to fill them again. That was one of the points he thought the makers would have to alter before the cells would be of any great service.

Mr. CROMPTON said he was sorry to say that in the old Institution, which he had the honour to represent, they had far too many cases of a meeting consisting either of a number of students or teachers, who had not yet had any practical experience of the business, or men who had all their own logs to roll. They sometimes got meetings that were not as practical as he would wish. He had read the discussions of the Northern Society, and they had appeared to him to be very much the sort of thing that he had often wished had been the case in his Institution. He had read Mr. Howell's Paper, and he thoroughly agreed with him in the remark he made on the subject that the men above all others whom they wished to hear speak were the men in charge of the stations. It had been said that he was what was called a low-tension man; he was not a low-tension man at all, but he was most strongly an anti-alternator current man. Alternating currents were no doubt a splendid thing in their way to professors and schoolboys, but nasty things to deal with in central stations. One of the principal reasons why they were so nasty to deal with was that they did not allow accumulators to be easily used. Mr. Howell had converted him to the use of accumulators, and the way he did it was to show him (Mr. Crompton) that he would be able to work without that anxiety and worry which attended all central-station work. It was perfectly true that accumulators did waste a certain amount of energy, but it was certainly not more than 15 per cent., and in some cases less. There was such a large saving by the better loading of the engines, and that was where the big saving took place. The difference between having engines loaded to about 50 per cent. and to about 90 per cent. was very large indeed. He had got an alternating station of his own at Chelmsford, and he had tried for two or three years to scheme in a few things to increase their income; one was the use of motors. He would only say that if any man would show him how he could drive four or five printing offices with motors without interfering with the lighting, he would make that gentleman a present of £50 to-morrow, and if they could show him how to use accumulators so that he could make money by them between his generating plant and his network, instead of between his network and the consumers, he would also be glad to hand over another cheque for £50.

Mr. HESKETH said he had heard it claimed by advocates of batteries that the ideal use of electricity was that given to gas—that was to say, to store it up to be used just as it was wanted. He was aware that the argument was very far fetched, and that it never was intended to accumulate all the supply, as in gas works; but an analogy taken from this view might be instructive. Suppose they had an accumulator with a capacity of 14,000 ampere hours, it would cost £7,000—that was to say, assuming 3½ watts per candle, they had for £7,000 a storage equal to 400,000-c.p. hours. For the same number of candle-power hours a gas-holder cost £1,500. There was rather a wide difference between those two figures, and if they were to adopt very extensively any system of storage they must have something cheaper than the present accumulators. He would like, if it was not asking too much, to have some typical cases given where the cost of coal could be given for the units that were taken out of the battery. As to the point mentioned by Mr. Cowan of overloading plant, he would not like to be in charge of a station where they could not overload at least 20 per cent., because if the plant broke down they must be able to overload at least to that extent.

Mr. FAWCUS said that, after the very strong condemnation of the use of the alternate current by Mr. Crompton, he felt some reply ought to be made. Although he was not a rabid supporter of any particular system, he desired to see the two fairly compared. He had taken out roughly the results obtained by the six commercially best low-tension stations and the six commercially best high-tension stations, and the low-tension had so far the advantage in cost of production. It so happened that three of each kind were managed by Corporations, and three by Companies. The six low-tension were Burnley, Brighton, St. James, Westminster, and Liverpool, and the six high-tension stations Newcastle, Newcastle and district, Hanley, Leeds, Huddersfield and Portsmouth. The cost of production in the low-tension stations was 1·78d. per unit, and in the high-tension stations 1·93d., being a saving in favour of low-tension stations of 7 per cent. in cost of production only; but that cost of production only meant about half the total cost of the current, so that the saving fell down to 3½ per cent. on the total cost. Again, the low-tension stations paid £120 per kilowatt for their plant, while the high-tension stations paid £80; that was to say, the low-tension stations, to obtain the saving, paid 50 per cent. more for their plant than the high-tension; also this comparison was very favourable towards the low-tension stations for another reason: the average time of running was four years, while the average time the high-tension stations had been run was two years. Again, the districts that were being served in the case of the low-tension were all congested districts, whilst in the other cases the districts were very much more spread about. He had remarked upon the peculiarity of the peak of the diagram shown of the American station, and suggested to Mr. Howell that as the heaviest load came on at four o'clock in an afternoon in June, the station was probably in the neighbourhood of the South Pole, or the diagram was taken during an eclipse. Mr. Howell had, however, assured him this peculiarity was caused by motors running in at four in the afternoon. At all events, it was a pity that a more reasonable diagram had not been chosen instead of one which appeared to show the station running under almost impossible conditions.

Mr. MOUNTAIN said he did not think the saving would be anything like that described. He thought Mr. Crompton did not apparently appreciate the position of electric supply undertakings in provincial towns. The fact mentioned by Mr. Fawcus was of great importance in considering the relative values of each method of supply. The area of supply must come very largely into the question. Taking Huddersfield as an example, some houses taking a supply of electrical energy were as much as 3¾ miles from the supply station, and these houses were actually the best consumers, taking more energy than the largest buildings in the central portion of the town, owing to the fact that they were burning their lights nearly all the night through, and he could not see how a provincial town was to be thoroughly covered with a network of low-tension mains owing to the enormous amount of money required, although for congested districts they might do very well indeed.

Mr. HENRY EDMUNDS (President) said he thought Mr. Howell had given them a very good and interesting Paper. Mr. Mordey had once said to him that the beauty of an alternating current was that it would not charge an accumulator. He asked him if he were still of that opinion on seeing him one day after reading the Paper. Mr. Mordey's reply was, "Show me a good accumulator—a really good one—and probably I shall alter my opinion." It was a good accumulator that was wanted.

Mr. HOWELL, in reply, said Mr. Cowan had unfortunately fallen into serious error in considering that the saving in coal would only be effected on the number of units stored by the accumulators. On the contrary, *the saving was made on every unit generated*, since the efficiency of the station as a whole was raised. As a corroboration of the saving of the 13 tons mentioned in the Paper, it was only necessary to refer to the Kennedy table, where the pounds of coal per unit for the day's output was 7·33, and for the period of maximum load, when the engines would be running at higher efficiency 6·1, or almost the exact ratio given for the station mentioned in the Paper, 80 tons without accumulators, 67 with. Mr. Cowan would thus see that his apparent generosity in *giving* the coal required to charge the battery was entirely misplaced, and, paradoxical as it might seem to him, the station required less coal for a greater number of units generated when fitted with accumulators than it would need for a small number of units generated without accumulators. With regard to Mr. Rider's remarks on accumulators and their use in alternating-current stations, there could be no question that the engineer in charge was considerably relieved by having in his exciting circuit a reserve such as an accumulator would give, and extension would probably take place in the way that Mr. Rider had suggested. Mr. Hesketh's demand for figures as to efficiency was somewhat amusing. What need of inquiring too closely into the efficiency of the battery when, inefficient as it was, it effected a saving in a station using 80 tons of coal of £4,300 a year. Mr. Hesketh, however, might take it that the energy efficiency over 12 months' running would not be less than 85·6 if the batteries were properly worked, and this figure had been attained in actual practice at one of the Westminster stations under Prof. Kennedy's charge. Accumulators were frequently overcharged, and it was not the fault of the accumulator manufacturers that the efficiencies obtained were frequently so low. Mr. Fawcus had brought an interesting list of stations. Portsmouth, which was one of the stations named, did not give a constant service; hence its figures were of no earthly value at all. Any station could generate current at period of maximum load and pay. It was the period of minimum load that made electric lighting in some cases difficult from a commercial standpoint, and it was this period of minimum load that accumulators took care of.

THE BRUSH CONSTANT POTENTIAL ARC LAMP.*

The growing demand for a reliable constant potential arc lamp for use on incandescent circuits has led the Brush Electric Com-

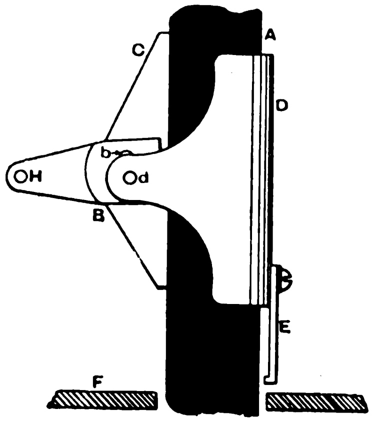

Fig. 1.

pany, of Cleveland, to design a lamp which will prove satisfactory under the various severe conditions to which such lamps are subject. This lamp, shown in the accompanying illustrations, is claimed to be without any of the objectionable features found in lamps of the

* From the *Electrical Engineer* of New York.

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clock-work type. The absence of springs renders permanent adjustment possible and, as the magnetism acts against the weight

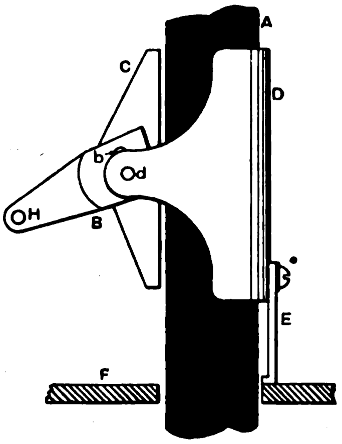

Fig. 2

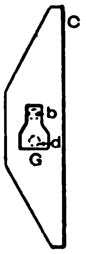

Fig. 3.

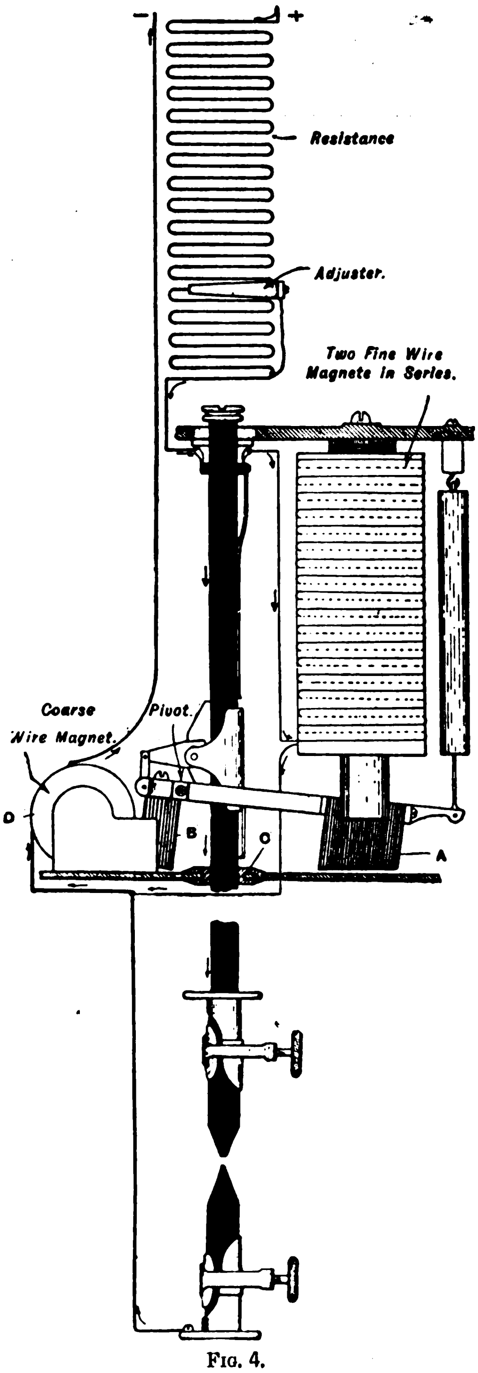

Fig. 4.

of the moving parts, the friction is diminished, and the weight greatly reduced.

Among the desirable features of the regular Brush constant current lamp that have been adapted to the new constant potential lamp, is the clutch, Figs. 1, 2, and 3, the result of 15 years of experiment and experience. In this clutch the lever B is supported at H by an armature lever. Fig. 1 shows the clutch gripping the rod, and as the armature moves up and down it will carry the rod also. However, in descending, the clutch will only grip the rod until the trip E touches the plate F, when any further fall of H will release the rod by pulling C back as in Fig. 2. The raising of the armature lever at H immediately closes the clutch and lifts the rod with the lever. This clutch presents such a long gripping surface that a dent or enlargement in the lamp rod will not affect its operation in the least. The opening G (Fig. 3) is of such form as to prevent clogging by dirt or dust, and never requires cleaning or repairing. The position of the rivets through the opening G is shown at *b* and *d*.

Fig. 4 is a diagram of the lamp, showing the carbons separated, as when the lamp is not burning. When the current is switched on its only path is through the fine-wire magnets, which at once draw up the armature A, slowly lowering the clutch and rod until the carbon points come in contact. If the trimming of the lamp is regular, the carbon points will touch before the clutch releases the rod, consequently the carbons cannot lap (a common trouble with constant potential lamps), for the instant the points touch, a path for the current is closed through the coarse-wire magnet D which attracts the armature B, overcomes the pull of the fine-wire magnets and lifts the clutch which again separates the carbons and establishes the arc. The pull of the fine-wire magnets is constant and the strength of the coarse-wire magnet varies with the resistance of the arc as they are in series. As the carbons burn away the resistance of the arc increases, and consequently the current flowing through the coarse-wire magnet decreases until the fine-wire magnets overcome its pull and slowly lower the carbon rod, thus maintaining a constant arc until the clutch trip reaches the plate C and releases the clutch. This allows the carbon rod to slide downward a little, but it is instantly caught and raised by the clutch as the carbon points come nearer and allow increasing current to pass through the coarse-wire magnet. When the carbons have been consumed, the circuit is opened at the arc of the first pair of carbons that can feed no more, and the carbons in the other lamp that are not yet consumed continue to touch and spark slightly, thus indicating that it is the dark lamp which needs trimming.

The lamp is simple both in design and construction and pleasing in appearance.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, June 14th,

Physical Society.

5 p.m. Meeting at Burlington House. The following Papers will be read: (1) "The Measurement of Cyclically Varying Temperatures," by H. F. Burstall; (2) "The Thermal Constants of the Elements," by W. F. Deerr; (3) "An Electromagnetic Effect," by F. W. Bowden.

WEDNESDAY, June 19th,

Royal Meteorological Society.

7:30 p.m. Ordinary Meeting at the Surveyors' Institution, 12, Great George-street, Westminster.

Society of Arts.

9 p.m. Annual conversazione at the South Kensington Museum.

A New Use for Accumulator Grids.—The return of the hot weather reminds us of an instance of the novel use to which an ingenious mind can put a secondary battery plate. Not a hundred miles from Farringdon-street there was to be seen last summer the grid of a secondary-battery plate of well-known type. As in ordinary practice, it lay in a glass cell; it also had an acid electrolyte, but the vessel was a cylindrical bowl and the electrolyte dilute "lemon squash." The use to which the grid was put was to keep in position the metal syphons used, a few of the meshes of the grid being cut away to admit the end of the syphon, and the corners of the grid were turned down, to keep it well clear of the bottom. It would be interesting to know how the owner of the business came into possession of the plate; also the effect of the liquid (which had to pass through the meshes of the grid) upon the internal economies of its consumers.

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The Electrician.

(The Oldest Electrical Journal, 1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices.*

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Owing to the growth of the electrical and allied industries the demands for space in "THE ELECTRICIAN" are, for the greater part of the year, so pressing that a permanent increase in the size of the journal has become necessary. To meet the increased cost involved by this step, and by other improvements, such as heavier paper and more numerous illustrations, the price of "THE ELECTRICIAN" has from May 3rd been advanced to 6d.

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ABSOLUTE RESISTANCE.

Few circumstances bring the scientist more completely face to face with the mutability of earthly, and indeed of all material things, than the attempt to rationalise any complex physical unit, such as that of electrical resistance, by expressing it in absolute measure. Interchange of exact thought in modern times calls into existence the need for a system of units; and it is desirable, if the researches of one man are to be intelligible to his fellows in all places and at all future times, that not only shall all men work with one universal system of units, but also that any one of those units shall be capable of reconstruction from an exact and unvarying specification. Thus arises the necessity for a standard of each particular unit; and it will be seen that, with a view to the selection of any standard, only two courses are, practically speaking, possible: either the standard unit may be arbitrarily fixed and crystallised, as it were, in a manufactured material apparatus, or it may be defined in terms of such physical properties of the universe as are least liable to change with time and throughout space. The latter has been named the absolute or rational method; because, on the hypothesis that it is a workable process, it would arrive at a unit which would be free from the changes and decay of ordinary material apparatus and things. The former method cannot in this sense be termed rational, and to make this clear let us fix our thoughts upon one particular unit—that of electrical resistance.

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By an Order in Council, dated August 23, 1894, the Queen approved of "a standard of electrical resistance denominated one ohm, being the resistance between the copper terminals of the instrument marked 'Board of Trade Ohm Standard Verified 1894' to the passage of an unvarying electrical current when the coil of insulated wire forming part of the aforesaid instrument and connected to the aforesaid terminals is in all parts at a temperature of 15·4°C." And the limit of accuracy of such a standard resistance is specified as being required to be "within one-hundredth part of 1 per cent." Although, therefore, a polite reference is made in the Order in Council in question to its scientific pedigree, the legal ohm is actually a material apparatus, and as such it is liable to suffer those changes which Time seems inevitably to effect in all material things, only one of these changes, namely, that of temperature, is guarded against in the specification. But, as was so clearly pointed out by Prof. VIRIAMU JONES recently, in his masterly lecture at the Royal Institution, there are other influences which are liable to arise which may vary the standard within the specified limits of accuracy. The state of aggregation of the material particles composing the standard resistance, and the condition of internal stress and strain among those particles, cannot either be guaranteed to be constant, nor can their variation be guarded against, as in the case of temperature, because it is not possible to determine the magnitude of their changes. Yet these exert considerable influences on the magnitude of the resistance. It was considerations such as these which led Prof. JONES, in his lecture on "The Absolute Measurement of Electrical Resistance," to which we have already referred, to advocate the "rational" method of fixing a standard of resistance, and to press the plea that the time is now ripe for its "frank and full acceptance" by the Government, though since the Government is now definitely committed to the metallic standard ohm, one would have thought that the time was, perhaps, over-ripe. The merits of this alternative and, by assumption, absolute method are based upon the fact that it depends upon only the most permanent phenomena of the universe—that, in fact, it defines the standard in terms of rational mathematical magnitudes, and banishes all the irrational quantities to the ether, "to which," as Prof. JONES quaintly observed, "they properly belong," and in which, at any rate, they will have the merit of being constant, even though they are not measurable. A unit which is constructed or defined only in terms of the joint properties of Space, Time, and the ether, and which has had eliminated from it every specific property of mutable matter, may fairly be termed rational and may be considered as close an approximation to the absolute as is attainable by the efforts of mere mortals. It is such a unit of electrical resistance as this that Prof. JONES advocated in his lecture—a unit depending only on the centimetre, the second and one specific property of the ether; in other words, the C.G.S. electromagnetic unit of resistance.

This little C.G.S. unit is no stranger to electricians; they have long recognised his existence in the abstract, and have even labelled their standard ohms as being equal to a certain number of millions of him. But it is one thing to know of the existence of a C.G.S. unit in the abstract—to be able, so to speak, to chalk it up on a blackboard—and it is quite another thing to materialise that unit in solid copper, within the degree of accuracy required by the specification of the legal ohm, viz., within an error of one part in 10,000. This is the crux of the whole matter. Can the reproduction of a given number of these absolute units, say 10^9, of them in a length of copper wire be guaranteed with the degree of accuracy required by law? Prof. JONES thinks he can undertake the task, and has given his grounds for so thinking. The geometrical and other physical dimensions of the apparatus which he has devised for the purpose of this absolute method, a model of which he exhibited in action at the Royal Institution, are capable, he assures us, of measurement considerably within an error of one part in 10,000. The quantities thus to be measured are: the configuration of a coil of copper wire carrying a current for producing the inducing field and the speed of rotation of the inductor disc in which the induced electromotive force—which is to balance the potential difference at the ends of the measured resistance—occurs. There should be no difficulty in ascertaining, to the required degree of accuracy, the dimensions of a cylindrical coil of the size and careful construction used, and Prof. JONES has abundantly proved that fluctuations of speed within this degree of error may equally easily be detected and compensated, while the actual speed itself is simultaneously determined to an equal approximation. The Imperial ohm, therefore, gains nothing in accuracy by being specified in terms of an actual piece of copper wire; while it runs the inevitable risk of suffering indeterminate changes in the magnitude of its real electrical resistance. And the Government possesses no means whatever of ascertaining from time to time whether such a change has or has not taken place. Let but a suspicion of inconstancy in this standard bit of wire arise in the official mind, what other safeguard can officialdom have than to compare its bit of copper with some other bit of copper, which may just as likely have undergone the elusive change? It has none whatever — unless, indeed, it elects to hand its standard over to Prof. JONES, and asks him to determine how many millions of his constant little absolute units it is equal to. And to do that would be to make the rational system of standardisation the final court of appeal—a course which, sooner or later, will have to be frankly adopted.

We cannot conclude our remarks on this subject, so intimately connected with the painstaking researches of Prof. VIRIAMU JONES, without paying a tribute to the lucid style and scholarly diction with which its intricacies were explained to his audience, largely non-technical, at the Royal Institution. It was a bold essay to attempt to interest and instruct such an audience in matters connected with coefficients of mutual induction, mathematical equations, and the like. But if those of his audience whose interests lay outside of technical matters were unable to derive much scientific instruction from lecture, we are sure that even to them the hearing of such a scholarly discourse must have been a literary treat; while to many present Prof. JONES' lucid style must have invested dry, every-day matters with an unexpected charm.

NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(Continued from page 195.)

42. **Battery Resistance.**—The most simple and reliable methods of measuring the internal resistance of a battery are Mance's bridge method and the half deflection method. These are described in the text-books, but it may be desirable to state them briefly here.

The connections for Mance's test are given in Fig. 118. The battery is disconnected from the key, and put on to the line and earth terminals of the bridge. Balance is obtained when

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no change in the galvanometer deflection occurs on opening or closing the test key. The resistance of the battery is then found by the ordinary bridge proportion, as if it was a simple resistance without E.M.F. It is necessary to use a shunt on the galvanometer to bring the deflection conveniently within the scale, and it is sometimes convenient, when the battery is a small one, to add a resistance to it, which is afterwards deducted from the bridge result.

The advantage in this test is that balance is obtained to one deflection. In observing that a given deflection does not alter on pressing a key it is not possible to make any mistake, as the very slightest movement of the spot from the fixed deflection can be detected. It might be called a null method to false zero.

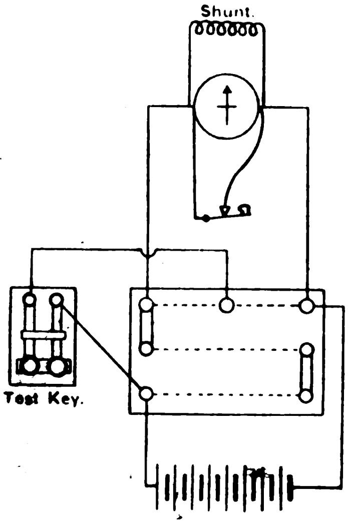

Fig. 118.

The half-deflection method is carried out by the simple connections given in Fig. 119. The galvanometer is shunted with a very low resistance—a few ohms—so that its resistance may be neglected in comparison to that of the battery and adjustable resistance, and a convenient deflection obtained with any resistance unplugged in the box. Note the resistance unplugged, and the deflection. Now unplug more resistance, until the first deflection is halved.

To halve the deflection (or current) the total resistance in circuit must have been doubled, and, therefore, the total resistance unplugged for half deflection must be equal to the battery resistance plus twice the first resistance. Subtracting twice the first unplugged resistance from the total resistance unplugged gives the resistance of the battery.

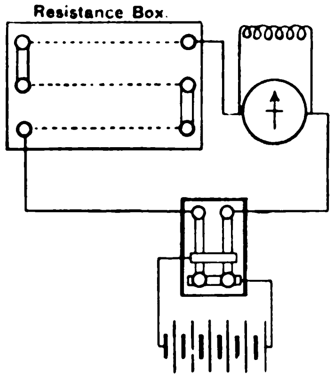

Fig. 119.

43. **Simultaneous Battery Resistance and E.M.F. Test.**—A reliable null method which in two readings would give both the E.M.F. and resistance of a battery appeared to the author to be desirable, and he has devised the following simple form of test.

The battery, whose E.M.F. (E) and resistance (b) we have to find, is connected direct to two resistances, R and r (Fig. 120). A standard cell of e volts is connected through a key and galvanometer across the resistance r, as shown. The smaller resistance (r) is fixed, while the larger resistance (R) is adjusted till there is no deflection on the galvanometer when the key is closed. We have then the distribution of potential shown in Fig. 121.

Now increase the small resistance n times (making it $n\,r$), and alter R till balance is again obtained. Suppose that R is altered to R_1 to effect balance. Then we have the distribution

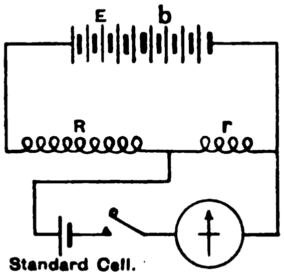

Fig. 120.

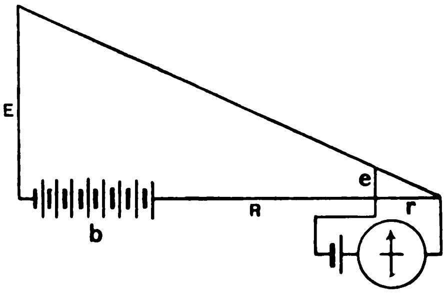

Fig. 121.

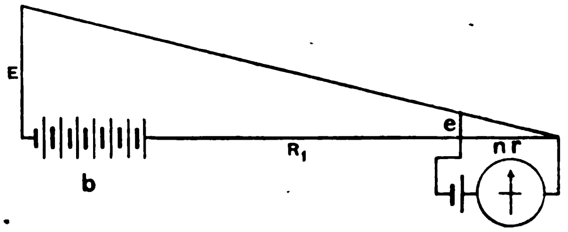

Fig. 122.

of potential shown in Fig. 122, and it is evident that, the current being $\frac{1}{n}$th of its former value and the two E.M.F.'s remaining the same, we have

$$R_1 + b = n\,(R + b),$$

whence the resistance of battery (b) is equal to

$$\frac{R_1 - nR}{n-1} \text{ ohms.}$$

Also it is evident that the E.M.F. of the battery (E) is equal to

$$e\,\frac{R + b + r}{r} \text{ volts,}$$

which can be put in the simpler form of

$$e\left(1 + \frac{R+b}{r}\right) \text{ volts.}$$

Hence, by two simple balances of the galvanometer to zero, we have both the E.M.F. and the resistance of the battery.

The ordinary bridge box can be used very conveniently for this test connected as in Fig. 123. It is convenient to use the two 100 coils in the bridge ratio arms for r, making it 100 for the first balance and 200 for the second (that is $n = 2$). With $r = 100$ we adjust the resistance in the box till there is no deflection on the galvanometer (the resistance so unplugged being R ohms). Then making $r = 200$ we adjust the resistance again to balance (the resistance unplugged being R_1 ohms). Then, since $n = 2$ we have

$$\text{resistance of battery} = R_1 - 2\,R.$$

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By having $r=100$ at first we ensure that, with a standard cell of a little over a volt, the current from the large battery through the bridge coils does not at any time exceed 14 or 15 milliamperes, which is too small to have any heating effect on the coils. A key is put in the large battery circuit, so that the current need only be on for a few seconds while getting balance.

An example will make the test clear. Suppose we use a Clark standard cell of 1·435 volt. (The standard cell must be joined in opposition to the battery, as shown in Figs. 120 and 123). With $r=100$, we balance the galvanometer with R adjusted to say 3,178 ohms. Again, with $r=200$ balance is obtained say with $R_1=6{,}568$ ohms. Then resistance of battery is

$$6{,}568-(2\times 3{,}178)=212 \text{ ohms},$$

and E.M.F. of battery is

$$1{\cdot}435\left(1+\frac{3{,}178+212}{100}\right)=50 \text{ volts}.$$

It will be seen that the formula for the battery resistance when $n=2$ is the same as for the half deflection method. But there is the advantage that no deflection has to be read in this test, and further, the value of n may be made 3, 4 or other higher values up to 10 to suit different batteries, all giving equally accurate results on account of reading the galvanometer to zero instead of reading deflections. When it is desirable to make r any other value than 100, or n any other value than 2, a separate resistance box should be used. This box should be put in series with the resistance R and

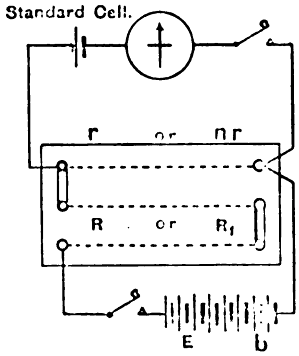

FIG. 123.

battery, and the galvanometer and standard cell connected across it. The maximum current put through the coils when r is 100 ohms is a very moderate one.

With a Clark standard cell of 1·4 volt the current is

$$\frac{1{\cdot}4}{100}\times 1{,}000=14 \text{ milliamperes}.$$

It will not be found necessary to make r less than 100 unless there is not sufficient resistance available for R, but in any case r should not be less than 50 ohms, which would cause a current of 28 milliamperes to pass through the coils when balanced.

To prevent an undue current being passed through the coils *before* the balance is obtained, it is advisable to calculate roughly what R should be. Knowing *approximately* the resistance of battery (b) and its E.M.F. (E), the resistance R should be about

$$r\left(\frac{E}{e}-1\right)-b \text{ ohms}.$$

For instance, we are to test, say, the resistance and E.M.F. of a battery of 40 cells. If they are good-sized Leclanché's they will probably have about 1·6 volts and 5 ohms per cell, or 64 volts and 200 ohms for the battery. Putting $r=100$ and using a standard cell of 1·4 volt we find that R should be about

$$100\left(\frac{64}{1{\cdot}4}-1\right)-200=4{,}270 \text{ ohms}.$$

Putting this approximate resistance for R at starting, its right value is soon afterwards found by adjustment until the galvanometer is balanced. A make and break key is put in the galvanometer circuit which must only be *tapped* while adjustment of R or R_1 is being made, in order to prevent any appreciable current leaving or entering the standard cell.

(To be continued.)

THE ABSOLUTE MEASUREMENT OF ELECTRICAL RESISTANCE.*

BY PROF. J. V. JONES, F.R.S.

§ 1. If we take a conductor such as this piece of copper wire, and make it part of a conducting circuit in which an electric current is flowing, we find that the electromotive force between its extremities is proportional to the strength of the current passing though it, so long as it remains in the same physical condition. If either the electromotive force or the current strength varies, the other of these quantities varies in like proportion. Their ratio is constant, *i.e.*, it has a value independent of them, and depending only on the dimensions of the conductor, the nature of the material of which it is made, the state of aggregation of its parts, and its temperature.

This ratio is called the electrical resistance of the conductor, and so defined it corresponds to a real physical quantity—it is a physical property of the conductor.

§ 2. Probably no physical measurement can be made with greater accuracy than the comparison of electrical resistances. Such comparisons are daily made in many parts of the world, and it is clearly desirable, in order that the results obtained by one man may have meaning for others, that all should make their reckoning in terms of the same unit. Accordingly, the scientific world has given great attention to the definition of such a unit, and much international negotiation has taken place with a view of securing world-wide agreement on this point.

The most obvious method of procedure is to fix upon some convenient conductor as a standard, and to call its electrical resistance the unit of electrical resistance, other electrical resistances being then expressed as so many times or such and such a fraction of the resistance of this standard conductor.

The disadvantage of this method of defining the unit is that the resistance of such a standard may change from time to time through alterations of its physical condition. The most notable change is consequent on change of temperature; this may, however, be allowed for by defining the unit as the electrical resistance of the standard conductor when it is at a specified temperature. But the other changes of physical condition, changes in the state of aggregation of the parts of the conductor, effects of strain, alterations of molecular structure, &c., are more serious, because they are unknown, and we cannot in our definition provide against unknown possible changes. We run the risk, therefore, of having a varying unit, and the prime requisite of a unit is constancy.

In England the Government has taken this risk, and committed itself—at least for the present—to this method of specifying the unit of electrical resistance.

The denomination of the standard of electrical resistance contained in the recent Order in Council regarding Standards for Electrical Measurements is as follows:—

"A standard of electrical resistance denominated one ohm being the resistance between the copper terminals of the instrument marked 'Board of Trade Ohm Standard Verified, 1894' to the passage of an unvarying electrical current, when the coil of insulated wire forming part of the aforesaid instrument and connected to the aforesaid terminals is in all parts at a temperature of 15·4°C."

This is a plain adoption of an arbitrary standard. The resistance of a certain piece of wire wound into a coil is made the legal unit, and if this resistance varies our legal unit varies with it.

It is true that in constructing the standard efforts have been made to ensure that its resistance shall be equal to 1,000

* Friday Evening Discourse, delivered at the Royal Institution, May 24, 1895

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million times the absolute unit of which I shall presently speak—that the standard was in construction based upon the ohm; but there is no provision in the Order in Council for revision if the standard varies, nor indeed has the Government any means at its disposal of directly measuring its standard in absolute measure.

I seem to be finding fault. That is not my intention. I am only advocating progress. The time is ripe for the adoption of the absolute unit, not merely nominally but really, for the frank acceptance of the absolute unit itself as the ultimate legal standard.

§ 3. Now, what is an absolute unit? The following considerations affecting physical measurements generally will, I hope, serve to make this clear.

In order to specify the magnitude of any physical quantity, we bring it into relation with a standard magnitude of the same kind, called the unit, and say that it is so many times or such and such a fraction of this unit. Thus we speak of a length of 6 centimetres, a mass of 50 grammes, a time of 20 seconds, an electric current of 10 amperes, an electrical resistance of 30 ohms, and so on.

For the purpose of this specification any convenient magnitude of the physical quantity to be measured may be taken as the unit.

But science has to deal with many kinds of quantities, and when we consider the various units as constituting a system, our arbitrary choice is limited by two conditions of fundamental importance:—

(1.) The units must be chosen so as to simplify as far as may be the statement of the quantitative relations existing between various kinds of quantities.

Physical science, in so far as it is quantitative—may we not say in so far as it is perfected?—tells us of relations of interdependence between many different kinds of quantities. Thus, in geometry we have such relations between lengths, areas, and volumes; in kinematics, relations between these mathematical quantities and times, velocities, and accelerations; in dynamics, between these mathematical and kinematical quantities and mass, momentum, force, work, and energy; in electrical and magnetic science, relations between the foregoing quantities and electrical and magnetic magnitudes; and so on.

These relations of interdependence are expressed in equations, and it is of obvious advantage, both for ease of arithmetical calculation and clearness of thought, to rid these equations as far as possible of superfluous arithmetical constants. This may be done by a judicious selection of units, by making the units of the quantities that appear most complex in their relations of interdependence depend upon the units of the quantities that appear in their nature to be simplest. A unit of any quantity so defined with reference to the units of quantities apparently simpler is called a derived unit with reference to the latter units as fundamental.

Thus, the attraction of the earth on a mass of 1lb.—the weight of 1lb.—is an arbitrary unit of force. The force that, acting on a mass of 1lb., increases its velocity by 1ft. per second every second is a derived unit of force with reference to the units of length, time, and mass, as fundamental. It is usually called the absolute unit of force on the pound-foot-second system; and by the very nature of its definition it gets rid of an arbitrary constant in the relation between force, mass, and acceleration. If the arbitrary unit of force mentioned above—the gravitation unit—is used instead of the absolute unit, our dynamical equations are uselessly complicated by the introduction of "g," the acceleration of gravity at the particular point of the earth's surface at which we happen to be, and at the particular time when our measurements happen to be made.

(2.) The second condition of prime importance to a scientific system of units is that the units of all quantities should be invariable, unaffected by conditions of time and place, and independent of the properties of particular bodies, *i.e.*, they should be *absolute*. The word "absolute" is in philosophy opposed to "conditioned." When it is applied to a unit in science the implication should be that the unit is the same at all times and in all places, and that it is unconditioned by the properties of any specified body or bodies, *i.e.*, that its magnitude is brought into relation with and depends upon only the most permanent phenomena of the universe.

The modern system of absolute units goes far to fulfil the first of our two requirements; it only very partially fulfils the second.

When we speak of an absolute unit at present we mean a unit the magnitude of which depends on nothing else than the units of length, time, and mass, and the properties of the ether. The latter may be regarded as universal enough, but the units of length, mass, and time are arbitrary standards. The metre depends on the properties of a particular bar, the gramme on the properties of a particular piece of platinum, the mean solar second on particular bodies of the solar system.

The time will come when we shall be able to take another step forward, when we shall be in a position to make the unit of mass a derived unit with reference to the units of length and time as fundamental through that universal uniformity of nature—the law of gravitation; the units of length and time being based on some more permanent phenomena of the universe (the properties of the sodium molecule have, for instance, been suggested) than the length of a particular bar, and the motion of the earth on which we live.

But we cannot take this step forward yet. We do not know either the gravitation constant or the velocity of light with sufficient accuracy to enable us to define by means of them units precise enough to meet the needs of practical life. Yet the fact that if we knew these constants we could make an important advance in the realisation of a system of absolute measurement is an excellent reason why the masters of physical measurement should apply themselves to their precise determination.

The use of a derived unit of mass would have this among other advantages: it would rationalise the dimensions of the electric and magnetic units in length and time, and relegate the irrationality to the ether, to which I believe it properly belongs.

We must, however, for the present be content with a less complete reference to the most permanent phenomena of the universe, and by absolute measurement to-night I mean measurement in terms of a unit derived with reference to the unit of length, time, and mass as fundamental, *i.e.*, a unit conditioned only by these units, and the properties of the ether.

§ 4. There is such a unit of electrical resistance—a unit derived with reference to the units of length and time as fundamental—the magnitude of which is independent of the properties of any particular conductor, any particular coil of wire, and which is conditioned only by the units of length and time, and the properties of the ether.

It may, indeed, at first sight seem astonishing that a quantity so different can be expressed in terms of a length and a time. Yet so it is. We can, in virtue of experiments made 63 years ago in this Institution by Michael Faraday, measure the resistance of a conductor with the help of no other standardising instruments than a tape or measuring machine and a clock. An electrical resistance is always proportional to a certain velocity, and if the magnetic permeability of the ether be taken to be unity, the number expressing the electrical resistance will be the same as the number expressing that velocity; the unit of electrical resistance may then be taken to be the resistance corresponding to unit velocity, *i.e*, on the C.G.S. system a velocity of 1c. per second, and any electrical resistance may be conveniently expressed in terms of this unit as so many centimetres per second.

[You will observe that I do not say electrical resistance *is* a velocity. That would be to neglect the unknown dimensions of the magnetic permeability of the ether.]

If the unit of length, the unit of time, and the properties of the ether remain constant, this unit of electrical resistance remains constant. It is unconditioned by the properties of any material, by position in space, or point of time, and so far deserves the name of the absolute unit of electrical resistance.

§ 5. How comes it that resistance can be so measured? The answer to this question is best found in a description of some one of the methods by which the measurement of an

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electrical resistance in terms of the absolute unit can be experimentally made.

And I proceed, therefore, to a description of the method which may fairly be described as the simplest, and which in my opinion, having regard to the magnificent possibilities of mechanical engineering operations in this country, is undoubtedly capable of being made the most accurate of all the methods that have been proposed since the British Association Committee, more than 30 years ago, propounded the theoretical definition of the absolute unit.

The method is due to Lorenz; and Lord Rayleigh, at the conclusion of his masterly determinations of the value of the B.A. coils in absolute measure, expressed himself in regard to it as follows:—

"On the whole, I am of opinion that if it is desirable at the present time to construct apparatus on the most favourable scale so as to reach the highest attainable accuracy, the modification of Lorenz's method last described is the one that offers the best prospect of success."

The Paper from which I quote contained a comparison of the various methods of measuring resistance in absolute units, and an invitation to others to join in the work. It was the starting point of my own researches in the matter, which have extended over some years, and I gladly take the opportunity of thanking Lord Rayleigh for this source of inspiration.

§ 6. Faraday discovered that, if a conductor is made to move in a magnetic field so as to cut across the flux of magnetic induction, the conductor becomes the seat of electromotive force, and that the electromotive force so developed is proportional to the rate at which the induction flux is traversed.

If, for instance, we take a metal disc and make it rotate about a horizontal axis n times a second, any radius of the disc cuts through the earth's induction flux, unless the plane of the disc is in the magnetic meridian. There will, therefore, be electromotive force between the centre and circumference of the disc. Further, since a radius traverses the whole area of the disc n times in a second, the rate at which the induction flux is being traversed by any radius is $n\,I$, where I is the total flux of induction through the disc area. But the electromotive force is proportional to this rate. Therefore we have (with a proper choice of the unit of electromotive force)

$$E_1 = n\,I,$$

where E_1 is the electromotive force between the centre and circumference.

But we may, instead of using the earth's field, obtain a magnetic field by means of an electric current. The disc may be made to spin in the magnetic field due to a current in a coil of wire placed so as to be co-axial with it, and so that its middle plane coincides with the plane of the disc. In this case the magnetic field is symmetrical with regard to the common axis, and we have once more

$$E_1 = I\,n,$$

where E_1 is the electromotive force between the centre and circumference consequent on the rotation of the disc at the rate of n turns per second in the induction flux due to the current in the coil, I being the total amount of that flux which passes through the disc circumference.

§ 7. Now the current strength in a given circuit is by definition proportional to the intensity of the magnetic field produced by it at any point, and hence the magnetic induction through the disc due to the current in the coil is proportional to the strength of that current.

It follows that the magnetic induction through the disc is made up of two factors, viz., the current in the coil and the magnetic induction that would pass through the disc if unit current passed through the coil. The latter factor is called the coefficient of mutual induction of the coil and disc circumference, and its value depends only on their dimensions and relative positions, and the magnetic permeability of the medium in which they are placed. If the latter quantity is taken to be unity the coefficient of mutual induction is expressible as a length, and it may be calculated from observations involving nothing else than measurement of the radius and breadth of the coil and the radius of the disc. Let this coefficient of mutual induction be denoted by M, and the current in the coil by γ_1; then

$$I = M\,\gamma_1,$$

and finally,

$$E_1 = n\,I = n\,M\,\gamma_1;$$

or

$$\frac{E_1}{\gamma_1} = n\,M.$$

§ 8. We have therefore two ways of expressing the ratio of an electromotive force to a current.

By definition (Ohm's law) this ratio is given to us as electrical resistance, or

$$\frac{E}{\gamma} = R.$$

By the experiment of the disc and coil it is given to us as the product of their coefficient of mutual induction and the rate of rotation of the disc (number of turns per second).

And if the ratio for the disc and coil is made the same as the ratio for the resistance (which it is possible in practice to arrange) we have

$$R = M\,n.$$

If the magnetic permeability of the medium be taken as unity, M is a length expressible as so many centimetres, and the number of turns per second is the reciprocal of the time of one revolution of the disc. Hence the resistance may be expressed as a velocity of M centimetres in the time of one revolution of the disc. This makes it clear that with the assumption in regard to the permeability of the ether (or air) that we have made above any electrical resistance is expressible as a velocity of so many centimetres per second.

§ 9. We can in practice make the ratio for disc and coil the same as the ratio for the resistance by first sending the same current through coil and resistance and then varying the speed of the disc so as to make the electromotive force between its centre and circumference equal to the electromotive force between the resistance terminals.

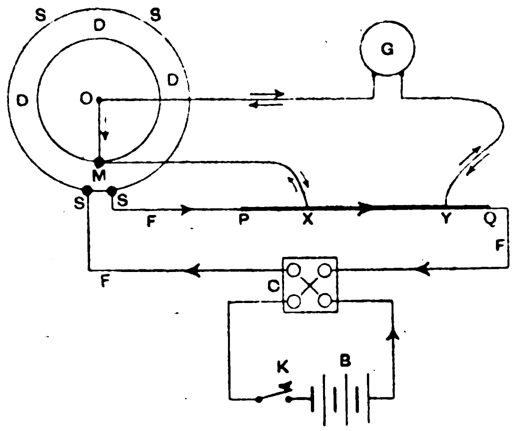

FIG. 1.

How can we test the equality of the two electromotive forces? If two equal electromotive forces act in opposite directions in the same circuit the result is electrical equilibrium. We have, therefore, to proceed as follows:—Place the two electromotive forces in the same circuit so as to act in opposite directions; then if they are the only electromotive forces in the circuit there will be an electric current round the circuit due to their difference if they are unequal, and no electric current at all if they are equal. The presence or absence of a current may be tested by the inclusion of a galvanometer in the circuit.

In practice it is not quite so simple as this, because it is impossible to make the two electromotive forces in question the only electromotive forces in the circuit. There will be others, and especially thermo-electric forces, always present. But this difficulty may be met thus:—Reverse the two electromotive forces we are comparing; if the current in the circuit is not changed by this reversal of both, they must be equal, *i.e.*, if the reading of the galvanometer be the same, whether the balancing electromotive forces are in one direction or the other, these electromotive forces are equal. The reversal of

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both our electromotive forces may be readily effected in practice by simply reversing the direction of the current through the coil and resistance.

To measure our resistance in absolute measure we have then—

(1.) To make the coil (S S S, Fig. 1) and the resistance (X Y) parts of the same main circuit (B C F S S S P X Y Q C B), and to pass through this circuit an electric current. A commutator (C) is to be inserted in the circuit in order that the direction of the current may be changed at will.

(2.) To insert the electromotive force between the centre and circumference of the disc (D D D) acting in one direction and the electromotive force between the extremities of the resistance acting in the opposite direction in a second circuit (X M O G Y X) containing a sufficiently sensitive galvanometer G. Brush contacts must be made at O and M.

(3.) To vary the rate of rotation of the disc until the reading of the galvanometer is the same whether the current in the main circuit through coil and resistance is being sent by the commutator in one direction or the other.

(4.) To measure this equilibrium rate of rotation.

(5.) To multiply this equilibrium rate of rotation (number of turns per second) by the coefficient of mutual induction of the coil and disc, which is calculated once for all from their measured dimensions. This product gives the resistance to be measured in absolute units.

[The necessary arrangements were here experimentally shown by the lecturer.]

(*To be concluded.*)

THE ELECTROLYSIS OF HYDROCHLORIC ACID WITHOUT A POROUS SEPTUM.

The salient points in a short Paper by Dr. Felix Oettel, appearing in the *Zeitschrift für Elektrochemie*, may be summarised as follows:—

When hydrochloric acid (in aqueous solution) is electrolysed without a septum between the electrodes, the output of H and Cl falls considerably below the calculated value on account of the solubility of chlorine in water and its consequent ready union with the hydrogen evolved at the cathode. The loss can be somewhat reduced by increasing the current density at the cathode. Thus, using a 12 per cent. solution of HCl, the author found the following values:—

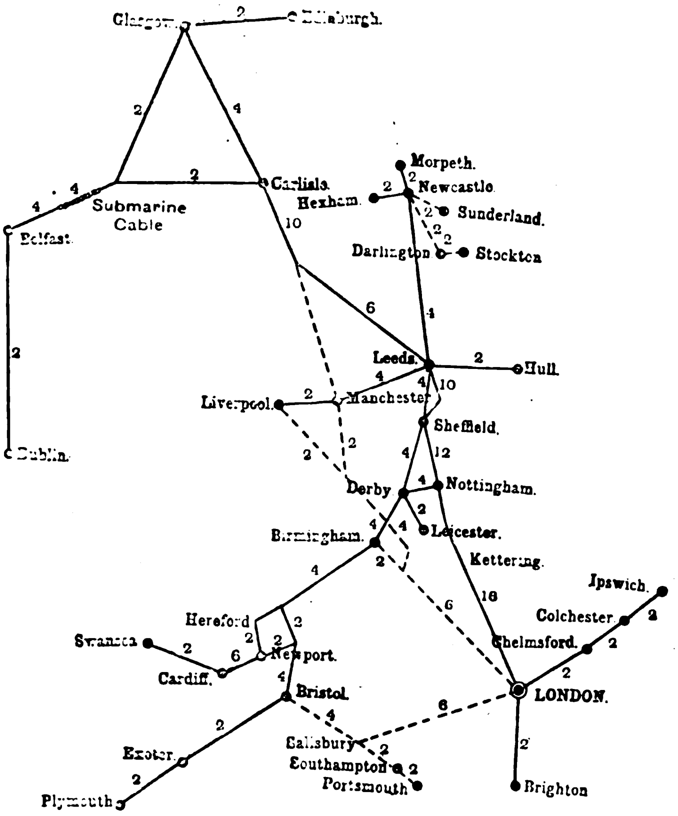
Current density. Amperes per square metre.	Output efficiency referred to current.	Voltage
	Per cent.	Volts.
240	41	1·4
600	55	1·6
1,200	66	1·7

A further advantage can be secured by diminishing the solubility of the chlorine by the use of an electrolyte containing some salt in solution in addition to HCl. A suitable solution is one containing 160grm. sodium chloride and 140grm. sulphuric acid per litre, partial decomposition taking place on the addition of the sulphuric acid, so that the substances present are HCl, NaCl and $NaHSO_4$. Using this as an electrolyte, an efficiency, referred to the current as distinct from the total energy absorbed, of 70 per cent. is obtained with a current density as low as 240 amperes per square metre, while when the current density is raised to 600 to 700 amperes per square metre the output is also enhanced, becoming 92 to 98 per cent. of that calculated from the current passing. Excess of sulphuric acid in the electrolyte causes oxygen to be evolved instead of chlorine, and, on the other hand, excess of sodium chloride causes eventually the production of sodium hypochlorite, the normal decomposition being determined. The highest efficiency is therefore obtained by working within comparatively narrow limits, such proportions as those given above being preferably adopted.

THE POST OFFICE TELEPHONE TRUNK WIRES.

On Wednesday afternoon the network of telephone trunk wires erected by the Post Office on the strength of the Treasury Minute of May 23, 1892, was formally "inaugurated" by the Lord Mayor of London conversing from the General Post Office, St. Martin's-le-Grand, with similar and similarly-situated municipal functionaries at Edinburgh, Glasgow, Belfast, and Dublin. What the conversations of these gentlemen related to is not accurately known, but it is reported to have had some reference to the weather.

The present and immediate future ramifications of the Post Office network are shown on the accompanying sketch map. The total length of wire required will be over 10,000 miles, and of this total 75 per cent. has already been erected. About one-



Post Office Telephone Trunk Lines.
Completed ——— In progress ········. Figures denote number of wires.

half of the 10,000 miles of wire runs 600lb. to the mile, the remainder being equally divided between 800lb. and 400lb. wire, the aggregate weight of copper being 2,829 tons.

The lines are all run on the "twisted" system, and where a large number of telephone trunk circuits are run on the same poles the circuits are also crossed at long intervals. The transmitter used is the Deckert, an Austrian improvement on the Hunnings microphone, and the receivers are simple double-pole Bell instruments. It may be mentioned that experiments have been made with a line extending 1,270 miles, from Plymouth to Dublin, by a circuitous and temporary route, and the results have proved satisfactory. This is the longest distance yet attempted, if we leave out the case of India, where the extreme dryness of the atmosphere gives facility for telephonic communication.

We may expect that, as soon as the telephone trunk system of this country has passed into the charge of the able heads which direct the telegraph system of the United Kingdom, the full capabilities of inter-urban telephony will be made apparent.

Royal Society.—The following Paper was down for reading yesterday:—Prof. S. P. Thompson, F.R.S., "On the Cause of the Differences in Lichtenberg's Dust Figures. Preliminary Note."

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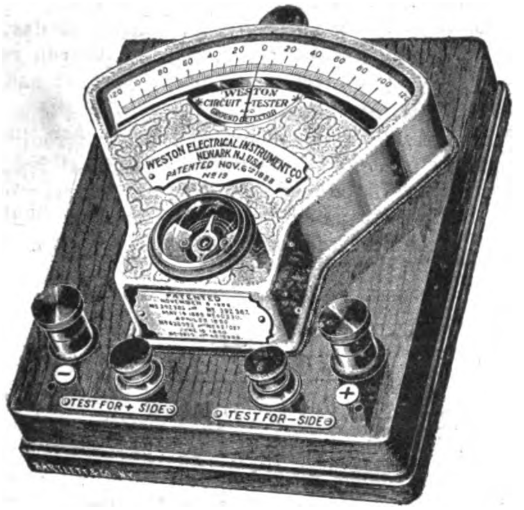
WESTON CIRCUIT TESTER.

Messrs. Elliott Bros. are introducing into this country several instruments made by the Weston Electrical Instrument Company, of Newark, N.J., and, amongst others, a circuit tester, or leakage indicator, for continuous-current circuits. The zero, as will be seen



Weston Circuit Tester.

from the illustration, is in the middle of the scale, and the two poles of the main being joined to the terminals direct, by depressing one of two keys either pole can be put to earth through a resistance of many thousand ohms, thus affording an easy means of obtaining information as to the state of the circuit under actual running conditions. The internal mechanism of this instrument is exactly the same as in the portable standard models with permanent magnets which are now so well known.

THE ELECTRICAL STANDARDISING, TESTING AND TRAINING INSTITUTION.

A dinner was given by the Electrical Standardising, Testing and Training Institution at the Imperial Institute on the 6th inst., under the presidency of Mr. Robert Hammond, in the absence, through domestic bereavement, of Lord Castletown of Upper Ossory. There was a large attendance, the company including Sir Courtenay Boyle, his Honour Judge Snagge, Col. Gouraud, Mr. Francis Ince, Mr. Ferranti, Prof. T. Hudson Beare, Mr. Musgrave Heaphy, Mr. P. W. d'Alton, Mr. H. A. C. Saunders, Mr. C. P. Sparks, Mr. G. W. Partridge, Mr. Albert Gay, Mr. W. W. Beaumont, and Mr. G. S. Ram.

The toast of "The Queen" having been duly honoured,

Col. GOURAUD proposed "The Electrical Standardising, Testing and Training Institution. In the course of a humorous speech he remarked that the Institution began with a much more modest name than it was at present known by, followed by the name of its founder, but the latter was a little "too previous." He himself (the speaker) once had the hardihood of bringing out a company with a million of capital, in 1882, with the object of lending money to people who wanted to go into this business. They obtained this capital from the public, and it was surprising the extent to which they had opportunities of lending it. In about a year's time, however, they found that there was not anything good enough to lend to, and they actually—this was an historic fact—called the shareholders together, and did something which he believed had never been done before in the history of English finance, and he was certain it would never be done again—they returned the capital to the shareholders, and informed them that they were ahead by ten years with their ideas. It was not their fault, but the fault of the British Government that they did not want at that time the electric light or the telephone; but they afterwards reformed their views. Mr. Hammond and his colleagues, seeing that their "too previous" idea in 1882 was about ripe in 1892, looked around them for the rehabilitation of the Institution, and in due course installed themselves at Faraday House.

The CHAIRMAN, in acknowledging the toast, remarked that Col. Gouraud had modestly put himself in the background, and had omitted to inform the company that among the enthusiasts who founded this industry he was himself one of the leaders. As the representative in this country of Mr. Edison, Col. Gouraud had done a very large amount of enthusiastic pioneering. The enthusiast had, perhaps, only one fault, namely, that he was often a burden to his family, for enthusiasm was not a thing that was always convertible into bank notes. Col. Gouraud had reminded them that the present Institution was founded upon the lines of the old Hammond Electrical Engineering College. In 1882 there were no skilled assistants to carry out the work that had to be done, and he (the speaker) could only be in one place at a time. There were, however, numerous jobs waiting to be executed. In 1881 he formed the idea that all the processes of rail making could be carried out in one shift in 24 hours if only the electric light was put on the rail bank. He conclusively proved at Middlesborough the correctness of this idea, and a few months afterwards every rail bank was illuminated by the electric light. This necessitated assistants; but they were not to be had, and the old Hammond College was then founded with the idea of manufacturing them. It was not until 1890, however, that they started the old College under its present happier name. They got hold of the enthusiasts in the form of students, and he thought there were men in the industry who would agree that that branch of the Institution's work had been a success. There were other enthusiasts in the industry besides students; there were the inventors. In those early days they had a primary battery offered to them every week. Inventors came to the Institution and took up the whole of their time, and he remembered saying to Lord Crawford, his colleague in restarting the Institution, "Let us found a primary battery repression society." Lord Crawford, however, on the contrary, suggested that they should test these primary batteries and other inventions and report on them. Having gone as far as that, they thought they might report on all inventions, and next they thought that they might standardise and put right the instruments of others. In every department of Faraday House they had placed all their resources at the command of those who were working out a new and useful invention.

Mr. FRANCIS INCE next proposed "The Visitors," and his Honour Judge SNAGGE replied.

The CHAIRMAN afterwards proposed "Past and Present Students." Some persons, he remarked, seemed to think that the electrical industry was played out, and that young enthusiasts who felt that they would like to be electrical engineers were likely to waste their time. He would endeavour to combat that opinion. In 1882, when the old Hammond College was first founded, there was only one house in England, if not in Europe, which was lighted from coal cellar to attic by the electric light, that house being either Colonel Gouraud's or his own. Since 1882, however, the electric lighting industry had shown such marvellous growth that at the present time there were 99 central stations for the supply of electricity for lighting and other purposes in the United Kingdom. Of these 55 were in the hands of companies, and 44 were in the hands of Corporations or Local Authorities. Not only had some £7,500,000 come into the industry in the same time, but the prospect before it was as bright as anything which it had achieved in the past. He believed that in the next 10 or 20 years they might look for an addition to the electrical plant of the country to the extent of £500,000 per annum. There were two other domains in which electrical engineering had an immense future—in the direction of the distribution of electrical power, and in the direction of electric traction. The students might be assured that a great field lay before them.

The toast was acknowledged by Mr. STOTHERT and Mr. GLADSTONE.

Sir COURTENAY BOYLE afterwards proposed "The Board of Control and Staff." He expressed his great satisfaction in proposing the toast, as he claimed that of all the multifarious duties which devolved on him at the Board of Trade—duties extending from China to Peru, and over all phases of commerce and functions of trade—there was none which gave him more interest than that which appertained to the electrical industry. Ten years ago, when he joined the Board of Trade as assistant secretary, the industry was not as flourishing as it was now. It might have been that the Act of 1882 did not achieve the result expected of it; but the position was very different now. Powers of supply and of lighting were given to and enjoyed by a large number of companies and municipalities, and he claimed that the Board of Trade had built up a code of law governing those bodies which was acceptable, which was working well, and which was successful in every point of view. During the last 10 years, too, the Department had produced an international agreement as regarded the ohm, the ampere, and the volt, and by doing this they had settled three standards which were extremely useful to the electrical industry. They had further—at least for the moment—pacified that quarrel of many years' duration which had existed between the telephone industry and electric traction as to the user of earth. He thought that no students were to be more congratulated than those who had to do with the advancement of electrical energy. He believed that the field which lay before them was unlimited and unexplored, and that it devolved on men like themselves to cultivate that field in the way it ought to be cultivated, and to produce from it those results which were obtainable therefrom. As long as their Institution was presided over by men like Mr. Harrison, he felt sure that it would prosper and succeed.

The toast was acknowledged by the CHAIRMAN, Mr. INCE, and Mr. HARRISON, and the company shortly afterwards separated.

BOOKS RECEIVED.

"Electricity in Medicine from a Modern Standpoint." By W. J. Morton, M.D. Reprinted from the *New York Medical Journal* for April 20 and May 4, 1895.

Proceedings of the Royal Society. Vol. LVII. No. 345. Price 4s.

Catalogue of the *Philosophical Transactions* of the Royal Society of London. 1890-1895. (London: Dulau and Co.)

Proceedings of the Royal Society of Edinburgh. Sessions 1892-93, 1893-94, and 1894-95. Vol. XX. (pp. 305-384.)

"The Telephone Systems of the Continent of Europe." By A. R. Bennett. (London: Messrs. Longman and Co.) Price 15s.

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PARIS NOTES.

(FROM OUR OWN CORRESPONDENT.)

PARIS, *June 10, 1895.*

Electric Tramways for Montmartre.—The city of Paris will at last be endowed with an exemplar of the conduit system of electric traction. As the result of a competition for the laying down of an electric tramway starting from the foot of the Butte Montmartre, Place Cadet, and going through the Rue Rochechouart, to finish at the opposite slope, two projects were sent in and examined, and the concession for the line has been granted to the Société d'Etudes Françaises et Etrangères, who offered to pay the highest royalty to the municipal authorities.

Heilmann System of Electric Traction.—The Compagnie des Chemins de Fer de l'Ouest has granted to M. J. J. Heilmann a concession for the overhead system of electric traction on the line Saint Germain—West to Saint Germain—Grande Ceinture. This line is a double-track road, and has been established quite recently; it has a length of 4 kilometres. An 800-H.P. plant will be installed at Saint Germain (West).

Condensers in Commercial Use.—The Secteur Électrique des Champs Élysées has employed for some time successfully a battery of condensers in series with the feeders in order to reduce the current when the secondary circuits are not loaded. Before these condensers, constructed by M. Boucherot, were added the current was equal to that of a 400-kilowatt alternator at full load. The same supply company has in view the laying down of an alternator for the purpose of compensating the disturbances due to want of synchronism of the alternators.

A Large Dynamo.—The Edison Company, after having obtained from the leading dynamo builders estimates and drawings of a 2,000 ampere 150 volt double dynamo for their Trudaine station, have placed the order with the Société des Etablissements Weyher and Richemond. This dynamo, of the Brown type, will be provided with two commutators for the purpose of feeding the three-wire distribution, and consequently will yield 2 × 2,000 amperes at 150 volts. It will be driven direct by a Van der Kerchove engine at a speed of 100 revolutions. The guaranteed steam consumption is 9·85kg. per utilised kilowatt-hour.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *June 1, 1895.*

The Telephone Situation.—The recent decision in the Berliner case has brought about a movement having in view the general organisation of telephone manufacturers and operating companies adversely affected for mutual protection against the American Bell Company. In the absence of the opinion of the Court, which will not be handed down for some days yet, the full effect of the decision rendered cannot be known, but on the face it appears to extend the telephone monopoly in this country until 1908. It is most probable, however, that this monopoly will not be established without a desperate struggle on the part of the numerous manufacturing and operating companies who had made large investments on the strength of Judge Carpenter's decision, nullifying the Berliner 1891 patent. This at least will probably have the effect of determining the real status of the Bell patents, which number perhaps over a thousand. While little is known about the most of these patents, yet even a cursory examination shows that many of them are of the kind so frequently issued in the early days of telephony and electric lighting, in which the only inventive skill exercised was in drawing up claims to cover "old chestnuts."

The American Institute of Electrical Engineers.—The geographical distribution of the officers of the American Institute of Electrical Engineers who were elected last week emphasises the national character which that body has attained. Until within a few years it was little more than a local New York affair, and the formation of the Chicago branch meeting may be considered as the first great step toward a broader sphere of influence. Another branch meeting will soon be organised, and it is quite probable that within a couple of years there will be a half-dozen such local meetings, thus greatly extending the influence and usefulness of the body. Of the newly-elected officers, President Duncan is from Baltimore; Vice-Presidents Pupin, Hasson, and Hebbard are from New York, San Francisco, and Chicago; and Managers Hering, Scott, Hutchinson, and Arnold are from Philadelphia, Pittsburg, New York, and Chicago respectively. The general meeting of the Institute will be held in Niagara Falls the last week in June, and will be one of unusual interest from the fact that Papers on almost all of the various technical features of the Niagara plant will be read, the Niagara Company and the several contracting companies having reserved the announcement of much technical information for this occasion.

CORRESPONDENCE.

ARMATURE DESIGN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I was particularly interested in your comments on the Paper on "Improvements in Armature Ventilation," by Prof. Harris J. Ryan, which appeared in *The Electrician* dated May 31, 1895.

Inasmuch as I was the chief designing engineer of the Edison General Electric for some time previous, and until the consolidation of that Company with the Thomson-Houston Electric Company, some comments from me on this subject may be of interest, especially since it was during this period that the change from bipolar to multipolar dynamos was commenced on a large scale. My experience confirms the statements made by you. I shall be glad, however, if you will allow me to discuss these statements, since I judge them to be of considerable practical importance.

First, with respect to the time required by an armature when under load to attain its maximum temperature. In machines of the same type the time increases with the volume of metal in the armature, but not, so far as I have been able to ascertain, by any ascertainable law. Small armatures usually attain maximum temperature after three or four hours; larger ones generally require from8 to 12 hours, and occasionaly longer. In the Edison it was and in the General Electric Company it is the practice to test each new type of armature until it has attained its maximum temperature.

With reference to the 75°C. increase, I may state that this is not considered by American engineers a normal nor a safe increase of temperature. Such machines are considered to be of an obsolete type; 30°C. increase is nearer the standard practice of to-day. The new machines are perhaps no more efficient than the old, but they certainly are more durable.

With reference to the standard speed of 3,000ft. per minute, I may state that this was true in the case of the bipolar type, but in the new types the peripheral speed varies with each class of dynamo. For direct-connected machines 2,500ft. per minute is an average value. For belt-driven machines of higher speeds 3,200ft. is a fair average. The peripheral speed of the armatures of commutating machines seems to be a function of the angular velocity, and in alternators a function of the frequency. I entirely agree with your statement, that a really satisfactory basis on which to estimate the cooling surface of armatures and to allow for different speeds of rotation is still to seek. The best approximation that I have been able to make from a great number of tests with the older type bipolar dynamo of larger size is: peripheral speed, 3,000ft. per minute, the increase of temperature per watt per square inch is from 30°C. to 40°C., and for 2,000ft. per minute 36°C. to 48°C. With the modern ventilated type the increase of temperature calculated in the same way is about one-half.

In a certain series of experiments on armatures with ventilating flues of the same type it was found that the ventilation increased approximately with the square root of the surface

speed. With the non-ventilated type I have been unable to satisfactorily to determine any law of the effect of peripheral velocity on increase of temperature.

With reference to the eddy current loss, this seems to vary in importance according to the size of the dynamo, and is of more or less importance according to the construction. In the larger Edison dynamos Foucault-current heating was troublesome, whereas in the smaller ones it was of practically no importance, since these machines were generally designed for small current output.

The present proportions of armatures have been determined principally with reference to the sparking limit. The maximum current output per pole is a limited quantity, and the number of poles has been increased to the present limit to suit the more exacting practical conditions as to sparking. Dynamos of half the number of poles, and with longer armatures of smaller diameter, could be made to be sufficiently cool; but they would be less satisfactory as to sparking. Great current output with small trouble from sparking can only be secured by a great number of poles, which is the natural complement of a short armature of large diameter.

I am not of opinion that such devices as commutating lugs and face winding are necessary to balance a dynamo (even with ventilating flues) so that the sparking and heating limit occur at the same output. As an example I would instance an 800-kilowatt railway dynamo designed by the writer and tested by the jury of awards at the Chicago Exposition. The armature losses were as small as the outside dimensions permitted, and small considering the output of the dynamo; every precaution had been taken to effectively ventilate the armature and commutator, yet the sparking was not noticeable for outputs considerably beyond the limit of output determined from the safe heating limit 40°C. Other machines constructed on the same lines have shown the same qualities. My own experience with commutating lugs has been unsatisfactory. In estimating the worth of such contrivances the cost of material and labour have both to be considered. Unless extra windings save a great part of the material, the complication of the dynamo is increased without commercial advantage.—Yours, &c., H. F. Parshall.

June 11, 1895.

ZICKLER'S UNIVERSAL ELECTRODYNAMOMETER.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: On page 75 of your issue of May 17th you published a long abstract from my pamphlet on the universal electrodynamometer designed by me, and you also referred to the same in your Editorial Notes on page 71 of the same issue. Permit me to make a few remarks with reference to the latter.

The conditions which an instrument for measuring potential has to fulfil, and which have to be considered in the construction of the same, are well known to me. They are comparatively easy to comply with when the instrument is only intended for measuring potential. In the case of the electrodynamometer here considered, however, the conditions take the following form. If, first of all, mirror-reading is supposed, then the watt loss and the influence of the self-induction can be made very small. In direct-reading electrodynamometers, torsion electrodynamometers, and electrodynamic current weighers, it is easily possible to bring the maximum watt loss down to about 0·1 watt for every volt of the potential to be measured. As an instance of this I may mention the centi-ampere balance of Lord Kelvin, where the same is used as a voltmeter. Again, the influence of self-induction in potential measurements of alternating currents can, with medium periodicity, be easily confined to a small percentage of the potential to be measured. An instance of this is the astatic potential dynamometer of Siemens and Halske, which, with alternating currents of 50 to 80 periods per second, show only 2 to 3 per cent. difference in the readings for continuous and alternating currents.

Considerably greater difficulties are caused in this direction when it is required to construct an instrument which, besides potential measurements, also permits of measuring current and electric power (watts) between very wide limits. One is generally obliged to make larger concessions with regard to watt loss and the influence of self-induction. We find, for instance, in the composite balance of Lord Kelvin, which serves for current, potential, and watt measurements of continuous current, a maximum watt loss of 0 5 watt for every volt of the potential, though this instrument has no conductor for big currents in the movable coil, but requires an auxiliary current to be taken through the movable coil when measuring big currents.

The result attained by my instrument of a maximum loss of 0·4 watt per volt of the potential is therefore better than the result of the above-mentioned universal instrument, the more so when one considers that even the biggest currents are conducted through the movable coil, and no auxiliary current is required.

The most unfavourable feature in the universal instrument, as compared with a simple potential electro-dynamometer, is the greater weight of the movable coil, which consists of a copper frame of 35 square millimetres, and 60 turns of a wire 1·2 millimetres thick. This requires, as you very truly remark, in order to attain a certain sensibility, a powerful spring, and therewith likewise the turning moment is settled, which the current-carrying coil has to exercise upon the movable coil. Having settled upon a suitable maximum for the voltmeter current, then the product $m_1 \times m_2$ of the number of turns of the fixed and movable coils will have a certain value. Theoretically speaking, then, other conditions being the same, the coefficient of self-induction of the coils is smallest when the sum of the turns $m_1 + m_2$ is a minimum. This is the case when $m_1 = m_2$. To get near this favourable point in practice without increasing the weight of the movable coil, the same can be made of *aluminium* instead of copper. An instrument of this kind is already in the course of construction, and, owing to the increase of windings of the movable coil and the decrease of the windings of the fixed coil, more favourable results in potential measurements of alternating current in respect to self-induction will be arrived at, so that, for instance, at the same torsion angle the variation between the readings for continuous current (600 volts) and alternating current at 100 periods should no longer be 50 per cent. (900 volts), but only 2 to 3 per cent. At the same time the watt loss in the instrument will become smaller. In future, therefore, all instruments will be so constructed that the influence of self-induction and the watt loss of the instrument will be confined within the desirable limits. This universal instrument should therefore be of great service to electricians in all those cases, which often occur, where no suitable instrument for the special measurement in hand is at their disposal.—Yours, &c., Karl Zickler.

MAGNETIC TESTERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I notice in the reports given in your valuable journal of the discussion on Prof. Ewing's Paper on a "Magnetic Tester," Prof. Forbes speaks of an apparatus made here some years ago and used by the General Electric Company, accrediting me with the design. I wish to say that the design of the instrument was due to Mr. Frank Holden, who was employed in the instrument department of the Company, and that he intends shortly to write a description of the instrument and give the results which he has obtained in its use.

Prof. Forbes's error in accrediting this instrument to me was natural under the circumstances, as I had spoken to him of another instrument made some years previously—I think in the latter part of 1889 – in which a pile of discs of standard size were driven in magnetic fields of varying strength by a small electric motor on the principle of the motor used in my recording wattmeter. A reading of the current required to be passed through the meter motor to overcome friction at any speed, in the absence of any magnetic field acting on the discs, was first taken, and another reading when the field was present. From the difference of these two readings the energy used in revolving the discs was easily obtained. Mr. Holden's instrument, however, is much nearer the simpler instrument proposed by Prof. Ewing.—Yours, &c., Elihu Thomson.

Lynn, Mass., May 31, 1895.

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THE REVISED BOARD OF TRADE REGULATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having a suggestion to make with regard to the new Board of Trade Regulations, and being neither a central station engineer nor one of the others interested who received a copy of the Regulations from the Board or the "whip" from the Electrical Trades Section, I beg leave to make it in your "Correspondence" column. Might not a regulation be added for the benefit of the central station people to the effect that, in house installations made after the date of the adoption of the revised Regulations, all single-pole switches and cut-outs should, so far as possible, be placed on the positive wire (or on the neutral wire in connections on the negative side of a three-wire network)?

I also think that, in view of the few accidents that happen, the use of the word "undertakers" in the high-pressure regulations (for instance, in No. 38) might be avoided, as it must unnecessarily jar on the nerves of those not accustomed to legal terms.—Yours, &c., C.

June 10, 1895.

LEGAL INTELLIGENCE.

Shelfer v. City of London Electric Lighting Company, and Meux's Brewery Company v. Same.

In the Court of Appeal on Wednesday, the Court consisting of Lords Justices Lindley, Lopes and Rigby, the cases of Shelfer *v.* City of London Electric Lighting Company and Meux's Brewery Company *v.* City of London Electric Lighting Company came on for hearing on motions by the defendants for leave to further stay the injunction which had been granted.

Mr. MOULTON, Q.C., told their Lordships that these were applications to suspend the injunctions granted in December last against the City of London Company on account of the nuisance caused to the plaintiffs by the vibration of the defendants' engines. The injunctions had been suspended for a month pending an appeal to the House of Lords, but in February last the defendants changed their manager, and employed a Mr. Frank Bailey, and he informed the Company that it was possible to stop the vibration complained of, and under these circumstances an appeal to the House of Lords was useless, so an extension of the suspension of the injunction was obtained to the first day of the Easter Term. The mode of stopping the vibration was by bringing about a radical change—viz., that the four large vertical engines near the "Waterman's Arms" were to be replaced by Parsons' steam turbines. What he (the learned counsel) asked for was that the injunctions be further suspended until the alterations could be carried out.

Lord Justice LOPES: What is to be done in the interval? Are the vibrations to continue?

Mr. MOULTON: We will do our best, and make the alterations as quickly as possible. Counsel suggested that the vibration was caused by the water under the soil.

In reply to Lord Justice Lopes, Counsel said that the contemplated appeal to the House of Lords had been withdrawn.

Mr. WARMINGTON, Q.C., for Mr. Shelfer, said that he was not treated fairly in this matter. Everything had been done to expedite the appeal, and on the last day for lodging causes it had been withdrawn. Nothing had been done; this engineer had been employed by the defendants since last February, and the nuisance complained of was still existing. This case had been compared to the well-known Manchester-square case, but there was no analogy between them, for in the latter there had been no vibration. Mrs. Shelfer's health had been much impaired, though at present the nuisance was somewhat mitigated, owing to it being summer. The steam from the defendants' works filled the house, making everything damp and dirty.

Lord Justice LINDLEY: How long will it take to move these engines?

Mr. MOULTON: One has gone already; we will remove them as quickly as possible.

Counsel went on to point out to their lordships the necessity of keeping a good supply of electricity in the mains for the public to draw from, and perhaps it would be advisable for the learned judges to nominate some engineer to estimate the time it would really take to remove them.

Lord Justice LINDLEY, in giving judgment, said that in this case the duty of the Court was not difficult to express. It was bound to see that private rights were not infringed, and also that public bodies were duly protected from oppression. Although not much impressed by the proposed turbines, he was satisfied that the efforts of the defendants to get rid of the nuisance were *bona fide*. Under the circumstances, however, he thought it right that the defendants should give an undertaking to answer as to damages. The injunction would be further extended to August 5th, the defendants undertaking to pay the costs of the applications.

Lords Justices Lopes and Rigby concurred.

Mr. Warmington, Q.C., M.P., Mr. Badcock and Mr. Waggett appeared as counsel for the plaintiffs; while Mr. Moulton, Q.C., M.P., Mr. Renshaw, and Mr. M. C. Braithwaite represented the defendants.

Direct Spanish Telegraph Company (Limited) v. The Owners of the Steamship "Caloric."

The plaintiffs are appealing in this action, which was tried before Mr. Justice Day in March last, and was brought to recover damages for alleged injuries to one of the plaintiff Company's cables in Bilbao Bay, by reason of the anchor of the "Caloric" fouling the cable whilst the vessel was lying at anchor. His Lordship found for the defendants on the ground that there was no negligence on the part of the defendants' servants, and it is against this decision that the appeal is taken.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices:—*

LABORATORY NOTES AND FORMS.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett (*now ready*). Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s. —each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 250 illustrations. Price 10s. 6d. post free (abroad 11s.).

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"ELECTRO-CHEMISTRY."—This useful work, by Dr. G. Gore, is still on sale, the price being 2s., post free.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. nett, is now ready.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d (abroad 8s.). Prospectus on application.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson, price 6s. 6d., post free.

"THE ELECTRICIAN."—A special notice concerning certain changes in the price, &c., of this journal will be found on page 228.

TENDERS INVITED.—The Electric Lighting Committee of the Corporation of St. Helens (Lancs.) invite tenders for the supply and erection of boiler and engine-house plant, switchboard and instruments, underground work (including cables, boxes, culverts, &c.), transformers and fittings, meters, and overhead crane for their electric lighting station. Specifications, plans, &c., can be obtained from Mr. Robert Hammond, the consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., and tenders are to be sent in to Mr. W. J. Jeeves, Town Clerk, Town Hall, St. Helens, not later than Tuesday, July 2nd. Some further particulars appear in our advertisement columns.

———— The Electric Light Committee of the Bedford Corporation invite tenders for the supply and erection of water-tube boilers,

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engines, and alternators, of which particulars are given in our advertisement columns. Specifications and particulars can be obtained at the offices of Mr. T. S. Porter, Town Hall, Bedford, to whom tenders must be delivered by Tuesday, the 25th inst.

TENDERS INVITED.—The Urban District Council of Clevedon require tenders for the public lighting of their district every night in the year from sunset to midnight. The tenders are to be for one, two, or three years, and must be sent in to Mr. H. C. Fry, Clerk of the Council, Clevedon, by July 1st. Further particulars are given in our advertisement columns.

——— The General Direction of Spanish Posts and Telegraphs are inviting tenders until July 5th for the supply of 25,000 zinc cylinders for Callaud batteries. Also by the 4th prox. for the supply of 10,000 grey and 40,000 white porcelain insulators. Tenders are to be addressed to the Registro General, Direccion General de Correos y Telegrafos, Madrid.

——— The Corporation of Birkenhead require tenders for the erection and completion of the boiler-house and other buildings, &c., in connection with their electric supply stations. Tenders must be in by 12 o'clock Thursday, the 27th inst.

——— The Gas and Electricity Supply Committee of the Bradford Corporation require tenders for the supply of coals, for use at the electricity supply station for a period of one or two years, commencing from August 1st next. Tenders must be sent in to Mr. W. T. McGowen, Town Hall, Bradford, not later than Wednesday, the 3rd prox.

——— The Corporation of Preston require tenders for the wiring of the Town Hall and Public Hall buildings, and for the electric light fittings required for the installation. Tenders must be sent in to the Town Clerk, by noon of July 1st.

TENDERS ACCEPTED.—The Brighton Corporation have received the following tenders for the supply and erection of arc lamps, switches, &c. :—

Sharp and Kent, London (accepted)	£2,167
Crompton and Co., London	2,633
J. A. Edmundson, Leeds	2,757
Siemens Bros. and Co., London	2,988

Tenders were also received from Messrs. Johnson and Phillips and the Electrical Company, but, being informal, were not entertained.

——— The Birkenhead Town Council have accepted the following tenders :—

Tetlow Bros., Hollinwood (three Lancashire boilers)	£1,745
Crompton and Co. (Limited) (three sets of steam dynamos, engines, and feed pumps)	4,987
Crompton and Co. (Limited) (instruments, apparatus, wires, &c.)	798
Electrical Power Storage Company (Limited) (accumulators)	837
Callender's Company (cables, street boxes, &c.)	4,894

——— The Halifax County Council have accepted the tender of the Electric Construction Company for the supply and erection of a combined alternator and engine for the electricity works for the sum of £3,050. This additional plant is to be fixed by October, as it is anticipated that provision will have to be made for no less than 6,000 additional electric lamps for the coming winter.

——— The Museum Building Committee of the Exeter City Council have accepted the tender of the Electrical and General Engineering Company for carrying out the installation of the electric light at the Museum for the sum of £299. 10s. The tenders were not advertised, the selection being left with the architect.

——— The tender of Messrs. R. E. and C. Marshall, for wiring and fitting up the electric light at the Cheltenham Public Library, has been accepted for the sum of £105. 10s. 6d.

——— Eight tenders have been received in connection with the lighting of the Cardiff Free Library, and the tender of Messrs. Knapman, Hodder and Co., Cardiff, being the lowest, has been accepted.

——— Twenty-seven tenders were received for the wiring of the Shoreditch (London) Town Hall, ranging from £848 to £178. The latter, the tender of the Electrical and General Engineering Company, was accepted by the Vestry at its last meeting.

——— The Yarmouth Town Council has accepted the tender of Messrs. Lawrence Scott and Co. for the supply of electric fittings, &c., required for lighting the Beach gardens, for the sum of £14. 7. 6d.

SALE BY AUCTION—Under an order of the High Court of Justice Mr. William Izard (Messrs. Izard and Izard), of 52, Gracechurch-street, London, E.C., will sell by auction on *Tuesday next*, June 18th, at 12 o'clock, the valuable and extensive stock, plant, and machinery of the Ford-Lloyd Manufacturing Company (Limited) at Phœnix-place, Mount-pleasant, Clerkenwell, E.C. Some further particulars are given in our advertisement columns.

APPOINTMENT VACANT.—The Streets Committee of the Commissioners of Sewers are about to appoint a working mechanic for their electrical laboratory. Applications must be sent in by 12 noon, Tuesday, July 2nd. Some further particulars will be found in our advertisement columns.

APPOINTMENT VACANT.—The Vestry of Shoreditch, London, E.C., require a clerk of the works, with practical experience, to supervise the works in connection with the dust destructor and electric lighting station buildings, at a salary of £3. 3s. per week. Applications must be sent in to Mr. H. M. Robinson, Town Hall, Old-street, London, E.C., not later than noon of the 24th inst.

APPOINTMENT.—Mr. Charles D. Copland has been appointed works manager at a salary of £180 per annum, and Mr. Horace Taylor assistant works manager at a salary of £130 per annum, at the electric supply station of the Newport (Mon.) Borough Council.

PERSONAL.—We understand that Mr. F. R. Davenport has recently returned to the British Thomson-Houston Company, with whom he was formerly engaged. Mr. Davenport has for some time been acting as assistant to Mr. W. H. Preece in connection with the consulting electrical practice of the latter, and he was closely connected with the construction of the electric supply stations at Worcester, Tunbridge Wells and other places as Mr. Preece's representative.

LIQUIDATIONS.—A meeting of the creditors and contributories of the Anglian Carbon Company (Limited) takes place at 10, Meadowside, Dundee, on July 8th, at 3 p.m., to receive an account of the winding-up proceedings.

——— A meeting of contributories and creditors of the Schanschieff Electric Battery Syndicate (Limited) will be held at 32, Poultry, London, E.C., on July 10th, at 12 o'clock, to receive an account of the winding-up.

REMOVAL.—The general offices of Dalziel's News (Limited) have been removed to 15, Moorgate-street, London, E.C.

AGENCY TRANSFER.—Mr. N. G. Thompson, electrical engineer, of 13, Victoria-street, London, S.W., whose name is well known in connection with the London agency of electrical supplies, has disposed of his supply and agency business to Messrs. J. C. Lyell and Co., of 55, Victoria-street, S.W. Mr. Thompson will in future give his whole attention to professional work as a consulting engineer, his address remaining at 13, Victoria-street, S.W.

SOLD.—Yesterday Messrs. Hibbard and Son, of 9, Walbrook, E.C., sold without reserve the stock of electric lamps, shades, fittings, &c., the property of the creditors of Poole and White (Limited), Bread-street, Cheapside, E.C. The probability, however, that the creditors will receive any benefit from the sale is very remote.

TUMBLER SWITCH.—Under date 11th inst., we are informed by the General Electric Company that the action for infringement of the Link Switch patent against Messrs. W. McGeoch and Co. and others has been satisfactorily settled. Messrs. W. McGeoch and Co., Verity and Sons, Evered and Co., and the Edison and Swan Company are licensees for this patent.

VICES AND GENERAL ENGINEERS' TOOLS.—Messrs. W. H. Willcox and Co. issue an illustrated descriptive pamphlet of a variety of parallel vices manufactured by the firm. From the very large number of these tools in use it is clear that the engineering trade appreciate Messrs. Willcox's efforts to supply a first-rate article at a low price.

ARC LAMP CATALOGUE.—Messrs. Girdlestone, Tatham and Co., sole manufacturers of Andersen's patent arc lamps, send us their latest list, which gives illustrations and particulars of a variety of lamps suitable for indoor and outdoor lighting. The list is accompanied by testimonials from a number of users, including Messrs. Willans and Robinson, of Thames Ditton. The Exhibition of Railway Appliances, held at the Imperial Institute, was lighted entirely by these lamps.

IMMISCH ELECTRIC LAUNCHES.—The Immisch Electric Launch Company (Limited) send us a copy of a pamphlet descriptive of the Company's launches on the Thames, which, in addition, contains a number of time-tables, maps, and up-river fixtures.

"THE ENGINEERING MAGAZINE."—The contents of the June issue of this magazine (now ready) will be found to quite equal those of its predecessors in interest and variety. The articles include: "The Malignant Effects of the Free Silver Delusion," by Edward Atkinson; "The Growth of American Export Trade," by T. A. Eddy and Carl Schurz; "Irrigation Surveying in California," by C. E. Fowler; "Practical Hints for City Officials," by Francis Collingwood and Rudolf Hering; "Power, Light and Heat in City Blocks," by J. E. Talbot; "Wooden Stavepipe for Conveying Water," by Arthur Lakes; "Heating and Ventilating Tall Buildings," by L. Allen; "The Advances in Modern Iron Smelting," by John Birkinbine, and "Hints for the Mechanic and the Employer," by Edwin Woodward. Many of these articles are handsomely illustrated; and the magazine also contains a complete index of the contents of the World's Technical Press. The new number and nearly all back issues may be obtained at the offices of the European edition, 1, 2 and 3, Salisbury-court, Fleet-street, London, E.C.; price 1s. (post free 1s. 3d.) monthly, or 12s. 6d. annum (post free).

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AYR.—Sanction has been given by the burgh authorities for extensions of the electric lighting mains at an estimated cost of about £990. It is expected that current will be available by the beginning of September.

BATH.—The new Municipal Buildings, which have been built at an outlay of £32,000, were opened on Tuesday. The electric light is used throughout and 240 lights are fitted. The buildings have been erected from the designs of Mr. J. M. Brydon, and the Council chamber is to be ventilated by means of an electrically-driven fan. This chamber is adorned with a 50-light electrolier. A part of the building scheme is the erection of technical schools to form the north wing of the Guildhall, but this portion of the structure is not nearly completed.

BELFAST.—The Electric Lighting Committee of the Corporation, at its last meeting, considered an application from the gas company for the supply of electric current to the gas works. Some amusement was caused by the application, which was referred to the Corporation's engineer for report.

BIRMINGHAM.—In response to a letter from the Edinburgh Merchants' Association, the Birmingham Chamber of Commerce has agreed to memorialise the Postmaster-General in favour of the State acquiring the telephone system and carrying it on as a branch of the Post Office.

BLACKBURN.—A scheme for the lighting by electricity of Railway-road and Salford Bridge, which was submitted by the Town Council's electrical engineer, has been referred to the Joint Lamp Sub-Committee to be carried out.

BLACKPOOL.—Messrs. Roger Dawson (Limited) have received an order for supplying the whole of the electric light fittings for the Empire Palace of Varieties now being built in this town.

BOARD OF TRADE REVISED REGULATIONS.—The Hull Corporation have suggested that some of the clauses of these regulations are of a grave and stringent character, and recommend that concerted action be taken by municipal authorities with a view of securing modification of these clauses. Mr. W. H. Brownlee, electrical engineer to the Dundee Council, objects to the leakage current allowed as being too small. The Islington (London) Vestry have referred the regulations to their Electric Lighting Committee, the strongest exception being taken to the clause under which the conduits and receptacles are to be so constructed as to prevent an influx of gas from the adjacent soil. It is pointed out by the Vestry Clerk that the local authorities will be at the mercy of the gas companies, instead of being in the position to require these companies to prevent the escape of gas from their mains into the electric lighting conduits.

BURNLEY.—The lighting of the large clock in the tower of the Town Hall is now effected by electricity; six 16 c.p. incandescents are used to illuminate the four dials and mirror. As it was formerly necessary to leave the gas turned on during the whole of the day, it is expected that a considerable saving will be effected by the use of the electric light.

CHESTER.—At the meeting of the Town Council on Wednesday a report of the Electric Lighting Committee was submitted recommending the Council to authorise the Committee's acceptance of the offer of Thomas Parker (Limited) to supply a complete electric lighting installation for the city for the sum of £14,200, exclusive of building, &c. (estimated at a further £3,000), and to run it for a period of one, two, or three years; to supply public and private lighting at the prices named; and to arrange the terms of the necessary contract and do what might be necessary to have the installation established. This recommendation, it was stated, was made on the advice of Lord Kelvin. Mr. B. C. Roberts, in moving the adoption of the recommendation, said that in delaying so long in carrying out the electric lighting of the city they had lost nothing, but gained a great deal. They had got all the newest improvements, and had also gained other advantages, one of which was that they were to obtain current at so low a price that he hoped they should be able to supply the electric light to the city and the citizens at a comparatively lower price than gas. The Committee's recommendation was adopted.

CLERKENWELL (LONDON).—The new Town Hall, built for the Clerkenwell Vestry from the designs of Mr. Evans Vaughan, is to opened this day (Friday) by Lord Rosebery. The entire building is fitted for the electric light.

COLLIERY PLANT.—Messrs. W. Bassano and Sons, of the Hadenhill Colliery, Old Hill, near Birmingham, have given orders for a complete electric plant to be put down for lighting and hauling purposes at the colliery.

COMMERCIAL PROGRESS.—Mr. Chauncey Depew, a leading American orator and financier, recently delivered an address on the subject of "Commercial Progress," in which frequent reference was made to the important part played by the submarine telegraph cable in the development of commerce and industry. The occasion of the address was the presentation to the Detroit Chamber of Commerce of a painting of Cyrus W. Field. Mr. Depew gave the submarine telegraph cable equal importance with the Crusades and the discovery of America, these three events together, in Mr. Depew's opinion, marking three great eras in the world's history, and were, together with the printing press, responsible for the commercial development of modern times. Commerce had been revolutionised, intelligence widely disseminated, and altogether a wonderful transformation in commercial and industrial intercourse has followed the development of submarine telegraphy.

DOUGLAS.—At a meeting of the Town Commissioners on Monday the draft agreement between the Electric Tramway Company and the Commissioners for the lease of the Douglas Bay Tramway for a further term of 21 years was considered. Several members contended that the Company's offer to pay 15 per cent. upon the gross earnings, and to construct and work a tramway to Upper Douglas was insufficient consideration for the extension of the lease. The agreement was ultimately confirmed by 10 votes to 8.

DURBAN.—The full text of the reports of Mr. W. H. Preece and Mr. H. Fletcher (borough engineer to the Durban Town Council) is issued as a supplement to the *Natal Mercury* of Tuesday, April 23rd. A digest of these reports appeared in our issue of the 31st ult.

DUTCH GUIANA.—After inquiry by a special Commission, it has been decided to adopt electric lighting at Paramaribo, Dutch Guiana.

EDINBURGH.—The Electric Lighting Committee have recommended the Town Council to approve the extension of the electric lighting mains to the Regent, Royal, and Carlton Terraces, to Canongate and the South Side, as suggested by their consulting engineer, Prof. A. B. W. Kennedy. The estimated cost is £3,500.

ELECTRIC LAUNCHES.—Last week was launched, from the shipbuilding yard of Messrs. J. and G. Thomson (Limited), Clyde Bank, the steam yacht "Urania," built for His Excellency Don Francesco Recur, of Madrid. The "Urania" is lighted throughout by electricity, the fittings being specially designed. In addition to powerful lighting plant, a large battery outfit is included. In addition, the "Urania" is provided with an electric launch fitted with batteries of sufficient capacity to allow the launch to travel 100 knots without recharging.

ELECTRIC LIGHTING OF BARRACKS.—In the House of Commons on Tuesday Mr. Campbell-Bannerman stated that no direct comparisons as to improved health from electric light instead of gas had, so far as he was aware, been made, although the advantages of electric light were undoubted. Offers to supply the electric light to barracks had been made, and declined for the present, at Great Yarmouth and Dover. A succession of experiments in electric lighting had been approved, and plans for providing the light in Colchester Hospital and Cambridge lines, Woking, were now in progress.

FULHAM (LONDON, S.W.).—A proposal, made by the Electric Lighting Committee of the Vestry, that a practical electrical engineer be invited to furnish a report on the advisability of introducing the electric light along with the dust destructor scheme, at a fee of 50 guineas, was adjourned for discussion at the next meeting of the Vestry.

GLASGOW.—The Town Council have unanimously adopted a recommendation of a special Sub-committee to increase the salary of Mr. Arnot, the Council's electrical engineer, from £350 to £450 per annum, a condition being that the whole of Mr. Arnot's time be devoted to the duties connected with the Electric Lighting Department.

HALIFAX.—It having been decided by the Governors of the New Infirmary to put down their own plant to supply the Institution with electric light, the Halifax Corporation have decided not to extend the electric lighting mains to the Skircoat district at present.

HARROGATE.—The General Purposes Sub-Committee have invited Mr. Robert Hammond to consult with Mr. Wilkinson, the Town Council's electrical engineer, with a view before carrying out the scheme for electric lighting, which had been adopted by the Council, of having the whole reconsidered as to system, site, and area of supply. Mr. Hammond will shortly report.

HASTINGS.—Extensions of the electric lighting mains of the Hastings Company across London-road into St. Leonards and in several other main thoroughfares of the town have been sanctioned by the local authorities.

HECKMONDWIKE.—Included in a scheme for alterations and additions to the central store premises of the Heckmondwike Co-operative Society is an electric lighting installation throughout the buildings. The cost of the alterations and additions will be £6,700.

HOLBEACH.—At the last meeting of the District Council, tenders were considered for lighting the district. Amongst the tenders was one from Mr. F. Barton, of Blackburn, through his agent, Mr. Bean, of Holbeach, to light the streets by electricity for £210 per annum for a term of seven years. This represented a difference of £50 in favour of gas lighting, which was ultimately selected.

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HULL.—The Corporation have received a notification from the Local Government Board, sanctioning the borrowing of a further £2,800 for electric lighting purposes, and it has been decided to apply for sanction to borrow another £8,000 for additional plant, which is almost immediately required.

INCORPORATED GAS INSTITUTE.—The thirty-second annual meeting of this Institute was opened at Edinburgh on Tuesday, and Lord Provost M'Donald, in tendering a hearty welcome to the members, said that in Edinburgh they had recently spent something like £125,000 upon their electric undertaking. He was of opinion, however, that in large cities the introduction of electric supply stations would not affect the consumption of gas in any marked degree. The Lord Provost, however, omitted to point out that in almost all cases where the electric light has been introduced a considerable reduction in the price of gas has resulted, and unless this policy is adopted by the gas companies to a larger extent the electric light will, in the near future, prove a much more serious competitor. The Institute's third prize was awarded to Mr. William Chew, of Blackburn, for his Paper read at last year's meeting on "Gas and the Electricity Supply of Blackpool."

IPSWICH.—A report of the Electric Lighting Committee of the Town Council was discussed at a special meeting last week, and was ultimately adopted. It recommends that the question of electric lighting be shelved for the present. In commenting upon this decision the *East Anglian Daily Times* calls attention to the fact that the proposal to adopt the electric light at Ipswich was first brought forward as a question of private enterprise. A resolution was carried at a Town Council meeting to allow a company to obtain a Provisional Order. This resolution was practically rescinded by similar powers being given to a competing company. In April, 1894, it was resolved by the Council to forthwith apply for a Provisional Order. Since this date, however, no steps have been taken to carry out the resolution. The arrangements with the Gas Company have not hitherto been altogether satisfactory, and, as a new bargain has shortly to be struck, the town is not likely to benefit by the action of the Council in shelving the electric lighting question.

KINGSTOWN (IRELAND).—It is stated that a new company, to be called the Electricity Supply Corporation of Ireland (Limited), is in course of formation, and has applied to the Kingstown Commissioners for their approval of an intended application to the Board of Trade for a Provisional Order to light the town and district by electricity.

KINGSWOOD (BRISTOL).—Efforts are being made to get the electric tramway extended to Warmley Hill. It is likely that this and other extensions will be incorporated in a Bill to be introduced in the next session of Parliament.

MADRAS.—It was originally intended to adopt the overhead system for the Madras electric tramways; but, as it was considered probable that difficulties might arise in connection with the local telegraph and telephone services, it was decided to substitute the conduit system for section No. 1 of the tramways. It has, however, been definitely arranged that in sections 2 and 3 the overhead system will be used. It is, moreover, possible that section No. 1 will be ultimately worked on the overhead system.

MAZARRON.—A central electric supply station has recently been erected at Mazarron, a large mining town in the Province of Murcia, Spain, and the first set of plant is erected and in working order. This consists of a 20 H.P. nominal Robey engine, and a 37-kilowatt Mordey-Victoria alternator, giving 2,000 volts at 650 revolutions. This is excited by a 30-ampere Royce shunt-wound dynamo. Steam is supplied by a 20 H.P. Robey locomotive boiler. The principal thoroughfares of the town are to be lighted by 16 c.p. incandescents, in series, at 2,000 volts, and the mines and private buildings are supplied with current from secondary mains at 110 volts. It is anticipated that two similar sets of plant will shortly be put down.

MELROSE (SCOTLAND).—The price of gas at Melrose is 5s. 7½d. per thousand, which Messrs. Parr and Gillies think justifies them in offering to light the borough with electricity, providing a demand for 1,000 16-c.p. lights is guaranteed.

MORECAMBE.—At the meeting of the District Council on Monday the Sub-Committee appointed to negotiate for the purchase of the local Electric Light and Power Company's undertaking reported the terms offered by the Company, and it was decided to employ an expert to inspect and advise the Council in the matter.

OLDHAM.—In moving the acceptance of the minutes of the Electric Lighting Committee, which were given in our last issue, Mr. Alderman Smith entered into details concerning the proposed extensions. The Committee recommend the purchase of two second-hand engines of 200 H.P. each, and dynamos, which would effect a saving of £1,000 over their estimate for new plant. The minutes were adopted.

OLYMPIA.—Messrs. Rowland, Barnett and Co., who have installed a private gas-driven electric light plant at Olympia, have sent us a table and other particulars of a set of tests made on this plant by Mr. T. Hanning for the Directors of Olympia. In actual work the combined plant is at full load during the whole time it is running; but in the tests its capacity and economy at varying loads have been measured. A combined efficiency of 69 per cent. is given at full load, a figure which is highly creditable, and the efficiency of the dynamo alone was found to be 92 per cent. At 25 B.H.P (full load) 26·4 cubic ft. of gas per brake horse-power was consumed, a useful electrical output of 638·4 watts per brake horse-power being obtained. The price paid for gas is 1s. 8d. per 1,000 cubic ft. There is a margin of about 7 H.P. in the capacity of the plant, and when the engine was run up to this limit, 38 H.P., the consumption stood at 24 cubic ft. per brake horse-power per hour.

RATHMINES.—At the last meeting of the Town Commissioners Mr. Hewson called attention to the subject of the electric tramways. He pointed out that the Commissioners had been supplied with a photograph which gave an exaggerated idea of the appearance of the overhead wires for an electric tramway system, and that the only effect of such a photograph would be that opposition would be advanced against the overhead system of electric tramways. It was pointed out that the Committee have unanimously adopted the resolution of opposing the Bill authorising the erection of the electric tramways unless an underground system is adopted by the Tramway Company.

SOUTHPORT.—A proposal to adopt the Brighton method of charging for electric current was under discussion at the last meeting of the Town Council on the initiation of the Chairman of the Electricity Committee, Councillor Esford, but no decision was arrived at. The introduction of the electric light into this district has already resulted in a reduction of the price of gas by 3d. per 1,000.

STAFFORD.—Considerable extensions of the electric lighting mains have been decided upon by the Town Council, the district chosen being Victoria-square, Foregate-street, and Newport and Lichfield-roads.

STRIKE AT PONDERS' END.—Last week a large number of the employés at the Ponders' End Works of the Edison and Swan United Company came out on strike, and the Company lost no time in declaring a lock-out, and unless the strikers speedily return to their work the Company threaten to send a large portion of their work to Germany. The question in dispute is, we understand, chiefly the rate of wages paid. It is unfortunate that the workers are not allowed to settle their dispute with the Company direct. The present dispute seems eminently one to be amicably settled by the parties immediately concerned.

SUNDERLAND.—A considerable extension of the electric lighting mains to the south-west part of the borough is in contemplation by the Corporation in response to the numerous applications received.

SYDNEY (N.S.W.).—It is not only in the Old Country that local authorities act the dog in the manger. Complaint is freely made of the action of the Sydney City Council in opposing the application of a local company for powers to supply the city with the electric light. About two years ago two Bills were before the Sydney Parliament for lighting the city electrically, one promoted by the local gas company and the other by a private electric lighting undertaking. The Sydney public were hostile to the application of the gas company, and the City Council effectually extinguished any chance the private company may have had of obtaining a Bill by themselves applying for powers to supply electric current. These powers were readily granted by Parliament, but, so far, no further steps have been taken by the Council to introduce the light, notwithstanding that evidence is forthcoming that a considerable demand would result from any well-considered scheme promoted by the local authorities.

TAUNTON.—Prof. J. A. Fleming's report to the Town Council states that the result of his thorough inspection of the electric lighting station, and of the new work carried out during the past year in connection with the establishment of the second transformer sub-station, is to show that everything is in good working order, and the whole of the plant carefully supervised.

THURMASTON (LEICESTERSHIRE).—The District Council are considering the advisability of lighting the district electrically at an estimated cost for street lighting of £1,000 and annual working maintenance of £189. The cost of an installation for private lighting on a 500-light basis has been given as £2,000, with an annual upkeep cost of £331. Gas in the district is 4s. 2d. per thousand.

TORQUAY.—During the inquiry held by Col. Luard into the application of the Corporation for powers to borrow £3,250 for the purpose of a refuse destructor at Upton, it was stated that a portion of the ground would probably be utilised as a sub-station for the supply of electric current. The Town Council have received a notification from the Board of Trade offering to extend the powers of the Council under their electric lighting Provisional

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Order for another twelve months, but intimating that no further extension will be granted.

WALLASEY.—The Ferry Committee of the District Council are arranging for the introduction of the electric light at Seacombe.

WEYBRIDGE.—A proposal was made at the last meeting of the Urban District Council that the tender of the Weybridge Electric Supply Company, for lighting the district by electricity, should receive the approval of the Council. Mr. Ward opposed this course being taken, and strongly recommended that the Council should themselves possess the electric lighting undertaking. After some discussion a resolution that the matter be referred back to the Highways and Lighting Committee for further consideration was carried.

WIGAN.—Some doubts having been expressed by members of the City Council as to whether it was likely that progress would be made with the electric lighting scheme, Mr. Holmes, Chairman of the Gas and Electric Lighting Committee, said that several meetings had been held, but up to the present the members were not quite agreed as to the carrying out of the scheme. His personal idea was that if they were to have the electric lighting they should be moving, or that the matter should be definitively shelved.

YARMOUTH.—Col. Hasted held a Local Government Board Inquiry at the Town Hall last week into the application of the Town Council for powers to borrow a further sum of £17,500 for electric lighting purposes. Mr. A. H. Preece, on behalf of Mr. W. H. Preece, consulting electrician to the Town Council, explained that the number of lights already installed was equal to the full power of the existing working plant, and as applications were coming in daily an extension was absolutely necessary. The Borough Surveyor said an immediate expenditure of £1,600 was necessary, and the remainder would be spent as required. No opposition was offered to the scheme. The Surveyor's report of the last meeting of the Town Council stated that 4,530 lamps are now connected or on order, from 87 consumers. The consumption of current shows a steady increase. A letter was received from Mr. Preece that the new dynamo would cost £1,346, the oil feeding apparatus £60, and the building works £100, increasing the estimate of £1,400. In view of the extended demand for the light the Surveyor was directed to get the work done as quickly as possible. Complaint is made that an offer of the local gas company to fix incandescent gas lights in several of the principal thoroughfares of the town has been too hastily accepted, it being pointed out that the Council have new plant and every necessary for lighting these thoroughfares by electricity from their own supply stations. The gas company's offer has been accepted for three years.

YORK.—At the meeting of the City Council, on Monday, on the presentation of the report of the Watch Committee, Mr. Ald. Rymer complained of the increased cost of the lighting of the police station and new public buildings, which he stated to be very much in excess of the late gas lighting cost. "The electric light was an expensive toy, which would be exploded by new improvements in gas lighting, and the Council would live to regret that they had never put gas in the new police station." In reply, Mr. Ald. Wragge pointed out that as the new police and fire brigade buildings had been considerably extended it was not surprising that a larger number of lights and better light was required. It was no use for Ald. Rymer to move dilatory resolutions in favour of keeping the electric light from the city. They must have the light, and they ought to have it speedily. The present state of things was a standing disgrace.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

May 18, 1895.

9,882. THE SAFETY TREAD SYNDICATE (LIMITED) and J. MASON. London. Improvements in and connected with conduits for electric light wires and the like.

May 20, 1895.

9,919. F. W. SCHINDLER-JENNY and P. STOTZ. London. Heating body for electric soldering irons.*

9,937. S. HAMMACHER. London. Improvements in the manufacture of active material for secondary batteries.*

9,939. A. L. ROBTON. London. Improvements in or relating to electric railways.

9,961. C. S. SNELL. Saltash. Improvements in connection with laying submarine electric cables.

9,956. A. L. DAVIS. London. Improvements in or relating to electric arc lamps.

9,967. H. N. MOODY. London. Improvements in electric regulators.

9,969. H. F. PARSHALL and THE BRITISH THOMSON-HOUSTON (LIMITED). London. Improvements in dynamo-electric machinery.

May 21, 1895.

9,981. A. E. OLD. Birmingham. The application of the motor-generator for purposes of electrolysis.

9,997. R. C. JACKSON. Newcastle-on-Tyne. Improvements in the application of electrical energy to the heating of air or other gaseous bodies.

10,017. M. L. DEFOUR. London. Improvements in telegraphic codes.

10,027. A. HAMM, G. BLANK, V. BRANDT, and G. KÖRMENDY. London. Improvements in telephonic installations for increasing the strength of the transmitted sounds.

10,029. J. W. SINGER, W. H. SINGER, and E. R. SINGER. London. Improvements in pendants or electroliers for electric lamps.

10,052. H. V. MILLER and A. C. MILLER. London. Improvements in electric railway signals.*

10,058. G. F. KENYON. Bradford. Improvements in or appertaining to electrically illuminated advertisements, signs, and like devices.

May 22, 1895.

10,114. R. J. CROWLEY. Queenstown. The galvanopile, an improved form of galvanic battery.

10,134. G. G. M. HARDINGHAM. London. Improved means applicable for use in the decomposition of substances susceptible to electrolytic treatment (R. Langhans, Germany.)

10,142. J. T. ARMSTRONG. London. Improvements in electric gas lighting devices.

10,154. G. G. SMITH. London. New or improved electrical attachment for drinking vessels.

10,155. M. FREUDENBERG. London. Improvements in or relating to telephone systems.

May 23, 1895.

10,223. A. J. BOULT. London. Improvements in or relating to microphones. (L. Wallach, Germany.)

10,241. A. LAUNCELOT, J. TAIT, and W. H. PEARSON. London. A novel construction and arrangement of appliances for generating electricity.

May 24, 1895.

10,249. H. OPPENHEIMER. London. Improvements in and connected with multiple switchboards for metallic circuit. (Actien Gesellschaft Mix Genest, Germany.)

10,250. J. SLOPER. Devizes. Improvements in or relating to electric bells, signals, and other means of electrical communication.

10,277. SIEMENS BROS. AND CO. (LIMITED) and E. F. H. H. LAUCKERT. London. Improvements in apparatus for measuring electrical currents.

10,302. C. S. SNELL. Saltash. Improvements in connection with laying submarine electric cables.

10,314. W. H. PEARSON and A. L. J. TAIT. London. A method of generating a current of electricity during the revolution of a carriage or car wheel.

10,308. L. DEFERT. London. An improved electric lock.

10,313. W. S. SMITH and W. P. GRANVILLE. London. Improvements in effecting telegraphic or telephonic communication through submerged cables, and in the construction of cables to be used for this purpose.

May 27, 1895.

10,334. W. A. PRICE. London. An improved arrangement of electrical call or sounding apparatus.

10,359. E. W. LANCASTER. Birmingham. Improvements in carriers for shades and like objects for gas and electric light fittings and the like.

10,360. E. W. LANCASTER. Birmingham. Improvements in tumbler switches for electric circuits.

10,366. D. ALEXANDER and C. HAMILTON (LIMITED). Glasgow. A new or improved electrical stage effect and appliances therefor.

10,408. H. SIMONS. Berlin. Improvements in or connected with apparatus for simultaneously shampooing and electrifying the human body.*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

11,022. DE FERRANTI. Alternate-current rectifiers.

13,063. PARFITT. Electric lighting circuits.

13,160. HARDINGHAM (Felten and Guilleaume). Electric cables.

13,363. BUCKLAND. Secondary battery plate.

13,594. HELBERGER. Insulating wires for electric heating.

19,121. WOOLVERTON. Arc lamps.

24,873. THOMPSON (Actien-Gesellschaft für Fernsprechpatente). Telephones.

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1895.

3,250. De Spruner-Mertz and Koch. Globes for electric glow lamps.
4,576. Brintnell. Electric motors.
5,568. Thompson (Mathiesen). Arc lamps.
5,699. MacIntire. Arc lamps.
5,998. Braham. Electric light fittings.
6,008. Siemens Bros. and Co. (Siemens and Halske). Electric conductors.
6,163. Buckland. Voltaic battery plate.
6,171. Stock. Telephone switches.
6,430. Cummings and Yawkey. Electric conduits.
6 652, Duffek and Holub. Electric accumulator plates.
6,781. Edison and Swan United Electric Light Company (Limited) and Proctor. Electric glow-lamp socket.
6,893. Lake (Fiske). Electrical signalling apparatus.
7,245. Guest. Electric railways,

WOODHOUSE AND RAWSON UNITED, LIMITED (In Liquidation).

By the direction of Mr. Justice Vaughan Williams, a largely attended meeting of Five and a-Half, Six, and Ten per Cent. Debenture-holders of this Company was held yesterday, at the Cannon-street Hotel, London, "for the purpose of considering and, if thought advisable, of authorising the employment of the funds of the debenture-holders upon legal proceedings against the Directors and auditors of the Company by the Official Receiver and Liquidator for recovery of moneys which counsel have advised that such Directors and auditors are liable to refund." The notice calling the meeting added that Mr. Justice Vaughan Williams had further directed that there should be one meeting for all classes of debenture-holders, but, if necessary, a vote of each class should be separately taken.

Mr. C. J. STEWART (the Official Receiver and Liquidator) occupied the chair, and reviewed the history of the Company and read the opinion of counsel to the effect that the Board of Directors were distinctly liable in regard to the dividend paid upon the balance sheet of 1891, they contending that £20,000 had been paid out of capital. The total ultimate loss that they might anticipate for all the debenture-holders and shareholders could not be taken at less than £500,000. He asked the meeting to put aside any vindictive feeling, and to decide in a dry commercial sense whether they would take this action for restitution or not.

After considerable discussion,

Mr. A. BOND, representing the Ten per Cent. Bondholders, spoke strongly against proceedings against the Directors, as he failed to see the advantage to accrue to that class of debenture-holders.

In reply to questions, the CHAIRMAN said that the cost that would be involved in going to law upon the matter would be about £2,000 on each side.

Mr. BACON strongly criticised the action of the Directors during the history of the Company, and said that he came to that meeting with the idea of pushing action to the uttermost against those Directors. He dealt with what the committee that was appointed before the Ten per Cent. Debentures were issued did in the interests of the Company. He said that he was a member of that committee, and he was now in accord with Mr. Bond that the Ten per Cent. Bondholders had nothing to do with taking action against the Directors, although he fully admitted that the Directors were deserving of the worst punishment that could be meted out to them. The action to be taken would rest, therefore, in the hands of the other classes of debenture-holders.

Mr. PILLING and other debenture-holders addressed the meeting, and expressed the opinion that those who were to blame for letting the shareholders into this trouble had made themselves pretty well secure. He strongly urged that the opinion of counsel should be acted upon. He failed to see where any doubt could be cast upon such an opinion as that of Mr. George Farwell, Q.C., and Mr. Howard Wright. He (the speaker) represented Five and a-Half and Six per Cent. Debenture-holders, and he would vote emphatically for prosecution.

Mr. SAMUEL POPE, Q.C., one of the late Directors, characterised the action of Mr. Pilling at the time of the public examination as showing animosity. He (the speaker) denied any criminal guilt, but they might be able from the action he had taken in good faith in connection with the Company to force him into the Bankruptcy Court. If he had done wrong he was ready to make restitution to the last farthing. He already stood to a loss of £10,000, and what more they could force further out of him he did not know. They could take the case to the House of Lords, and he would still defend himself; but what would be left to him when the case came out of the Lords he was perfectly unable to say.

The CHAIRMAN, in reply, said that he feared there was no likelihood of the amount referred to in the opinion of counsel (£20,000) being divided, if it were gained, amongst the Five and a-Half per Cent. Debenture-holders.

Mr. JONES asked whether the Five and a-Half per Cent. Debenture-holders had only the chance of individual action. They were all Six per Cent. Debenture-holders at one time, and they were led to believe that the whole of the Six per Cent. Debentures were to be converted. They ought to have a meeting called of the Five and a-Half per Cent. Debenture-holders to consider how they became Five a-Half per Cent. Debenture-holders.

The CHAIRMAN said that was the case, the Five and a-Half per Cent. Debenture-holders only had individual action.

Mr. MATHESON said that he had investigated that matter for the Receiver, and the reason there were both Five and a-Half and Six per Cent. Debenture-holders was that the whole of the Six per Cent. holders did not choose to convert. To win the action against the Board they must prove dishonest intent. (No, no.)

The CHAIRMAN: No, no.

Mr. MATHESON said that, as representing Mr. Wood, the plaintiff in the action and holder of £2,000 of Six per Cent. Debentures, he would vote against taking any proceedings.

Mr. PAYNE said he was instructed by the largest but one Six per cent. Debenture-holder to say that he was strongly opposed to the taking of any action.

The CHAIRMAN, in response to a suggestion of Mr. Fladgate, proposed that the meeting of the Five and a-Half per Cent. Debenture-holders should be adjourned, and the voting of the Six per Cent. and Ten per Cent. Bondholders should be conveyed to them later.

The general feeling of the Five and a-Half per cent. Debenture-holders was in favour of the proposal.

The CHAIRMAN thought that there could be no legal objection to an adjournment. He only proposed an adjournment of only a few days for the Five and a-Half per Cent. Debenture-holders' meeting.

Mr. TURNER referred to the Hansard case, and asked whether it was not true that, though a large sum was recovered, it was compromised, and a very little got into the hands of the unfortunate sufferers?

The CHAIRMAN said there were civil proceedings in the Hansard case, and that a considerable sum was very rapidly recovered. He then put the question of the adjournment of the meeting of Five and a-Half per Cent. Debenture-holders to that section of those present, and declared that 26 voted for it and 26 against, and he then gave a casting vote in favour of the adjournment.

The question of taking proceedings against the Directors was then put to the Ten per Cent. Debenture-holders, and unanimously rejected.

The Six per Cent. Debenture-holders then voted, and on a show of hands, there were four hands for proceedings and about a dozen against.

The meeting of the Five and a-Half per Cent. Debenture-holders was then adjourned till Wednesday next, 19th inst., at 33, Carey-street, Lincoln's Inn-fields, W.C.

A vote of thanks to the Chairman closed the proceedings, which had lasted close upon two hours.

COMPANIES' MEETINGS.

West Coast of America Telegraph Company (Limited).

The eighteenth ordinary general meeting of this Company was held on Tuesday at 50, Old Broad-street, Mr. J. Denison Pender in the chair.

The SECRETARY (Mr. Fred. L. Robinson) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN then said: In moving the adoption of the report and accounts, I will just put you in possession of some of the facts and particulars relating to the Company. They are not very bright, I am sorry to say; but the best that can be said about our affairs is that they are certainly brighter than they were when I met you this time last year. The traffic receipts show an increase of £8,057 as compared with those of the previous year, and the interest account a decrease of £1,401. This is owing to our having to use by degrees our reserve fund, which, of course, is not now bringing us in anything like what it did some time ago. Our gross receipts were £6,657 in excess of those of 1893. The revenue derived from the line of the Pacific and European Telegraph Company is very satisfactory. As you are aware, this line was opened to the public on March 19, 1894, and since the opening we have by degrees gained the confidence of merchants and shippers trading with Chili and Peru. This has only been done by giving a thoroughly efficient service, and we now have a fair share—a good share I might say—of the traffic. This, has been a gradual process, as you may imagine, after our competitors had been in possession of the entire traffic for two years, but so much has been done, and we hope to keep what we have got and to increase the number of our customers. It would not be politic to give you details as to the amount of this traffic, or its value to us, as any such statement would be giving too much information to others, who are not interested in our welfare. The local traffic for 1894 exceeded that of the previous year by over a quarter of a million words, but what we have gained in traffic we have lost in exchange: the average rate was 12d., as against 14d. in 1893. The fluctuation in the rates of exchange entirely upset any calculation as to the sterling value of this class of traffic, the rates being collected in currency, and so many of our expenses, particularly salaries, being paid in sterling. We may reasonably expect that we shall not in future be much troubled with these fluctuations, as the paper currency of Chili is now replaced by gold, for the first time in 17 years, on a basis of 18d. to the dollar, and the exchange will not greatly fluctuate from that figure. The rate of exchange at the present time is 17¹⁄₈d. Our gross expenditure for 1894 shows an increase of £521. 8s. 5d. as compared with 1893, the cost of maintaining our cables and land-lines being largely responsible for the increase. With regard to the cost of maintenance, this is naturally a varying amount, and dependent entirely upon the number of breakages to our cables and the time occupied in effecting the necessary repairs. The ship we keep out there has certain standing charges in connection with it, but we do not keep the crew on board all the time, and when any break takes place the cost of the vessel is naturally greatly increased, not only on account of the extra crew that has to be taken on board but on account of the coal consumed by the

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vessel for her journeys, which, as a rule, are pretty long ones up and down the coast. We had two cables interrupted last year—the Caldera-Serena section and the Valparaiso-Talcahuano. The former fault was caused by the rocky nature of the bottom over which the cable was laid, and in this case the line of cable was diverted to a better bottom, after a delay of 12 days, owing to bad weather: the latter fault was caused by a submarine disturbance. The Chorillos shore end at the northern termination of our system was renewed. It is worthy of notice that the original shore end had not been disturbed since it was first laid—a period of 19 years. A new station was opened on December 31st last at Coronel, a port of call and coaling station a little to the south of the city of Concepcion, and connected with our Talcahuano cable by a land line. This addition to our system acts as a feeder, not to a great extent certainly, but it is a paying connection, and may become of more value hereafter if trade out there improves. These, I think, are all the particulars which I have to bring forward, without going too closely into the details of the traffic, as such information would go into the hands of people who are competing against us, and taking every opportunity they can of making use of anything we say or do. There is one circumstance which I may mention to you which will show you how really efficient the line is. We endeavoured the other day, with a piece of news which has been used before with a similar object, to see how quickly a message could be sent over the line. The Derby, in which all parts of the world, whether English or foreign, seem to take an interest, was won the other day, I believe, at 25 minutes past 3 o'clock, and that news was up in our office at Valparaiso at 28 minutes past 3. It therefore took only three minutes to get from Epsom to Valparaiso. You will see, by looking at the map, that this message had to go from Epsom to London, London to Porthcurnow, from Porthcurnow to Lisbon, from Lisbon to St. Vincent, from St. Vincent to Pernambuco, from Pernambuco down the coast to Buenos Ayres, and then over the Pacific and European Company's line to Valparaiso. I therefore think that this was one of the smartest pieces of telegraph work which has ever been carried out; but what makes it so pleasing, especially to myself, is that I have a great deal to do with the Eastern Company, of which I am the Managing Director, and I am also a Director of the Brazilian Company; and the fact I have mentioned shows that the staff right throughout must be very efficient. As to the outlook, I am not going to prophesy. It is quite impossible for us to speak with any degree of confidence, so much depends upon circumstances beyond our control. Up to the present time it looks as if during the year upon which we have now entered, we shall at least be able to pay our expenses and debenture interest without having to encroach again upon our reserve fund, which has become very low; the greater portion of it is invested in cable, and I am sorry to say, therefore, that it is not in securities available at any moment. Looking further ahead, we continue hopeful as to the future of the Company, and the shareholders may rest assured that everything possible is being done. When I tell you that we are now, I hope, paying our working expenses and our debenture interest, you may say that that is not very much; but, remember, when I came before you last year we were not doing anything like that. We have got to obtain this traffic from the Central and South American Company, who have held it before we were able to carry it. They have had a free hand for two years, and we have to get the traffic back. I can only tell you that there is a large increase in the traffic, and I think there may perhaps be enough for both of us if we but act perfectly fair to each other. I do not see why we should cut each other's throats. We are getting this traffic steadily, and I believe that it is through the very efficient way in which it is being carried. I shall be glad to answer any question, so long as it is not prejudicial to the interests of the Company, and to give any further information that may be asked from me. I now move—

"*That the report and accounts for the year ending December 31, 1894, now presented, be received and adopted.*"

Mr. FREDERICK WALTERS seconded the motion, which was carried unanimously.

The CHAIRMAN: Since the death of Mr. Roberts there have only been two Directors of the Company. I do not think it is any use adding to the number, and the Company derive a certain benefit by the fees of the third Director going into its coffers. It is not worth while to alter the Articles of Association so as to make one Director retire instead of two, as at present.

Mr. J. Denison Pender and Mr. Fred. Walters having been severally re-elected to their seats at the Board.

Mr. LAMONT proposed the re-election of the auditor, Mr. J. F. Clarke. Incidentally, the speaker expressed satisfaction at the statement of the Chairman that the traffic of the present year was likely to cover all the expenses and liabilities of carrying on the concern. He only trusted that the Chairman's hopes would be fulfilled, and exceeded.

Mr. FROST seconded the motion, which was unanimously carried.

The CHAIRMAN: In regard to the few words which have fallen from Mr. Lamont, I wish it to be thoroughly understood that I believe at the present time, as near as we can get the figures, that the Company is paying its debenture interest and working expenses. The traffic, however, may fall off, and we may not be doing so well some months hence, so I do not want it brought up against me in future that I made a statement which was not accurate.

Mr. PACE then proposed a vote of thanks to the Chairman and Directors, who, he said, were working an uphill business with great care. The fact of there being only two Directors meant that those gentlemen must do rather more work.

The motion was seconded and carried unanimously.

The CHAIRMAN: I beg to thank you on behalf of Mr. Walters and myself for your kind expressions. If you will allow me I will include the staff in this vote, because it is always satisfactory to those who are working hard in the London office and at the other end of the world to have their services appreciated. They are, I believe, doing their very best, and working very keenly to bring this Company into the position it held a few years ago.

Hobart Electric Tramway Company (Limited).

The second annual meeting of the shareholders of this Company was held at the offices, College Hill Chambers, Cannon-street, E.C., on Tuesday, under the presidency of Dr. Alfred Mattei.

Mr. G. CARNABY HARROWER (the Manager) read the notice calling the meeting, and the Directors' report was taken as read.

The CHAIRMAN said: Gentlemen, you have already received a copy of the report and balance sheet, and from it you will have seen the good work we have done. We have carried 2,478,938 passengers, and we have run 584,117 car miles, and our latest report from our Manager shows that for the month of April we have reduced the working cost to 6½d. per car mile. This is our first revenue account, and I wish to make a few remarks. Taking the revenue account for the year ended December 31st last, we think the items of £5,759 for wages and £1,042 for fuel too high. We have written to our local committee in Hobart, and to our able Manager there, Mr. A. C. Parker, to reduce these items consistently with the due efficiency of the service. I have reason to believe that we shall succeed in reducing these items. We all agree that the administration expenses, including Directors' fees and office expenses, are too high. We are doing our best to reduce these charges. Cables and law charges amounting to over £100 are an expense which, though necessary at the beginning, should now be considerably curtailed. Our local committee object to the payment of income tax, at all events on their fees, and we shall try to arrange this. The standing item of £2,500 per annum being 5 per cent. on the £30,000 First Mortgage Debentures, and 5 per cent. on the £20,000 Second Mortgage Debentures, cannot, of course, be reduced. There is one item which I am glad to say we shall not see again in our accounts, and that is the large amount payable to Messrs. Siemens Bros. and Co. (Limited) for working the line. It would be not only ungracious but unjust if I did not, on behalf of myself and my colleagues, express our gratitude for the generous support that Messrs. Siemens Bros. and Co. have given to us in every possible way. Indeed, I wish again to testify to the satisfactory manner in which they have performed their contract. I am glad to say that we are doing the work ourselves cheaper, for we paid Messrs. Siemens Bros. and Co. £1,000 per month, and we are doing it for less, as it is natural we should, having a committee of local gentlemen and a local manager on the spot. The revenue, taking everything into consideration, is satisfactory. Tasmania, in common with the rest of Australia, has gone through a great crisis. We have, of course, suffered like the rest. Since opening the line we have carried a very large number of passengers indeed. We are told that our permanent way might be more satisfactory, and this matter continues to have our constant attention. The cars have not been used in their full number, two of them having been damaged. At the same time I am glad to be able to say that we are fully equipped to do the service which we are called upon to do. As to the capital account, we have taken powers from the shareholders and from the holders of the Second Mortgage Bonds to increase the issue of Second Mortgage Bonds by £5,000, and these bonds now stand at the total amount of £20,000, and there are £30,000 of First Mortgage Bonds, making a total of £50,000. With this £5,000 we have settled the liability of Messrs. Siemens Bros. and Co. of £3,400 and the vendors £500, leaving in our hands a small balance of authorised but unissued Second Mortgage Bonds. I am glad to say that our Hobart letters advise us that they had out of revenue paid off the bank overdraft of £295 and the £1,286 for outstanding accounts in Hobart, so that our next balance sheet will compare very favourably with this one, except as to the increased amount of Second Mortgage Bonds. On the other hand, you will remark that we are having a car shed constructed, which, according to latest advices, should now be completed. We have not forgotten the lighting of Hobart by electricity, but I regret to say that I am not now able to say more upon this subject than that we stand in an exceptionally favourable position with regard to that matter. My friend Sir Edward Braddon, the Premier of Tasmania, writes to me that our tramway has become not only popular with the Hobart people, but a municipal necessity, and nobody would now dare to interfere with it. This is very reassuring, coming, as it does, from such a source. I am able to say that we were most fortunate to have secured the services of Sir E. Braddon, and of Messrs. Barclay, Syme and Grant, to act as a local committee, for there is no doubt that it is due to them that so many of the difficulties which are always met with in an enterprise of this kind—with the Government, with the Telegraphic Department, and with the Municipality—were overcome, and in Mr. Parker the Board feel they have a gentleman in whom they can place the utmost confidence for the successful working of the line. In conclusion, I think the bondholders, especially the holders of the First Mortgage Bonds, have ample evidence from the result of this year's working to feel satisfied that they have a well-secured 5 per cent. bond, and if all the assurances we receive from Tasmania are verified, the shareholders in the immediate future will have no cause for regret at having invested their money in this enterprise. I beg to move the adoption of the report and accounts.

Mr. D. J. MACKAY seconded the resolution, and after a brief discussion the report was adopted.

Mr. J. G. BELLAMY was re-elected a Director of the Company, and Messrs. G. N. Read, Son and Co. were reappointed auditors.

The usual vote of thanks to the Chairman and Directors closed the proceedings.

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NEWCOMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1895, pages *304-332, &c. &c.*]

REFLECTOR SYNDICATE (LIMITED).—This Company has been registered with a capital of £2,000, in £1 shares, to carry on business as manufacturers of and dealers in all kinds of reflectors and projectors. The first Directors are Sir B. W. Walker, Bart. (or some one nominated by him), L. W. N. Hickley, and H. H. Hosack.

RENNY, FORBES AND CO. (LIMITED).—This Company has been registered with a capital of £2,000, in £5 shares, to enter into an agreement with Messrs. R. H. A. Atkin and W. A. Wade for acquiring the business of chemical manufacturers, &c., hitherto carried on by Renny, Forbes and Co. at Alperton, Harrow, Middlesex.

CONNOLLY BROTHERS (LIMITED).—This Company was registered on June 1st with a capital of £20,000, in £5 shares, to acquire and take over as a going concern the business of insulated cable manufacturers and electricians carried on at the Blackley Vale Mills, Blackley, Lancs., by John T. Connolly and James Connolly, under the style or firm of "Connolly Brothers," and to enter into and carry into effect an agreement to be made between the said vendors and the Company, and to carry on the business of manufacturers of and dealers in insulated and other wires and cables for use for telegraphic, telephonic, electric lighting and other purposes, electricians, engineers, merchants, bankers, shippers, manufacturers, contractors, &c. The subscribers are:—

	Shares.
John T. Connolly, Vale Mills, Blackley	1
James Connolly, Vale Mills, Blackley	1
Thomas Connolly, Eastwood, Clayton Bridge	1
Louis Frankenstein, 33, Miller-street, Manchester	1
Mrs. E. Connolly, Eastwood, Clayton Bridge	1
William Connolly, Eastwood, Clayton Bridge	1
Joseph H. Peters, 62, King-street, Manchester	1

The first Directors are John T. Connolly and James Connolly, who are to be the Governing and Managing Directors, and to hold office until 1899.

FAREHAM ELECTRIC COMPANY (LIMITED).—The annual return to April 16th has been filed. The nominal capital is £5,000, in £1 shares, of which 4,158 have been allotted. The full amount has been called upon each.

GLOBE ELECTRIC COMPANY (LIMITED).—The annual returns to March 15, 1894, and March 14, 1895, were filed on May 27th. In each case 5,607 shares were taken up out of the nominal capital of £10,000, in £1 shares; of these 5,500 have been issued as fully paid to Sir William Vavasour, Bart. The full amount has been called and paid on the remaining 107 shares.

HOPE-JONES ELECTRIC ORGAN COMPANY (LIMITED).—The annual return to October 31, 1894, was filed on May 22nd. The nominal capital of £25,000 is divided into 1,200 "A" and 1,300 "B" shares of £10 each, and all the latter have been taken up, and are considered as fully paid; 765 of the former class have been subscribed for and allotted, upon which £7,640 has been paid.

HOVE ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return to March 25th has been filed. The nominal capital is £40,000, in shares of £5 each; 5,049 have been taken up, and the full amount per share has been called on 4,502, while calls amounting to £2 per share have been made on the remaining 547; £23,614 have been paid (which include the sum of £480 received in advance of calls), leaving £170 unpaid.

CITY NOTES.

AMERICAN BELL TELEPHONE COMPANY.—The usual quarterly dividend of 3 per cent. has been declared, with 1½ per cent. bonus extra.

CHATHAM, ROCHESTER, AND DISTRICT ELECTRIC LIGHTING COMPANY (LIMITED).—An adjourned annual meeting of this Company was held last week, Mr. H. Jasper, the Chairman of the Company, presiding. For the second time no quorum of members was obtainable. The Chairman remarked that they could not submit and adopt the report by resolution, as there was not a sufficient number of shareholders present. They might, however, declare the dividend as recommended, and this was agreed to. In reply to several questions the Chairman said he was sorry they had not more customers, but the public had not taken the light so extensively as was hoped. They had two new engines, one of which was erected and in use, and the other would shortly be ready. They had lost two of their largest customers, and this had reduced their profit. These two were supplying their own light. The price the Company were now charging, when compared with gas, showed an equivalent of gas at 1s. 11d. per 1,000. The Directors' report states that the profit of the year ended December 31st last was £456. 13s. 6d. As there is every indication that the Company will earn greater profits, the Directors propose to pay a dividend of 2½ per cent. out of the net profits earned, carrying forward £396. 6s. 5d. The arc lamp plant will be completed shortly, and numerous customers are desirous of using these lamps. It is proposed to sell the current for these lamps at a rate which is the lowest in the kingdom out of the coal districts; but the Directors nevertheless anticipate from their extremely low working expenses a fair amount of additional profit.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this railway for the week ended June 9th were £904, as against £911 in the corresponding period of 1894, being a decrease of £7. The total receipts for the half-year amount to £21,437, against £20,924, an increase of £513.

COMMERCIAL CABLE COMPANY.—The management of this Company has declared the usual quarterly dividend of 1¾ per cent., payable on July 1st next. The transfer books will be closed from June 21st till July 2nd.

ELECTRIC AND GENERAL INVESTMENT COMPANY (LIMITED).—For the purposes of preparing the dividend warrants, the transfer books and register of members of the Company will be closed June 19th to July 2nd inclusive. The Directors have decided to recommend the payment of a further dividend on the capital paid up on the Ordinary shares at the rate of 30 per cent. per annum for the six months ended 31st May last, making, with the interim dividend already paid, a total of 20 per cent. for the year, and also to make a distribution of £35. 16s. on each Founder's share for the year.

ELECTRIC CONSTRUCTION COMPANY (LIMITED).—The numbers are issued of 10 debentures of £100 each, one debenture of £50, and 120 debentures of £10 each of the Six per Cent. Second Mortgage Debentures of this Company, which were drawn on the 7th inst. for payment on July 1st next.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL COMPANY (LIMITED).—The fourth annual meeting of this Company was held at Winchester House, London, on Wednesday, Mr. MacFarlan presiding. The Chairman said, as to the present position and progress of the Company, he was glad to say that from January 1st to June 8th—that was to Saturday last—the weight of goods sold amounted to 63½ tons, as against 22 tons for the same period last year. Although the price of copper had been low—in fact, the lowest on record—their prices remained high, averaging £98 to £100 per ton. The Company's products had won their way into the esteem of consumers, as was exemplified by the fact that during the 23 weeks ended Saturday last 397 orders were received, against 579 orders during the whole of last year, and their customers had increased from 243 on December 31st last to 309 on the 8th inst. As many as 71 orders had been received from one customer—a fact which gave them hope for the future. The Company had introduced a new article, made by the Elmore process, which was likely to monopolise the market—a copper condenser cover for torpedo boats, and several of these had been supplied to Government contractors in Germany. Their new plant was giving great satisfaction, and a considerable sum had been expended in altering and improving the old plant. They hoped to be able to put down a further 16 tanks—equalling four tons a week—before the end of the present year. The Directors were satisfied that the concern was likely to prove a valuable property. They had been approached in two or three different directions by capitalists offering to find large sums of money for filling the factory with plant, and for the purposes of the Company generally.—Mr. Peters pointed out that the same plausible statements had been made that day as for three years past, and none of the hopes held out had been fulfilled. They had a paid-up capital of something like £230,000, and the chief asset of value was patents, £215,000. Considering the results achieved, he should like to know what these patents were really worth. He thought the best thing would be to wind up.—The report and accounts were, in the end, adopted.

GREAT NORTHERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of May were £28,400. The receipts from January 1st to May 31st were £124,000, and in the corresponding months of 1894 and 1893 £105,800 and £108,000 respectively.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended the 9th inst. amounted to £1,671. The amount for the corresponding week last year was £843. Increase, £828.

THE METROPOLITAN ELECTRIC SUPPLY COMPANY (LIMITED).—This Company announces the payment on July 1st of interest for the half-year ended June 30th on the Four and a-Half per Cent. First Mortgage Debenture Stock, and the transfer books will be closed from the 17th to the 30th inst. inclusive.

NATIONAL TELEPHONE COMPANY (LIMITED).—The transfer books of the Three and a-Half per Cent. Debenture Stock of this Company are announced to be closed from the 17th to the 29th inst. inclusive for the purpose of preparing the interest warrants due July 1st.

PHONOPORE COMPANY (LIMITED).—The transfer register of this Company is closed from June 13th to 27th inclusive. A meeting of shareholders was held yesterday (Thursday) at Winchester House, London, E.C.

TELEGRAPH MANUFACTURING COMPANY (LIMITED).—The annual ordinary general meeting of the proprietors of this Company was held last week, when it was decided to distribute as usual a dividend of 5 per cent., and in addition a bonus of 2½ per cent., both free of income tax.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended June 7th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,650.

WESTERN UNION TELEGRAPH COMPANY.—It is announced that the Directors of this Company have declared a quarterly dividend of 1¼ per cent.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, June 5.		Price Wednesday, June 12.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending June 12.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	10/0	Anglo-American	46	48	46	48	4 3 4	Jan., Apr., July, Oct.	46¼	..
£2,993,560	Stock	20/0	Do. Preferred	81½	85½	84½	85½	4 14 2	,, ,,	85¾	85⅝
£2,993,560	Stock	5/0	Do. Deferred	8¼	8¾	8¼	8¾	..	..	..	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	103	106	3 16 9	January and July ..	104¾	..
130,000	£10	3/0	Brazilian Submarine	13	13½	13	13½	4 16 4	Mar., June, Oct., Dec.	13½	13¼
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 7 11	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock	154	158	154	158	4 8 7	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	,, ,,	..	..
12,931	5	2/0	Direct Spanish (fully paid)	3½	4½	3½	4½	4 8 11	April and October ..	..	—
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10¼	9¾	10¼	4 7 7	,, ,,	—	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	105%	108%	105%	108%	4 3 4	..	..	—
60,710	20	2/0	Direct United States Cable, 1877	9¼	9¾	9¼	9¾	4 0 5	Jan., Apr., July, Oct.	..	..
400,000	10	2/6	Eastern	16¼	16½	16¼	16½	3 18 9	,, ,,	16⅞	16¼
70,000	10	6%	Do. 6 per Cent. Preference	17¼	17¾	17¼	17¾	3 7 7	,, ,,	17⅝	17½
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	123	126	123	126	3 3 6	May and November	125	123¾
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	109	106	109	4 13 3	February & August	..	..
250,000	10	6/6	Eastern Extension	16⅞	17⅛	16⅞	17⅛	4 7 7	Jan., Apr., July, Oct.	17⅛	16⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	124	127	124	127	3 3 0	February & August	..	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	104	108	104	108	4 14 7	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	104	108	104	108	4 14 7	,, ,,	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	107	110	107	110	3 13 7	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	111%	114%	111%	114%	3 10 6	May and November	..	—
180,227	10	2/3	Globe Telegraph and Trust	10	10¼	10	10¼	3 12 0	Jan., Apr., July, Oct.	10 3/16	10 1/16
180,042	10	6%	Do. 6 per Cent. Preference	16¾	17	16¾	17	3 10 7	,, ,,	17	16¾
150,000	10	7/2	Great Northern	22	22½	22	22½	3 11 1	Jan., April, and July	22	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	105½	..
17,000	25	37/6	Indo-European	44	47	44	47	5 6 5	May and November	45	45
37,548	10	2/6	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	106	110	106	110	5 10 7	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	106	109	106	109	3 14 7	..	108	..
11,839	8	4/0	Reuter's	3½	4½	3½	4½	..	April and October .	..	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	124	129	124	129	4 13 0	,, ,,	127½	..
15,609	10	5/0	West African Telegraph	4½	5½	4½	5½	..	January and July ..	..	—
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	102	105	102	105	4 16 5	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	100	105	100	105	7 12 5	June and December	100½	—
88,321	10	6d.	West India and Panama	¾	1¼	¾	1	..	..	1 3/16	..
84,563	10	6%	Do. 6 per Cent. 1st Preference	9¾	10¼	9¾	10¼	5 6 8	May and November	..	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	6 6 4	,, ,,	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110	113	110	113	4 10 4	June and December	..	..
64,242	15	6/0	Western and Brazilian	10¼	10¾	10¼	10¾	4 17 11	May and November	10½	10¼
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	—	6 5/16	6¼
33,129	7½	1/6	Do. 5 per Cent. Deferred	4¼	4¾	4¼	4¾	..	..	4¼	..
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	103	107	103	107	5 14 3	February & August	107	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	103	107	103	107	5 14 3	,, ,,	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	5 19 2	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	101	103	101	103	5 18 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	—	..	..	..
224,850	10/0	1½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	—	May and November	..	—
171,504	£1	8·215d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	..	..
484,597	5	2/6	National	5⅝	5¾	5½	5¾	4 6 11	June and December	5 7/16	5⅜
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15½	16½	15½	16½	3 12 9	,, ,,	16⅛	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½	15½	14½	15½	3 17 5	,, ,,	..	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅝	6⅛	5⅝	6⅛	4 1 8	—	6	5⅞
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	104	106	3 6 0	January and July ..	105½	105
58,000	5	1/0	United River Plate	1½	2½	1½	2½	..	,, ,,	1¾	—
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	87	92	87	92	5 8 8	,, ,,	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	14	15	14	15	1 13 4	—	14⅞	14⅝
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15½	16	15¾	16¼	3 13 10	..	15⅝	15 11/16
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	134¾	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	—	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	..
8,322	£5	..	House-to-House Electric	—		—		..	—	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	—		—		..	—	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	..	—	..
45,000	£5	5/0	Liverpool Electric Supply (fully paid)	7¾	7⅞	7¾	7⅞	..	January and July ..	—	..
111,000	5	..	London Electric Supply	..		..		..	—	..	..
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	10¾	11¼	10¾	11¼	2 13 4	..	11	10⅞
£150,000	Stock	4½%	* Do. 4½% Debs.	117	119	117	119	3 10 11	June and December	118¼	..
6,452	£10	2/0	Notting Hill Electric	8	8½	8	8½	..	—	..	..
19,980	£5	4/6	St. James and Pall Mall	8¼	8¾	8¼	8¾	..	—	..	..
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9¼	8¾	9¼	3 15 8	—	9¼	..
59,900	5	5%	Westminster Electric Supply (fully paid)	7¾	8¼	7¾	8¼	3 2 6	—	..	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅜	2⅝	2⅜	2⅝	5 14 3	—	2 9/16	..
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2¼	2½	4 16 0	—	2⅜	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	112	115	112	115	3 19 1	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref	2½	3	2	3	..	January and July ..	..	..
12,139	5	—	Edison and Swan United	1¾	2¼	1¾	2¼	..	..	2⅛	1 15/16
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		—		..	..	—	..
120,000	2	..	Electric Construction	½	¾	½	¾	..	..	..	—
12,845	2	2/9¾	Do. 7 per Cent. Cumulative Pref.	1½	2	1½	2	..	..	1 9/16	—
91,195	2	10/0	Elmore's Patent Copper Depositing	1	1¼	1	1¼	..	..	1⅛	1
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	February & August	22 1/16	22¼
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 7 7	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..	—	..	..
16,000	£10	..	Do. 8 per Cent. Preference	—		..		..	..	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	⅛	⅜		⅛	..	December and June	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	43	45	43	45	5 6 8	March and July ..	45	44
£150,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4 11 9	January and July	..	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,[illegible]70	10	12/0	W. T. Henley's Telegraph Works Ordinary	10	11	10	11	5 8 1	..	11	10¾
£30,000	10	7%	Do. 7 per Cent. Preference	14	15	14	15	4 13 1	..	15	14½
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1½%	City and South London Railway	44	46	43	45	2 15 7	May and November	43½	..
7,000	10	5%	Do. 5% Perpetual Preference	14	16	14	15	3 6 8	..	..	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture xd	131	133	131	133	3 0 2	May and November	133½	132½
37,500	£10	2%	Liverpool Overhead Railway	9⅞	10	9⅞	10	2 0 0	..	..	..
6,295	10	5%	Do. 5% Preference	14¾	15¼	14¾	15¼	3 5 7	..	..	—
125,000	Stock	4%	Do. 4% Debenture	111	113	111	113	3 10 2	January and July ..	—	..

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 892. [No. 8. Vol. XXXV.] FRIDAY, JUNE 21, 1895. PRICE SIXPENCE.

NOTES.

It not unfrequently happens that when the din and dust of a lengthy scientific discussion subside the painstaking, persevering individuals who have endeavoured to follow the varying fortunes of the verbal battle are left to draw their own conclusions, and as often as not, are quite unable to draw any definite conclusion whatsoever from the maze of conflicting assertions. Whether this was the unhappy state of any of our readers at the termination of the great "Sine Wave Controversy," which we light-heartedly set in motion one day last summer, or whether there was such an irresistible preponderance of evidence on one side that conviction must have been carried into the minds of all but the obstinately perverse, it is not for us to say. But those who remember the lines of argument advanced by the opposing champions will no doubt agree with us, that if there ever was any room for doubt in the matter it arose from the difficulty—in fact, the then impossibility—of experimenting under conditions which should be precisely similar except in regard to the form of the electromotive force or current wave. It was as if we were asked to believe that blue paint was bad for a dynamo, because a dynamo of this cerulean tint happened to work exceeding ill, whereas another painted red worked exceeding well.

This essential obstacle in the path of the investigator into the influence of wave-form upon the conditions of alternate-current working has now been overcome by the ingenious and painstaking researches of Messrs. J. M. Barr, S. Beeton, and C. P. Taylor, the first portion of whose joint communication on the subject will be found in our columns this week. In the hands of these experimenters a current wave has lost its rigidity; it has become a flexible thing, which they are able to bend and mould to any pattern that they please. The sine wave, for example, may be flattened on the top, or elevated into an Alpine peak, or fashioned into other forms, without other change in the electrical arrangements than the timely "injection" into the circuit of some form of distorting influence. By regulating the epoch and the period, as well as the magnitude, of this element of distortion any desired modification of any initial wave-form can readily be effected. It will be apparent to everyone that the two most convenient means for introducing distortion are electrical resistance and electrostatic capacity, and it is these which have been employed.

Having arrived at a method of producing waves of various forms, and being able to depict graphically the shape of the waves which were being used, the next problem was to ascertain the precise influence of each wave type upon the working of alternate-current machinery, including generators, transformers, mains and electric arcs. This is, of course, the whole practical drift of the investigation; and it is interesting to learn that the influence of wave-form upon, say, transformer efficiency or arc-light efficacy is by no means the microscopic, philosophically interesting, but practically unimportant magnitude which some would have us believe. We are not yet in the position to publish the actual figures, which will, however, be given by the author later on; but we may say that the importance of wave-form in regard to transformer efficiency is high enough to command the attention of practical alternate current men; and that in the case of alternate-current arc lamps the importance is even greater than with transformers.

The theory that the temperature of the electric arc is regulated by the vapourising point of carbon, although somewhat shaken, is not likely to be wholly shattered by the tentative and unfinished experiments of Mr. W. E. Wilson, some account of which he recently gave in a Paper before the Royal Society. Mr. Wilson believes that the temperature of the arc decreases as the surrounding pressure is increased, in which case, if there is any connection between the two things, the emissivity and the vapourising temperature are an inverse function of each other. And certainly it does seem that, in an atmosphere of nitrogen, increase of pressure causes a diminution in the emissivity. But evidence is wanting as to the corresponding effect of changing the pressure with atmospheric air, or, better still, with an absolutely inert gas, which nitrogen is not. Moreover, the author does not state whether any change was made in the total number of watts supplied to the arc as the pressure was increased; his statement that "the current could be varied from 40 to 10 amperes" being very vague. Mr. Wilson, in fact, leaves us on the horns of a dilemma—namely, that if the temperature of the arc is not identical with the vapourising point of the carbon we are unable to account for the volatilisation which goes on at a constant and well-determined rate; while, if the temperature *is* identical, we are quite unable to reconcile the fall of temperature, on rise of pressure, with the well-established laws of thermo-dynamics of vapours.

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At a recent meeting of the Berlin Elektrotechnischer Verein the important question of the disturbance caused by electric traction currents to physical laboratories was discussed at some length. Prof. Kohlrausch, who was in the chair, stated that experiments carried out on May 27th resulted in a considerable disturbance of the more delicate instruments belonging to the Reichsanstalt. The galvanometer deflections amounted to as much as 1·2min. of arc, the irregularities being of such a capricious nature as to exclude all possibility of precise observation. Unless these disturbances could be removed, Prof. Kohlrausch said that he would have to continue his opposition to the proposed electric equipment of the Berlin-Charlottenburg tramway, the largest deflection which could be permitted being ·1min. of arc. Herr Wilhelm von Siemens stated that he thought electrical engineers would be able to reduce these disturbances to the required figure by making use of the three-wire system of traction. Prof. Dorn, however, thought that there was no reason why we should not all revert to the double-trolley system, and argued that it was of prime importance to secure the Reichsanstalt immunity from disturbance. Only one professor was found in the ranks of the enemy, namely, Prof. Slaby, who maintained that, in view of the probable future adoption of electric traction on a large scale, it behoved those in charge of physical laboratories to accept the inevitable and make suitable arrangements for their own defence; though as to what these arrangements were to be Prof. Slaby gave no hint.

It is impossible, it seems to us, for any general rule to be laid down in regard to the relative rights of physical laboratories and electric railways. In some cases it is obvious that the immense importance of the scientific work being carried on at a given institution must outweigh the question of public convenience, although in the majority of cases it will be well for Prof. Slaby's advice to be taken to heart, and for those responsible to devise means for protecting their delicate instruments, rather than to trust to Parliament to throw out the Bill of any and every electric railway threatening to incommode those engaged in physical, educational, and research work. At any rate, so far as the Reichsanstalt is concerned, there will be a general consensus of opinion that the work it carries on is of such great international importance that an electric tramway cannot be allowed to interfere with it.

One can quite understand that in view of the recent gas explosions, the various local authorities of London would be somewhat circumspect in granting permission for the laying down of any novel, untried, or possibly dangerous type of electric main. The refusal of the Kensington Vestry to sanction the use of armoured cables in their district is, however, somewhat extraordinary. If it was the fear of gas explosions that influenced the Vestry's decision, one can only remark that it is impossible to imagine any system of mains so certain to be absolutely free from explosion troubles as a network of heavy armoured cables laid direct in the ground, and even if the armoured cables are run through iron pipes so little space is left for the accumulation of gas that they might well be reckoned as less liable to suffer from the negligence of the gas companies than many other systems of mains which could be named. Of course, the gas explosion scare may have had nothing whatever to do with the Vestry's veto on the use of armoured cables by the Notting Hill Company. If so, it would be interesting to learn exactly what it is that has brought armoured cables under the parochial displeasure. That there is death in the pot we have known on good authority for some few years; can the Kensington Vestry by any chance have unearthed a new danger to modern man in armoured cables?

The reason for the action of the Vermont Electric Company, in giving each motor a meter, even where the same customer employs several motors, is not stated in the brief description of that Company's Winooski station, which we reprint in another column; but the course thus adopted is likely to lead to, at any rate, one useful result. It may be objected that the use of several small meters is more costly than the employment of a single large one, and, with meter rents as high as they are in this country, this objection would, from the customer's point of view, certainly be valid. Meter rents may, however, be unheard of in Vermont. In any case useful information should be accumulated by the supply company which uses meters so lavishly. Motors on one class of load will differentiate themselves from motors on another class; the load factor of, say, a sausage machine will probably prove to be different from that of a dinner lift, and as a consequence, the supply company should ultimately be in a position to introduce an advantageous system of differential charges, based on the demands on the mains likely to be made by the several classes of motors.

The Presidency of the Royal Society.—It is probable that Sir Joseph Lister will be Lord Kelvin's successor in the Presidency of the Royal Society. Lord Kelvin's five years of office expire this year.

Cable Interruptions:

	Date of Interruption.	Date of Repair.
Mollendo—Arica ...	June 4th, 1895.	June 15th, 1895.
Mozambique—Laurenço Marques	June 9th, 1895.	June 17th, 1895.
Arica—Iquique ...	June 13th, 1895.	June 17th 1895.

The "Electrical Journal."—From San Francisco comes the news that yet another new American electrical periodical is about to make its appearance—the *Electrical Journal*, which is to be an illustrated monthly review of the industrial applications of electricity, gas, and power.

The State of Electrical Trade in America.—According to the latest issue of *Electricity*, of New York, which has reached us, the "condition of affairs in the electrical trade" of America "is worse than unsatisfactory." Our contemporary asserts that "not one concern in twenty is making even a moderate interest upon the capital invested."

Electric Traction for Milan.—An agreement between the Edison Company of Milan and the Corporation of the same town has just been signed, by which the former acquires the right to work the entire tram system of the town by electricity for 20 years, commencing at the expiration of the old tram company's concession in 1896.

The Theric-Oblasser Accumulator in Switzerland.—A company has just been formed in Freiburg, to be known as the Société Germano-Suisse de l'Accumulateur et des Procédés Theric-Oblasser, to acquire and work the Theric-Oblasser accumulator patents in Switzerland and Germany. The capital of the Company amounts to £30,000.

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The Telegraph Service in Paris.—On the 1st prox. a new order relating to the telegraph service in Paris comes into force. At present at many telegraph offices in Paris telegrams are not accepted for delivery the same evening after 9 p.m. It has, however, been arranged that at 17 of the principal telegraph offices telegrams will, from July 1st, be accepted up to 11 p.m. for delivery the same night.

The German Electro-Chemical Society.—At the annual meeting of the German Electro-Chemical Society, held at Frankfort, a sum of 200 marks was voted to the Helmholtz Memorial Fund. It was also announced that the membership now amounted to no less than 420, as against only 65 a year ago. Prof. Arrhenius and Prof. Van't Hoff were elected honorary members of the Society.

Niagara Falls and Lewiston Electric Railway.—Work is progressing on this railway, which is to extend along the bottom of the Niagara River gorge, the road bed being about 20ft. above the level of the water. A great amount of blasting is required to cut a bench for the road bed in the steep, rocky walls of the gorge. The line will be double track, standard gauge, and will be equipped with observation cars, having all the seats facing the river.

Royal Society.—The following Papers were down for reading yesterday:—Capt. Creak, F.R.S., "On the Magnetical Result of the Voyage of H.M.S. 'Penguin,' 1890-93;" Prof. J. Larmor, F.R.S., "A Dynamical Theory of the Electric and Luminiferous Medium. Part II.—Theory of Electrons;" J. W. Rodger and W. Watson, "On the Magnetic Rotation of the Plane of Polarisation of Light in Liquids. Part I.—Carbon Bisulphide and Water."

The Laval Steam Turbine.—The Laval steam turbine is rapidly coming into favour in connection with electric lighting work in France. During the twelve months ended with February last the Company exploiting the French patent rights disposed of no less than 39 sets of combined turbines and dynamos, representing an aggregate horse-power of 1,038. The largest set was one of 300 H.P., supplied to the Société d'Eclairage et de Force par l'Electricité of Paris.

A Unit of Sound.—Mr. Hiram S. Maxim has written to *Engineering* to suggest that there ought to be a standard of sound. He advocates some form of telautographic record on smoked glass as a suitable means for embodying the standard and for comparing it with other sounds. Mr. Maxim thinks that such a standard would be useful in cases where the noise of machinery is made the ground of an action at law; as the noise of the machinery could be compared with "the noise produced by a Salvation Army band, or with other disagreeable sounds which are tolerated by law, at the same distance."

The c.-s. "Mirror."—Sir John Pender and a party of guests left Gravesend on Saturday morning in the Eastern Telegraph Company's cable-steamer "Mirror" to take part in the opening of the Baltic Canal at Kiel. The guests include Viscount Peel, Viscount Wolseley, Mr. Bayard (the United States Ambassador), Lord Charles Beresford and General Ardagh. Mr. F. E. Hesse, Secretary of the Eastern Extension Telegraph Company, accompanies the party. On Wednesday, the Hamburg Senate invited Sir John Pender and his guests to take part in the great banquet held at the New Rathhaus After the celebration the "Mirror" proceeds to Denmark and Norway, touching Scotland on her return.

Damage by Lightning.—During a severe thunderstorm at Helpringham, South Lincolnshire, last week, three agricultural labourers, who were returning home from work, were struck by lightning. One of them was killed, and the others severely injured.—During a brief but severe thunderstorm which passed over the Lochaber district last Wednesday week, a flash of lightning entered the Ben Nevis Observatory, fusing the telegraph wire and damaging an instrument at a point where the wire was exposed. The lining of the Observatory, which consists of wood and dry felt, caught fire, but, fortunately, the flames were prevented from spreading.—It may also be of some interest to learn that at Rome last week lightning struck the main circuit of the town lighting, extinguishing all the electric lights in the city. The power for the electric lighting, it will be remembered, is transmitted overhead from Tivoli.

Water Power at Minneapolis.—According to the *Electrical Engineer* of New York, the project of building a new dam across the Mississippi River at Minneapolis, which has been discussed for over a quarter of a century, is at last under way. The dam will be erected by the Pillsbury-Washburn English Syndicate. Its object is to utilise the power which has for so many years been wasted, and to increase by one-half the water power of the City of Minneapolis. The power will be used in generating electricity for general purposes. The dam will be two years in building. It and the power-house will cost about £200,000, and for the expenditure of this sum the Syndicate expects to realise about 10,000 H.P. The dam will be 900ft. long. The power-house will contain 40 turbine wheels, arranged to be used in sets of four. In times of low water the flour mills of the city are now compelled to use steam, so that the profits of milling are largely decreased. The new dam gives more than enough cheap power for all the needs of the city.

A Natural Science Studentship.—*Nature* announces that the Board of Managers of the Arnold Gerstenberg Studentship, at Cambridge University, give notice that a studentship on this Foundation will be offered for competition in 1896. The competition will be open to men and women who have obtained honours in Part I. or Part II. of the Natural Sciences Tripos, and whose first term of residence was not earlier than the Michaelmas term of 1890. The studentship will be awarded to the writer of the best essay on one of six subjects. The essays must be sent before October 1, 1896, to Dr. Sidgwick, Newnham College, Cambridge. The studentship will be of the value of nearly £90. It will be tenable for one year only, but subject to no conditions of tenure. Among the subjects proposed for treatment are: "A statement of the physicist's 'working conceptions' of Matter and Motion, together with a discussion of the philosophical questions to which they give rise," and "A criticism of the diverse views that have prevailed from the time of Newton onwards as to the conceivability or otherwise of *Actio in distans.*"

A Salomons Scholarship at Cambridge.—Sir David Salomons, who is a graduate of Gonville and Caius College, Cambridge, has founded and endowed a scholarship at that college to be called the Salomons Scholarship. The person elected to the scholarship, which is of the annual value of £40 and tenable for three years, is required to sign a declaration that it is his *bonâ-fide* intention to enter the engineering profession as a civil and electrical engineer, and, if required by the governing body of the college, to become a candidate for the Mechanical Sciences Tripos. The first examination of candidates for this scholarship, who are required to be under 19 years of age, will be held on Tuesday, October 1st. The subjects of examination will be (*a*) euclid, algebra, plane trigonometry, geometrical and analytical conic sections, elementary statics and dynamics, and differential calculus; (*b*) physics, including dynamics and hydrostatics, with practical work. Candidates must send their names, with testimonials of good conduct and certificate of birth, on or before September 29th, to the Rev. E. S. Roberts or Dr. Reid, the tutors of the College, who will supply further information if required.

Road Traction.—Mr. Shaw Lefevre has brought in a Bill to amend the law with respect to the use of locomotives on highways. The Bill only contains one clause, and its object is to exempt carriages propelled by other than horse-power from the regulations of the Locomotives Act in cases where they were not used for traction purposes. Hon. members, he said, who had recently visited Paris would have observed that there were a not inconsiderable number of carriages propelled by petroleum, gasoline, steam, and in some cases by electricity. These carriages were completely under command, and horses were not frightened by them any more than by the ordinary traffic. The use of these carriages was practically prohibited in this country by the regulations of the Locomotives Act, which was passed with the object of applying mainly to engines used for traction purposes. Under the provisions of that Act, it was necessary that every such locomotive should be in charge of

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three persons at least—one walking in front, one behind, and one driving, and the engines could not proceed at a greater speed than four miles in the country and two miles in a town, and were also subject to a licence of £10 each for every county where they were used. These regulations were totally inapplicable to the light carriages such as he had described as in use in Paris. Under the circumstances, it appeared to him to be reasonable that the House should exempt carriages of that kind from the provisions of the Locomotives Act. They would be subject to the ordinary regulations of other carriages, or to any other regulations that the House might think fit to be made by the Local Government Board.

Telegraphy without Wires.—Prof. A. E. Dolbear, writing on the above in the *Electrical Engineer* of New York, of May 29th, makes the following statement :—

"The increasing interest in the attempts to telegraph without wires, both here and abroad, makes it worth while to make mention of some facts which have been forgotten or ignored, and I venture to point out that the method which has lately been employed so successfully in England for telegraphing across a sheet of water between three and four miles wide with no connecting cable was fully described by Prof. John Trowbridge, of Harvard University, in 1880. He made his original researches between the Observatory in Cambridge and the City of Boston, between which is a time-signal wire, having the circuit broken by clock once a second. He found he could hear the clock beats a mile away from the line by connecting a telephone to a wire 500ft. or 600ft. long and grounding their ends parallel with the circuit. His experiments and conclusions are detailed in a Paper given before the American Academy of Arts and Sciences and are published in their *Proceedings* for 1880. How completely he covered this ground of doing telegraphic work by means of earth conduction will be seen by the following quotations from those *Proceedings*: 'The theoretical possibility of telegraphing across large bodies of water is evident from this survey which I have undertaken. Theoretically, however, it is possible to telegraph across the Atlantic Ocean without a cable. Powerful dynamo electric machines could be placed at some point in Nova Scotia, having one end of their circuit grounded near them and the other end grounded in Florida, the conducting wire consisting of a wire of great conductivity and being carefully insulated from the earth except at the two grounds. By exploring the coast of France, two points on two surfaces not at the same potential could be found, and by means of a telephone of low resistance the Morse signals sent from Nova Scotia to Florida would be heard in France.' This is precisely what is being done in England, carrying out Trowbridge's method. In the various descriptions of methods and operations which I have seen there is no mention of the work of Trowbridge, and whatever merit and utility there may be in this method of doing telegraph work belongs to him. Shortly after the publication of the Paper from which I have quoted, Dr. Edward Everett Hale wrote a short story for the *Atlantic Monthly*, in which these earth sheet currents played an important part. Beyond that I have never seen mention of the discovery—for it was a discovery, and an important one, too—that slight currents could be detected at relatively great distances from their source by means of a telephone connected to the ground."

Polyphase and Monocyclic Systems.— M. Blondel has addressed the following letter to the *Electrical World* of New York, giving his views as to the definition of the term "polyphase" and its relation to the "monocyclic" system of Mr. Steinmetz :—

To me the definition of a polyphase system is very simple. "Poly" means several; consequently, a polyphase system is, in the words of M. Hospitalier, the creator of the term, "a system comprising the employment of several alternating currents of different phase." I do not see why, for the sole sake of pleasing Mr. Steinmetz, we should modify a definition so clear and one so universally admitted during the last four years. Mr. Steinmeitz himself—coming from whom the new definition is still more to be criticised—would doubtless never have thought of advocating the change if the accepted definition did not have for him an entirely special inconvenience—that of causing the monocyclic system to fall into a known category. The monocyclic system is, in fact, nothing else than a *polyphase system*, by means of which two phases are transformed (for what reason we do not know, unless it is to avoid the patents of another company) into three phases or into one, according to whether the motors are starting up or working under load. To wish to modify the definition of polyphase currents in order to avoid this conclusion is evidently a radical proceeding, and one which will not be countenanced by those having no ulterior interest in the matter. By applying the same method of reasoning, we can, in fact, just as well show that a dog which can momentarily support himself on his hind legs is not a quadruped. If I may be permitted to make a trivial comparison, the monocyclic system may be defined as a two-phase animal which dispenses with one of its phases when the motors are running under load. It is, without doubt, from the considerations referred to that Mr. Steinmetz rejects the word polyphase; the ordinary public, however, which calls a spade a spade, is, unfortunately not apt to lend its attention to such subtleties, and will not be pleased by having its supposed credulity thus imposed upon. As to the system which has been the subject of this curious discussion, it is certainly very ingenious, as is everything which comes from the same capable source. I confess, however, to not having been able, any more than Mr. Scott, to see its advantage over a properly-designed two-phase system, while I do see very well that it is inferior to such a system, both in the power and efficiency of its machinery. One may assign it the finest name in the world, and change all known definitions—this will avail nothing.

Science and Technology.—The difference between the scientific and the technical society is, says *Engineering*, "much smaller than that between the poet and the mechanic. The object of the one is to search out the meaning of the great universe which incloses us all, and that of the other to turn the knowledge to account to make life easier for humanity. They are but two links in the same chain. Sometimes the links are far apart, but often they are close together, and always they are of the same material. The labours of a Faraday in deducing the laws of electromagnetic induction are very similar to those of a Wheatstone, or of a Siemens, in making a practicable dynamo. Regnault's researches into the properties of steam are not more important than the experiments of the engine builder who embodies their results in a motor of surpassing economy. Lord Kelvin is not greater when he is investigating the physical constitution of the ether than when he is quadruplexing [?] an Atlantic cable. Nevertheless humanity has made up its mind that useful practical knowledge stands on a lower footing than that which is free of all taint of utility. It does not stay to examine if there be any difference in intellectual interest between the two. The moment it sees a commercial bearing in a discovery it puts it, and its author, into a secondary position. It says of him, as does the Scripture of the ostentatious giver, 'He has his reward,' and feels absolved of all necessity of affording him further recognition. His discovery may be the result of deep thought and prolonged research, but it is technical, and, therefore, it confers no claim to admiration and fame. Herein lies an error. While it is undoubtedly true that life is more than meat, yet there is not necessarily anything debasing about that which conduces to our well-being. If a subject requires the highest qualities of our minds for its due comprehension, it does not cease to be intellectual because it simplifies the struggle for daily bread."

The Electric Furnace.—In a recent number of *Nature* Prof. Roberts-Austen gives the following description of the appearance of the interior of an electric furnace projected on the screen when the furnace is arranged for the melting of metallic chromium. Directly the current is passed, the reflected picture shows the interior of the furnace like a dark crater, the dull red poles revealing the metallic lustre and grey shadows of the metal beneath them. A little later these poles become tipped with dazzling white, and, in the course of a few minutes, the temperature rises to about 2,500°C. Such a temperature will keep chromium well melted, though a thousand degrees more may readily be attained in a furnace of this kind. Each pole is soon surrounded with a lambent halo of the green-blue hue of the sunset, the central band of the arc changing rapidly from peach blossom to lavender and purple. The arc can then be lengthened, and as the poles are drawn further and further asunder, the irregular masses of chromium fuse in silver droplets, below an intense blue field of light, passing into green of lustrous emerald; then the last fragments of chromium melt into a shining lake, which reflects the glowing poles in a glory of green and gold shot with orange hues. Still a few minutes later, as the chromium burns, a shower of brilliant sparks of metal are projected from the furnace, amid the clouds of russet or brown vapours which wreathe the little crater; while if the current is broken, and the light dies out, you wish that Turner had painted the limpid tints, and that Ruskin might describe their loveliness. The effect when either tungsten or silver replaces chromium is much the same, but, in the latter case, the glowing lake is more brilliant in its turbulent boiling, and blue vapours rise to be condensed in iridescent beads of distilled silver which stud the crater wall. Such experiments will probably lend a new interest to the use of the arc in connection with astronomical metallurgy. Lockyer has shown how important it is, in relation to such storms, to be able to study the disturbances in the various strata of the stellar or solar atmosphere. Layers of metallic vapour which differ widely in temperature can be more readily obtained by the use of the electric furnace than when a fragment of metal is melted and volatilised by placing it in the arc, in a cavity of the lower carbon.

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ELECTROMAGNETIC THEORY.—LXX.*

BY OLIVER HEAVISIDE.

(Continued from page 184.)

§ 272. Fourier's theorem as exhibited by equation (53) applies to the diffusion of charge in a cable in two cases only. First, let the cable be infinitely long, all in one piece, and let it be charged initially in a periodic manner, say arbitrarily between $x=0$ and $2l$, and with repetitions of the same state in all the other sections of length $2l$. Then the expansion (53) is obviously the proper one. The function $f(x)$ represents the initial state of potential. The state at any time t later is got by introducing the time factor ϵ^{pt}, as in previous cases, in the summation on the right side. This allows the harmonic terms to subside or decay, leaving only the mean value of the initial state behind finally.

But, secondly, it answers the purpose equally well to have a finite cable, of length $2l$, with the ends joined to make a closed circuit. We may take the origin ($x=0$) anywhere, and $x=2l$, $4l$, &c., mean the same as $x=0$. Equation (53) is the appropriate expansion to employ, with the time factor introduced to indicate the resulting state at any time.

The action of the time functions is always to make the later terms in the expansion insignificant compared with the earlier, so that we may generally say that the successive terms of the summation, not counting the outside constant term, are of regularly decreasing importance. And, indeed, in making practical applications, it will be found that this is usually true for the initial state itself. We usually find that the natural order of the harmonic terms in the expansion of a function is the order of their relative importance inversely. But this property is by no means a necessary one. One or any number of terms may be wholly absent, or if not absent may be very small, and followed by bigger ones. There is then an exceptional state at the first moment, and for a certain time after. But when the decadence has progressed sufficiently we must arrive at a state of things in which the order of the terms that exist at all is also the order of their magnitude.

When a cable is closed upon itself, say as described above, the real potential, whatever it may be, is necessarily a periodic function of x. Now Fourier's theorem in the form (53) is the fully periodic form. It might therefore seem that the mere fact of the periodic character of the potential in the case of a closed circuit made the periodic form of Fourier's theorem obligatory. But this is only accidentally true, as it were. The expansion (53) is only one of an infinity of expansions applicable to a closed cable, each in its proper place. For (53) to be applicable, it is not only necessary for the cable to be closed, but also for it to be self-contained—that is, there must be no external connections imposing some restraint upon the potential or the current at a particular place. The "terminal" conditions are that V at $x=0$ and V at $x=2l$ are identical, and that C is also continuous at those places, because they are united, and in such a manner as not to interfere with the continuity of V and C. We may, indeed, choose the initial state to violate these conditions. But the violation is only momentary, for continuity is instantly established by the action of the time functions.

But suppose we put a simple leak on at the place $x=0$, everything else being unchanged. The charge in the cable will redistribute itself now in an entirely different manner. For one thing, it will all leak out of the cable, instead of settling down to a state of uniform distribution. It is obvious that the periodic form of Fourier's expansion of the initial state is unsuitable, although the real potential of the line is periodic. There is no difficulty in obtaining the proper series, though it would be too great an interruption of continuity to give it just now. The peculiarity is that although V is continuous at $x=0$ and $2l$ (except, it may be, at the first moment), C is not continuous. The discontinuity in C at the joined terminals is proportional to the potential there, by Ohm's law applied to the leak. The proper Fourier series must be found to satisfy this condition as well as that of continuity of V in order that it shall, when the time factors are introduced, represent the potential at any moment. The initial state may be chosen arbitrarily and so as to violate the conditions stated, but this is of no consequence at all in the complete solution for V at any time.

The simple leak may be generalised to any combination having a definite resistance operator, by substituting the latter for the resistance of the leak. Thus we obtain any number of Fourier series for a closed circuit, which may represent one and the same arbitrary function (the initial state). All are continuous as regards V, but discontinuous at the junction $x=0$ as regards C according to the special law imposed by the nature of the leak. That is, when t is finite; for, going right back to the moment $t=0$, there may be failure then, viz., by choosing the arbitrary initial state so as to fail to comply with the conditions.

Instead of a discontinuity in the current (or in the derivative of the potential), we may make it be a discontinuity in the potential inself. Thus, we may put a coil in circuit with the cable, doing away with the leak. And, as before, this may be variously generalised. Or we may have the potential and the current both discontinuous at the junction of the beginning and end of the cable by suitable electrical devices. In every case there is one and only one appropriate Fourier series, and there is no difficulty (save complication in detail) in finding it by seeking the solution of the physical problem of decadence of an initial state subject to the imposed conditions. On the other hand, if we eliminate the physical ideas and also the time variation, and look at the matter from a purely mathematical point of view, there are serious difficulties introduced.

The initial state may be one of equilibrium, say $V=0$ everywhere. That is, we may expand zero in any number of ways in a Fourier series. To do this, we require an external source of electric or magnetic energy. We may, for example, insert a charged condenser and coil in sequence between earth and the cable at the junction of $x=0$ and $x=2l$. Let the initial state be a charge in the condenser, but none in the cable. The initial arbitrary function to be expanded in a F. series of a very special kind is zero. The time factors make the series be finite, and express the potential at time t due to the condenser's charge. Finally, if the condenser is leaky, we come to zero potential again in the cable.

We may also require to determine a Fourier series not merely so as to express $f(x)$ (including zero as a special case) between certain limits, but also so that certain functions of the Fourier series may have special values in addition. And then connected systems of Fourier series are sometimes required, as when the line is divided into connected sections, with external conditions imposed at the junctions. Or we may have a network of cables, of the same type or different, with imposed conditions, and have to find a set of Fourier series (or other kind of series if a cable varies in its resistance, &c.), to satisfy all the conditions. And so on to any extent.

There is no difficulty in obtaining the operational solutions by the method of resistance operators in a clear and definite manner, and when that is done we are virtually in possession of the real algebraical solutions in the cases of simply periodic impressed forces, and steady and impulsive forces, and arbitrary initial states, for the conversion from operational to algebraical form involves only formal transformations. But we must now return to Fourier's theorem. The above remarks originated in the departures from Fourier's theorem required even when the function under consideration is everywhere continuous and periodic. In the treatment of Fourier series to be found in certain works, the reader can hardly find a glimmer of a notion of the subject in its general and comprehensive aspect.

§ 273. There are two special forms of Fourier's theorem in the form of a double integral which should be noted. Referring to the diagram of impulses, § 271, we see that when l is ∞ the sines u, say u_2, is reduced to represent merely a positive unit impulse at y, and an equal negative one at

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$-y$. The cosines u, say u_1, on the other hand, represents a positive impulse both at y and at $-y$. The formulæ are

$$u_1 = \frac{2}{\pi}\int_0^\infty \cos sy \cos sx\, ds, \tag{56}$$

$$u_2 = \frac{2}{\pi}\int_0^\infty \sin sy \sin sx\, ds. \tag{57}$$

So, if we use these in the fundamental formula (24), or

$$f(x) = \int f(y) u\, dy, \tag{58}$$

the result on the left side, which is $f(x)$ when u is a single impulse within the limits as before stated, will depend upon the limits employed. If the limits in (58) are complete, viz., $-\infty$ to ∞, and we use u_1, we shall obtain $f(x)+f(-x)$. But if we use u_2, we shall obtain $f(x)-f(-x)$. For the impulses are double, and positive or negative as described.

We may, of course, choose the limits so as to exclude both x and $-x$. Then the result is zero. Or we may include just one of them, and get either $f(x)$ or $\pm f(-x)$. The most useful way is to exclude the whole of the negative values of x. Then (58) applied to u_1 and u_2 makes

$$f(x) = \frac{2}{\pi}\int_0^\infty\int_0^\infty f(y)\cos sy \cos sx\, ds dy, \tag{59}$$

$$f(x) = \frac{2}{\pi}\int_0^\infty\int_0^\infty f(y)\sin sy \sin sx\, ds dy. \tag{60}$$

These are very useful in the mathematics of physics, perhaps more so than the complete formula (55). The following way of looking at them is interesting. Given that

$$F(x) = \left(\frac{2}{\pi}\right)^{\frac{1}{2}}\int_0^\infty f(y)\cos xy\, dy. \tag{61}$$

Then the symbols F and f are interchangeable. That is, we also have

$$f(x) = \left(\frac{2}{\pi}\right)^{\frac{1}{2}}\int_0^\infty F(y)\cos xy\, dy. \tag{62}$$

There is a corresponding interchangeability in the other case. That is, if

$$G(x) = \left(\frac{2}{\pi}\right)^{\frac{1}{2}}\int_0^\infty g(y)\sin xy\, dy, \tag{63}$$

then

$$g(x) = \left(\frac{2}{\pi}\right)^{\frac{1}{2}}\int_0^\infty G(y)\sin xy\, dy. \tag{64}$$

The corresponding property connected with the zeroth Bessel function is that if

$$F(x) = \int_0^\infty f(y) J_0(xy) y\, dy, \tag{65}$$

then the symbols F and f are interchangeable. To prove them, put say (62) in (61), and we get (59). That is, we get an equivalent, the notation being changed. We have dy both in (61) and (62), but of course in the double integral it is desirable to have them different.

The above is the way Fourier's theorem often turns up in practice. We have an integral of the form (61) say, and we can at once deduce another one. It is not necessary to go through the work of making up the double integral, and so using Fourier's theorem explicitly. But it may not be convenient to have the $(2/\pi)^{\frac{1}{2}}$ coefficient. Then, partially sacrificing the perfect interchangeability, we may put it thus. If

$$F(x) = \frac{2}{\pi}\int_0^\infty f(y)\cos xy\, dy, \tag{66}$$

then it follows that

$$f(y) = \int_0^\infty F(x)\cos xy\, dx. \tag{67}$$

Similarly when we write sin for cos in these formulæ. Examples are numberless. One or two will suffice here to illustrate. Say that we know that

$$J_0(sx) = \frac{2}{\pi}\int_s^\infty \frac{\sin xy}{(y^2-s^2)^{\frac{1}{2}}}\, dy. \tag{68}$$

It follows that

$$\frac{1}{(y^2-s^2)^{\frac{1}{2}}} = \int_0^\infty J_0(sx)\sin xy\, dx. \tag{69}$$

Observe that the limits in (68) are not complete. From $y=0$ to $y=s$, the $f(y)$ function integrated has no existence—that is, y must be greater than s. Consequently, in (69), y must be greater than s. If y is less than s in (69) the value of the integral is zero. (We have assumed that x is positive in (68). If negative, the $-$ sign must be inserted.)

If we reversed the process and passed from (69) to (68), we should require to know that the (69) integral is true as given when $y>s$, but is zero when $y<s$. This will exclude the region 0 to s from the first integral (68).

Similarly, if $G_0(sx)$ is the companion function to $J_0(sx)$, the second kind of oscillating function, and we know that

$$\frac{1}{(y^2-s^2)^{\frac{1}{2}}} = \int_0^\infty G_0(sx)\cos xy\, dx, \tag{70}$$

when y is greater than s, but that it is zero when y is less than s, then we deduce

$$G_0(sx) = \frac{2}{\pi}\int_s^\infty \frac{\cos xy}{(y^2-s^2)^{\frac{1}{2}}}dy, \tag{71}$$

the region from $y=0$ to $y=s$ being excluded. This is like going from (67) to (66). Reversing the process, we observe that the condition $y>s$ in (71) has to be preserved in (70). Else we get zero.

As an extreme case of (61), if we take $f(y)$ to be a single unit impulse at the point $y=z$, we obtain $F(x)=(2/\pi)^{\frac{1}{2}}\cos xz$. Next, using this function in (62), we come back to the impulsive function, in accordance with (56) above. There is a similar property involved in all normal functions, since they are capable of expressing arbitrary functions, and, therefore, a single impulse. Observe that the (69) integral contains two normal functions, so that we may not only deduce (68) from it, but also another integral, by employing the inter-changeable property involved in (65).

§ **274.** Now, a few words on the reversibility of the process of getting Fourier series operationally. Given a Fourier series, say $f(x)=\Sigma A \sin sx$, can we find its meaning operationally? Of course, its immediate meaning is given by the F. itself. But what the resultant meaning of the sum of the series harmonic functions may be is not evident, and it may be rather a serious matter to find it by numerical calculation, though after all the meaning may be quite simple, a straight line, for example. There is matter for regret here, for whilst the solution of problems by F. series may be easily elaborated, the ease is confined to the formulæ, not to their calculation, which gets more and more difficult.

One way of finding the meaning may be briefly mentioned here. By the introduction of a time-factor to every term of the F. series we may make it (if of a suitable kind) represent a real physical problem in diffusion. Then $f(x)$ means the initial state. Now I have already pointed out the identity of the wave solutions and F. series. It will have been observed that we can pass continuously from the waves to the F. series. For we can construct the wave solution of a diffusion problem expressing the effect due to a given source, subject to terminal reflections, by writing down the waves themselves in operational form, first the initial waves and then their consequences in order, as done in §§ 255 to 260. Adding these together, we obtain the condensed operational solution, which may be independently obtained without thinking out the waves in detail. Finally, we can convert the result to a F. series, as explained in §§ 265 to 270 in special cases, and in a general way that will come later.

Is this process reversible? It is certainly reversible on one side, for we convert the operational solution to the wave form by algebraical division. It is not only in the simple cases of terminal earth or disconnection that the meaning of the individual waves can be ascertained, though I have not given any advanced examples in detail yet. As regards the other side, we can plainly pass from the diffusion solution in a F. series to the operational solution by simply reversing all the steps. Referring to examples before given—first, the constancy of power of the time-differentiator on ϵ^{Pt} enables us to put the circular function occurring in the F. series outside the summation sign, by taking s^2 to mean $-RS(d/dt)$. Then the summation that is left, or $\Sigma\epsilon^{Pt}$, may be converted to the operational form $\Sigma(1-P/p)^{-1}$. This series of fractions may then be summed. The final result is an operational formula with unit operand.

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But if the reader will apply this reversed process to the examples in detail hitherto given, he will find that he will not be able to do it safely with his eyes shut. This is because in going from the operational equation to the F. series, certain operations are nugatory, and are omitted. So in the reversed process, they should be restored. This can only be done by careful inspection of the problem, and is a question of experience and judgment. The terminal conditions satisfied by the solution in F. series should be examined. They must be satisfied all the way through, and this will enable the complete reversal to be effected. But, though there may be troubles of the above kind to be surmounted, it is not a useless way of transforming from the F. series to waves when the sources are of a simple nature. On the other hand, should the sources be not simple, as in the case of subsidence from an "arbitrary" state, the case is altered, on account of the integration which is involved in the determination of the coefficients of the F. series, which complicates the matter considerably. We may therefore leave this question on one side.

§ 275. Another way of regarding F. series operationally will be conveniently introduced by considering an elementary example. Given

$$f(x) = \frac{2}{\pi}\Sigma_1^\infty \frac{1}{n}\sin\frac{n\pi x}{l}. \qquad (72)$$

Find what $f(x)$ means, without numerical calculation, and also without introducing time functions to make a diffusion problem. We see that $f(x)$ is an odd function of x, and that it is periodic. It is therefore sufficient if we know its meaning from $x=0$ to $x=l$.

Regard the right member of (72) operationally as a function of x in the same way as our previous functions of t. Let Δ stand for d/dx. This replaces the former p, the time-differentiator. Then first we have to convert the series to operational form as a function of Δ. This is easy. For we have

$$\sin sx = sx - \frac{(sx)^3}{\lfloor 3} + \frac{(sx)^5}{\lfloor 5} - \dots$$

$$= \frac{s}{\Delta} - \left(\frac{s}{\Delta}\right)^3 + \left(\frac{s}{\Delta}\right)^5 - \dots = \frac{s/\Delta}{1+(s/\Delta)^2}. \qquad (73)$$

Similarly, in passing, we see that $\cos sx =$ same with 1 for numerator.

Next, using (73) in (72) we produce

$$f(x) = \frac{2}{\pi}\Sigma\frac{1}{n}\frac{\frac{n\pi}{l\Delta}}{1+\left(\frac{n\pi}{l\Delta}\right)^2} = \frac{1}{l\Delta}\Sigma\frac{2}{1+\left(\frac{n\pi}{l\Delta}\right)^2}. \qquad (74)$$

We have already had occasion to employ this formula, equation (13), with ql instead of $l\Delta$. So

$$f(x) = \coth l\Delta - \frac{1}{l\Delta}, \qquad (75)$$

with unit operand understood. That is, in getting (73), we imagine the operand to start at $x=0$, and be 1 afterwards.

Next, expand the coth function in (75) by division. Thus,

$$(fx) = (1-x/l) + 2\epsilon^{-2l\Delta} + 2\epsilon^{-4l\Delta} + 2\epsilon^{-6l\Delta} + \dots, \qquad (76)$$

where we have also algebrised the $(l\Delta)^{-1}1$ in (75).

Now this equation (76) expresses the full algebraical meaning of $f(x)$ on the assumption made, namely, that it begins at $x=0$. The value of $f(x)$ is explicitly represented by (76) from $x=0$ up to $x=\infty$. It is $1-x/l$ from $x=0$ to $x=2l$. All the following terms are then zero. From $x=2l$ to $x=4l$, the first auxiliary term exists. Its value is 2, and makes $f(x) = 3-x/l$. From $x=4l$ to $6l$, the second auxiliary exists as well as the first. This adds on another 2, and makes $f(x)=5-x/l$, and so on regularly. How these jumps come about through the auxiliary terms will be explained next.

(*To be continued.*)

Telephone Cable.—The municipal authorities of Königsberg have just agreed to the laying of a telephone cable across the bed of the River Pregel. This will place the Königsberg telephone exchange in connection with the Memel-Berlin trunk line.

THE ABSOLUTE MEASUREMENT OF ELECTRICAL RESISTANCE.*

BY PROF. J. V. JONES, F.R.S.

(*Concluded from page 234*).

§ 10. I trust that I have said sufficient to make clear to you the general theory of the measurement of a resistance in absolute measure by this method. It now remains to consider very briefly the practical side of the matter, the difficulties that arise, the way in which they may be met, and the accuracy attainable. The time at my disposal does not allow me to do this at all completely, and I must content myself with touching on a few points of special importance and interest.

The first great desideratum is that we should have the rate of rotation of the disc well under control, that it should run as uniformly as possible, and that its rate should be capable of sufficiently exact determination.

The disc, axle, and bearings in my apparatus at Cardiff are of phosphor bronze (Figs. 2 and 3). The disc is insulated from the axle by well-paraffined ebonite (Fig. 4), otherwise there would be short-circuiting of part of its radius through the bearings and bed.

It was at first intended to drive the disc by rope gearing from the electromotor; but in the course of preliminary experiments, though the rope was 40 yards long, and joining of the ends took place over a length of at least 6ft., there was a sudden variation in speed, producing a distinct movement of

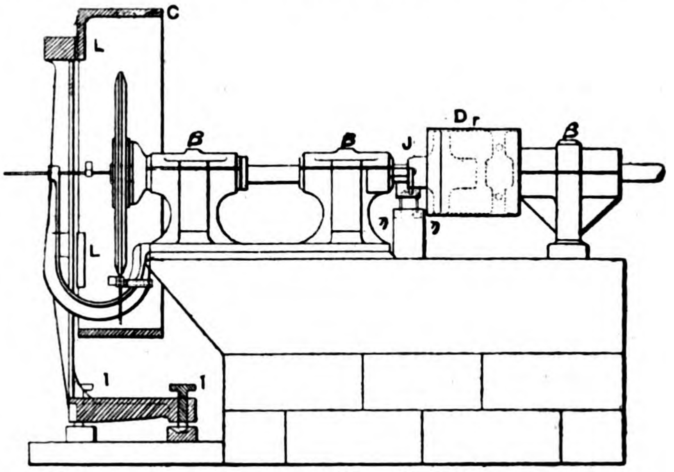

FIG. 2.—Disc and Coil. Elevation and part Section on line A B. Dr = Drum with rows of teeth on it.

my galvanometer needle, and visible at the tuning fork, of which I shall presently speak, whenever the joint passed over the pulley. The rope gearing was therefore abandoned, and the motor coupled direct. The current driving the motor is supplied from secondary cells. It passes to the motor through resistance coils, and may be increased or diminished by throwing some of these coils into or out of the circuit. It may also be varied continuously through a small range by a slide resistance of platinoid wire after the larger adjustment has been made. A shunt worked by a lever provides means of taking out or putting in a small resistance suddenly, so as to allow the observer controlling the speed while an observation is being taken to counteract small variations of speed due to alteration in the lubrications of the bearings and the friction of the brushes on the commutator of the motor. With these arrangements we can obtain any required rate of rotation from about 150 to 1,500 revolutions per minute.

It is of the greatest importance, if the observations presently to be described are to be made with ease, that the rate of rotation should remain constant for the four or five minutes required, and no effort made to compass such uniformity is thrown away. The design, workmanship, and lubrication of

* Friday Evening Discourse, delivered at the Royal Institution, May 24, 1895.

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all the bearings require closest attention, and the friction between the brushes and the motor commutator should be reduced to a minimum. In my Cardiff apparatus the axle near the motor bears a heavy flywheel.

During a run the observer controlling the rate of rotation requires some test of uniformity, so that he may, if there is a quickening or slowing down, diminish or increase respectively the current through the electromotor so as to recover the initial speed.

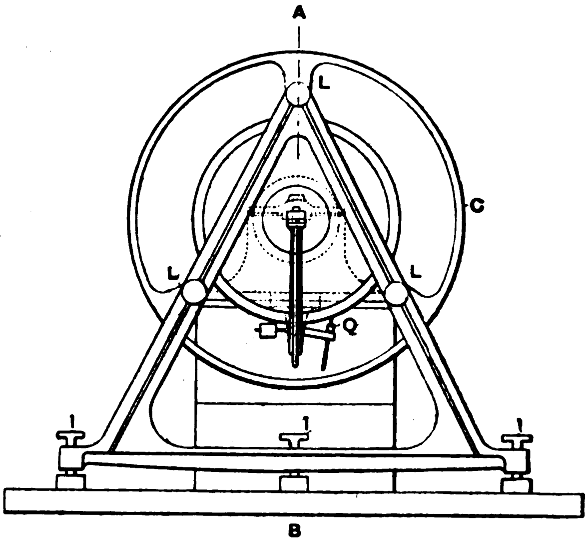

FIG. 3.—Disc and Coil. End View.

To accomplish this it is convenient to refer the rate of rotation by a stroboscopic method to a suitable tuning fork provided with riders and maintained in vibration electrically. Here is such a fork. At the end of each prong there is an aluminium plate with a slit in it parallel to the prong. When the fork is in equilibrium the slits are opposite one another, and an observer can see through both. When the fork is in vibration he can see through the slits only when they are

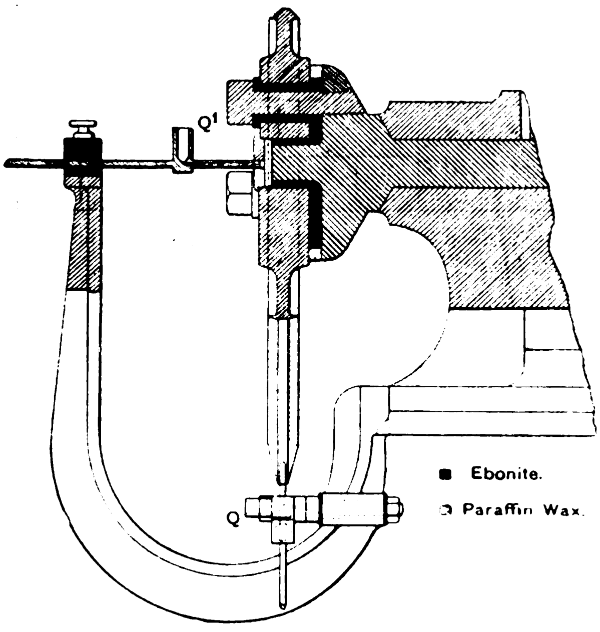

FIG. 4.—Details of Disc Insulation and Brushes. Part Elevation and part Section on lines *a b*, *b c*, Q Q^1 = brushes.

opposite one another. This position occurs twice in every complete vibration. Hence, if the number of vibrations per second is, say, 64, he obtains 128 views per second.

Now let us suppose that he looks through the vibrating slits at a drum or disc coloured black, on which a number of white spaces, which I will call teeth, are painted at equal angular intervals. Here is such a disc attached to the rotating axle; on it there are three circular rows of radial teeth.

When the disc is in rotation, if the rate of rotation is such that in the interval between two views a tooth in any row exactly takes the place of the next, that row will appear, to an observer looking through the fork slits, stationary; if it does not quite do so, the row will appear to be moving backward; if it passes beyond, the row will appear to be moving forward.

These phenomena I can show you by illuminating the rotating disc by intermittent light. The light of this alternating arc varies in intensity at each alternation, passing from maximum to maximum through a minimum that is, however, very far from darkness. Our speed is such as to make the row of 14 teeth appear almost stationary in this intermittent light. You can see the teeth, but they stand out somewhat faintly. The faintness is due to the fact that we have not complete darkness between the maxima of illumination.

We may do much better with such a tuning fork as I have described. I place its slits in front of this electric lantern, in which there is a continuous arc. The light falling on the disc has passed through the slits of the vibrating fork, and by varying the rate of revolution we obtain perfectly distinct stationary teeth. Let us suppose that the fork permits the light to pass through it 128 times per second, and that the row on the disc which looks stationary has 14 teeth on it; then one tooth takes the place of the next in $\frac{1}{128}$th of a second, but this corresponds to $\frac{1}{14}$th of a revolution, so that one revolution is performed in $\frac{14}{128}$th of a second, and the number of turns per second is $\frac{128}{14} = 9\frac{1}{7}$.

And generally

$$n = \frac{2P}{Q},$$

where P = the pitch of the fork,

n = the number of turns of the disc per second,

Q = the number of teeth in the stationary row.

We may then make the stationariness of a tooth as seen by an observer through the slits a test of the uniformity of the rate of rotation. If a tooth begins to move past a fixed reference wire placed immediately in front of the rotating disc or drum, the observer can at once bring it back by altering the current in the motor.*

If the tuning fork were itself a reliable time indicator to the degree of accuracy required, we might calculate from its pitch the speed corresponding to stationariness of a given row of teeth. But my experience is that the vibration period of a fork maintained in vibration electrically is not sufficiently constant. If stopped and set going again it may start with a period different from that of its last performance by several parts in 10,000. No previous determination of the pitch of the fork can therefore be relied on to give us the rate of rotation to a hundredth per cent., though once started the fork goes sufficiently uniformly to give us the means of control.

The period of a bowed fork does not vary in this fashion, but it is more troublesome to use for the purpose. The constant bowing required takes too much of the attention of the observer.

Accordingly, it is necessary to measure the rate of rotation during each run while the galvanometer observations are being made. This may be done telegraphically with great accuracy. The rotating disc is by means of an eccentric attached to its axle caused at each revolution to make and break an electric circuit passing through a Bain's electro-chemical telegraph instrument. The standard clock telegraphs seconds to the same instrument. The two records lie side by side on the same tape, and simple counting with careful fractional estimate gives with great precision the mean rate of rotation during the few minutes occupied in taking a set of galvanometer readings.

With this means of measuring the rate of rotation we may, establishing synchronism with a fork in the way I have indicated, find the pitch of the fork.

Table I. gives a set of measurements of the pitch of a bowed fork; I bring it before you as indicating the accuracy both of the synchronising and the time measurement.

* So far as I know this method of measuring a rate of rotation was first used by Lord Rayleigh. The method used by Macleod and Clarke for measuring the pitch of a tuning fork bears much likeness to it.

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Table I.

Date.	Duration of observation.	Temperature. Centigrade.	Pitch of fork. (Corrected to 15·5°C.)
1892.	Minutes.	Deg.	
July 16	2	19·67	65·1823
July 17 (1.)	4	19·17	65·1823
July 17 (2.)	4	19·65	65·1827
July 17 (3.)	5	20·05	65·1814
July 18 (1.)	4	19·56	65·1809
July 18 (2.)	4	19·92	65·1823
July 21	4	18·18	65·1812
July 22	4	17·96	65·1831
		Mean.	65·1820

Extreme variation from mean is about 1 in 65,000.

§ 11. When I first began working at this method I found it extremely difficult when the disc was in rotation to obtain a steady reading at the galvanometer. My galvanometer is a very sensitive Thomson reflecting galvanometer of about 1 ohm resistance, made by Elliott Bros. and fitted by my assistant, Mr. Harrison, with a long suspension for the support of the needle by a quartz fibre. When the disc was in uniform rotation the spot of light roamed continually over 50 or 100 divisions of

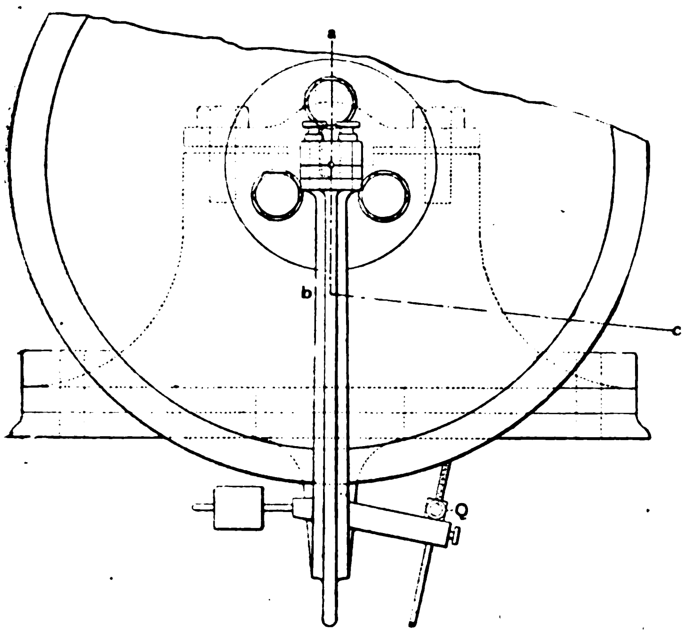

Fig. 5.—Part End View.

the scale, and frequently there were sudden jerks of a most embarrassing kind. Readings with a galvanometer so sensitive were in fact impossible. (The scale divisions are 40 to the inch, and the scale is about 40in. from the galvanometer.)

Now the electromotive force in the circuit of the galvanometer when there is no current through the standard coil is due to three causes :—

(1.) The cutting of the earth's flux of induction by the radius of the rotating disc. The electromotive force due to this cause is small in my apparatus, owing to the fact that the plane of my disc nearly coincides with the magnetic meridian. For a uniform rate of rotation it is constant.

(2.) The thermo-electric forces due to the general distribution of temperature in the galvanometer circuit. Changes in this distribution would be gradual, and would not account for the sudden irregular movements of the galvanometer needle.

(3.) The thermo-electric force at the contact of the external brush with the circumference of the disc. The sudden movements of the needle were obviously due to variations in this thermo-electric force.

I made many experiments with a view of diminishing these changes. I first tried an ordinary phosphor-bronze brush made of a number of layers of thin sheet and controlled by a spring, brush and disc circumference being well amalgamated. This was not at all successful. Trials were then made with amalgamated copper and amalgamated lead, and with the substitution of a dead-weight pressure for a spring. But no satisfactory result could be obtained.

It was noticed, however, that after amalgamation the readings were fairly steady for a short interval, and it seemed likely that if mercury could be continuously supplied to the surface of contact between the brush and disc the electromotive force at their contact would be rendered much more constant. This led on to the idea of a brush consisting of a single wire, perforated by a channel through which a constant flow of mercury might be maintained from a cistern of adjustable height, and a brush of this description was made (Fig. 5). Trial showed that our difficulty was at an end. The variations almost disappeared, the sudden jumps quite ceased to trouble us, and the motion of the needle did not extend over more than one or two divisions of the scale for many minutes. A multiplication of such brushes round the circumference would make still further improvement.

§ 12. In measuring a resistance we have to determine what I have called the equilibrium rate of rotation corresponding to that resistance—*i.e.*, the rate of rotation such that, on reversing the direction of the current through coil and resistance by the commutator, the reading of the galvanometer is unchanged.

Now, it is not very easy to hit this exactly without making a great many trials, and, fortunately, it is not necessary for us to do so. The current produced in the galvanometer circuit by the difference of the electromotive forces at the disc and at the resistance is proportional to that difference, and, if the current is small, it is proportional to the scale deflection on reversal. We shall commit no appreciable error, therefore, if we are near the equilibrium rate, in assuming that the difference between the equilibrium rate and the actual rate is proportional to the scale deflection on reversal, or, what comes to the same thing, that the difference $R - Mn$ is proportional to the scale deflection on reversal.

If we take four or five rates of rotation near the equilibrium rate, and determine the deflections on reversal corresponding to each, we can by interpolation determine the rate of rotation that would correspond to no deflection, *i.e.*, the equilibrium rate. If, say, we take five such rates, some on one side and some on the other of the equilibrium rate, we get five equations as follows :—

$$R - M n_1 = C l_1,$$
$$R - M n_2 = C l_2,$$
$$R - M n_3 = C l_3,$$
$$R - M n_4 = C l_4,$$
$$R - M n_5 = C l_5,$$

where l_1, l_2, l_3, l_4, l_5 are the deflections corresponding to rates of rotation n_1, n_2, n_3, n_4, n_5, and C is a constant.

Combining these by the method of least squares, we may readily obtain the most probable values of R and C.

If the greatest accuracy is not required, we may content ourselves with two observations, one on one side of the equilibrium rate, and the other on the other side.

The elementary observation in the determination of a resistance with any given apparatus is, then, the determination of scale deflection on current reversal corresponding to a rate of rotation simultaneously measured.

To obtain this scale deflection accurately we must obtain it as a mean of the values given for it by a number of successive reversals succeeding one another as quickly as possible, in order to eliminate slight variations in the position of the galvanometer needle due to the slight remaining variations in the thermo-electric force at the external brush contact, and the slight variations of speed that the observer at the tuning-fork has to correct. It is therefore best not to wait for the needle to come even approximately to rest after the disturbance due to the induction current on reversal; but to take the readings for the extreme positions in an oscillation, and having previously found the coefficient of damping, to calculate the position of rest from these two readings.

Here is a table of an average set of such observations taken during a three minutes' run. The readings with the commutator in one direction are denoted by E, and those with the

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commutator in the other direction are denoted by W. The deflections on reversal are given in the column marked W – E.

Table II.

E.		W.		E. (Calc.)	W. (Calc.)	W – E.
–33·0	+19·5	+14·5	–19·0	–2·3	–5·1	–2·8 –3·4
–28·0	+17·0	+16·5	–18·5	–1·7	–4·0	–2·3 –1·0
–28·5	+15·0	+15·0	–21·5	–3·0	–6·4	–3·4 –2·8
–28·5	+14·0	+17·0	+22·0	–3·6	–5·8	–2·2 –2·8
–27·0	+14·0	+17·0	–22·5	–3·0	–6·1	–3·1 –2·8
–29·0	+15·0	+19·0	–23·5	–3·3	–5·9	–2·6 –3·5
–27·0	+15·0	+18·5	–22·5	–2·4	–5·5	–3·1 –2·3
–26·0	+13·0	+18·0	–22·0	–3·2	–5·4	–2·2 –2·4
–28·5	+15·0	+18·5	–22·5	–3·0	–5·5	–2·5 –2·0
–29·5	+15·0	+16·5	–23·0	–3·5	–6·6	–3·1 –3·5
–26·5	+13·5	+22·5	–24·5	–3·1	–5·0	–1·9 –2·5
–26·5	+14·5	+19·0	–22·5	–2·5	–5·3	–2·8 –1·8
–29·5	+15·0	+16·5	–21·0	–3·5	–5·4	–1·9 –2·9
–26·5	+14·5	+18·5	–21·5	–2·5	–4·9	–2·4 –2·1
–28·5	+15·5	+17·0	+22·0	–2·8	–5·8	–3·0 –2·6
–22·5	+10·5	+22·5	–25·0	–3·2	–5·3	–2·1 –2·4
–26·0	+13·5	+18·5	–22·5	–2·9	–5·5	–2·6
Coeff. of Damping $= \frac{1}{1·41}$					Mean...............	–2·57

Summing up, then, we have during an observation one observer controlling the speed by the tuning fork method I have described; another at the galvanometer continually reversing the commutator and calling out the galvanometer readings; at the same time the rate of rotation is being recorded on the tape of the Bain's telegraph instrument under the watchful care of a third; and a fourth person is required to write down the readings called out from the galvanometer. The run usually lasts one, two, or three minutes according to the degree of accuracy required.

The concordance of the results obtained from successive runs in measuring the same resistance is the best test of the success of the combination.

The following is a set of observations of a resistance of about $\frac{1}{2000}$th of an ohm made in July and August, 1893:—

Table III.

July 17th, morning.................................	0·00050016
July 17th, afternoon	0·00050016
July 19th, morning..............................	0·00050015
August 2nd, afternoon	0·00050020
August 3rd, morning	0·00050021
August 4th, morning	0·00050016
August 4th, afternoon	0·00050013
August 5th, morning	0·00050019
August 9th, morning	0·00050021
August 9th, afternoon.............................	0·00050018
Mean....................................	0·00050017

The maximum divergence from the mean is 0·00000004, or about one part in 12000.

Here is another set, made last year in determining the value of the international ohm in absolute units.

The results are as follows, the figure in each case giving the value of the international ohm in true ohms:—

July 7th.—Standard coil carefully adjusted. Three-minute tapes.

0·999703
0·999761
0·999807

Mean............ 0·999757

July 9th.—No readjustment of standard coil. One-minute tapes.

0·999757
0·999711
0·999683
0·999782

Mean............ 0·999733

July 10th, morning.—Standard coil readjusted. One-minute tapes.

0·999734
0·999818
0·999726

Mean............ 0·999759

July 10th, afternoon.—No readjustment of standard coil. Three-minute tapes.

0·999708
0·999742
0·999764

Mean............ 0·999738

July 11th, afternoon.—Standard coil readjusted. Three-minute tapes.

0·999693
0·999692
0·999679

Mean............ 0·999688

July 12th, morning.—No readjustment of standard coil. Resistance coils reversed.

0·999713
0·999711
0·999692

Mean............ 0·999705

July 12th, afternoon.—Standard coil readjusted. Resistance coils removed from the mercury cups and replaced. Three-minute tapes.

0·999774
0·999787
0·999759

Mean............ 0·999773

July 13th.—Standard coil readjusted. Resistance coils removed from mercury cups and replaced. Three-minute tapes.

0·999847
0·999809
0·999782
0·999842 (morning of the 14th)

Mean............ 0·999820

July 14, morning.—Standard coil readjusted. Resistance coils removed and replaced. Three-minute tapes.

0·999695
0·999692
0·999717

Mean............ 0·999701

July 14, afternoon.—Standard coil readjusted. Resistance coils removed and replaced. Three-minute tapes.

0·999853
0·999866
0·999875

Mean............ 0·999865

These results show that no single observation differs from the mean of a number by more than one part in ten thousand.

§ 13. We have now to consider the other factor in the resistance—the coefficient of mutual induction of the coil and disc. This depends merely on the dimensions of the coil and disc if they are accurately centred, and as the adjustment for centre was made in between the successive sets given in the last table we may take for granted that it can be made with the requisite accuracy.

The circumference of the disc is a sufficiently true circle, the disc having being ground true in place. Disc and axle were then removed and transferred to my Whitworth measuring machine. The measurement of the disc's diameter presented no difficulty. It was easily determined to the ten-thousandth of an inch. The mean radius of my coil cannot be determined

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with the same accuracy, but I believe it is known to the thousandth of an inch. The coil consists of a single layer of silk-covered wire wound in a screw thread cut in a brass frame. The silk covering of the wire introduces some uncertainty. It was measured bolted to its stand as in use. Measurements were taken along 18 diameters in the Whitworth machine with the following results :—

Diameter.	Measurement.	Diameter.	Measurement.
0°—180°	21·0898	90°—270°	21·1038
10 —190	21·0929	100 —280	21·1056
20 —200	21·0951	110 —290	21·1041
30 —210	21·0933	120 —300	21·1014
40 —220	21·0960	130 —310	21·0979
50 —230	21·0998	140 —320	21·0945
60 —240	21·1017	150 —330	21·0924
70 —250	21·1026	160 —340	21·0900
80 —260	21·1044	170 —350	21·0910
Max., 21·1056		Mean, 21·09757	
Min., 21·0898		$t=17°C.$	
	0·0158		

These measures clearly show that the coil is elliptical in section, the difference between the major and minor axes being about 0 008in., or about one part in 1,300. The way in which this fact emerges from the measurements is, however, some indication of the accuracy with which the individual measurements in the machine can be made, even in the case of a coil of insulated wire.

My coil, then, is faulty on account of this ellipticity. I have not yet calculated the possible error due to this cause; it cannot be very great. How much it is only calculation can settle; and the calculation is not without difficulty. But this, after all, is only a question of my apparatus, and does not affect the general question of the possible accuracy of the method.

A more solid metal frame might, no doubt, be turned true to the accuracy required, and if so turned might then be measured with the requisite accuracy in the Whitworth machine.

A still further improvement may be made by making the coil frame of insulating material, say paraffined marble, and winding on it naked wire instead of silk-covered wire. The radius might then be measured with certainty to something much better than 1 part in 10,000. The use of a coil with a single layer of wire instead of many layers is a great improvement for the purposes of determining the mean radius. It, of course, necessitated the finding of a new formula for the coefficient of mutual induction.

This I obtained by direct integration of the general integral for the case in point, viz., a circle and coaxial helix. The coefficient of mutual induction is given us as a sufficiently converging series involving elliptical or quasi-elliptical integrals.

We may, then, in the result conclude that, though I cannot guarantee my own coefficient of mutual induction as correct to 1 part in 10,000 till I have calculated the effect of the coil ellipticity, it lies well within the resources of our mechanical engineers to make a coil and disc free from uncertainty to this degree of accuracy. And if this be so I am warranted in stating that a resistance can be measured in absolute units to 1 part in 10,000.

Now, in the Order in Council, from which I quoted in the early part of my discourse, it is stated that in the use of the ohm standard the limit of accuracy attainable is one-hundredth part of 1 per cent.—*i.e.*, one part in 10,000. Hence the Government gains nothing in precision to compensate for the risk it has taken in adopting as unit the resistance of a standard coil, which may vary from time to time in consequence of changes in the physical condition of the coil.

There is no valid ground left for adopting as ultimate unit any other unit than the absolute unit itself. We have not in our electrical standard legislation given full credit to the mechanical engineer for what he can do for us. He can make a machine that will measure resistance in absolute units with a precision as great as—I might even say greater than—that with which the Government is prepared to guarantee its comparisons. Such a machine ought to be at work in the Board of Trade laboratory, in order that there may be opportunity from time to time, at regular intervals, to measure the Government coil or coils in absolute units. It is necessary that this should be done if we are to be guarded against the perpetual inconvenience of unknown possible changes in the coil, the resistance of which is now the legal unit.

§ 14. Such a step would have collateral advantages. It would enable the Board of Trade to certify standards of low electrical resistance. With such a machine standards of from a thousandth to a two-thousandth of an ohm may be measured to nearly the same percentage accuracy. All we have to do in dealing with the very low resistances is to pass a sufficiently large current through them, and shunt the standard coil of the machine. But to enter into details on this point would lead me too far. I must content myself with saying that I believe such a machine is much the best instrument for standardising low electrical resistances, and that accurate standards of low resistance would be of great service both in the laboratory and the workshop.

I have in conclusion only to express my obligation to my assistant, Mr. Samuel Harrison, for the great and constant help he has given me in the course of my investigations on this subject.

WAVE FORM SYNTHESIS.

BY JAMES MARK BARR, STANLEY BEETON, C. PERCY TAYLOR.

On October 5th of last year we suggested that it would be useful if a given alternate-current dynamo could be caused to produce E.M.F. waves of any desired shape for experimental purposes. It was proposed to obtain these wave forms by inserting resistance, inductance or capacity in the armature circuit at synchronously timed "epochs" and for various "intervals." We made our first trial with a small Gramme dynamo, connected up as an alternator, and we subsequently used a Ferranti machine, its frequency being more suitable for experiment.

It was found quite feasible to produce almost any wave shape at will, and we have obtained a number of interesting and important results, and we are at present finishing a series of transformer tests, which we shall supplement with some tests on the light given out by alternate-current arc lamps with widely different wave forms. Heretofore it has been necessary to employ a number of dynamos of different types in order to experiment with several wave forms, and hence the greatest advantage of the method described in this Paper is that a single alternator is made to produce the wave forms of any other types of dynamos, besides giving waves of intermediate shapes. Before describing our apparatus and dealing in detail with a number of wave forms obtained, we shall give a *résumé* of a number of the most important effects of wave forms upon the efficiency of practical apparatus. These points were brought out last summer in a dispute known as the "Sine Wave Controversy" between the American engineers and various contributors in *The Electrician*. It was this discussion which suggested the work of this article, and the arguments advanced on both sides well show the importance of the subject. It had appeared that the sine wave shape for electromotive force in alternators was regarded in America as being better than any other form for all purposes—indeed, as the *sine quâ non*. It was claimed by *The Electrician* that many practical cases existed in which other wave shapes might be better, and while that paper admitted the general lack of faults in the sinusoidal form, it objected to the belief that the latter wave possessed especial value. As in the wrangle of the two-sided shield, there was much misunderstanding in the controversy due to the fact that some controvertists spoke of electromotive force waves, some of current waves, and, judging from the points sought after by others, a number of writers dealt with curves of induction. When one said that "the apparatus was supplied with a sine wave" the whole argument depended upon whether the electromotive force wave was sinusoidal, and whether the conditions were such as to cause a distorted current wave, or whether the resultant induction waves were of the sinusoidal form. If we are to presume that all writers have referred to the same wave, we come to a perplexing instance, in the *Electrical World* of September 15, 1894, on page 264, where Prof. Fessenden entirely disagrees with *The*

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Electrician, and considers the sine wave form the best—we presume that he means the potential difference wave. But he goes on to state that a "rectangular curve will give a slightly greater amount of power in a circuit for a given amount of hysteresis." If the curve referred to be the wave form of the potential difference, one experiences a difficulty in making this coincide with the statement of Mr. Steinmetz that a peaked electromotive force wave gives the smallest hysteresis loss. Again, the controversy becomes involved by assumptions with regard to the sine curve which have been based upon fallacies. We believe that Mr. Dunbar, in the *Electrical World* of August 18th, inadvertently made such assumptions. In attempting to prove that the sine wave is the best for the applied electromotive force in all cases, he first drew the strong analogy between a force, as a time function ($f(t)$), acting upon a mass, and an electromotive force sending a current through a circuit. Mr. Dunbar then says for the absolutely general dynamic case that " . . . . for maximum efficiency the ratio of the average momentum to the average force must be a maximum; that is,

$$\frac{\dfrac{\int_0^T\int f(t)\,dt.dt}{T}}{\dfrac{\int_0^T f(t)\,dt}{T}} = \frac{\int_0^T\int f(t)\,dt.dt}{\int_0^T f(t)\,dt}$$

must be a maximum. Taking the first differential coefficients and equating to zero, we have

$$\left(\int_0^T f(t)\,dt\right)^2 = \Big[f(t)\Big]_0^T \cdot \int_0^T\int f(t)\,dt.dt.$$

"Now the only function which satisfies this condition, that the square of its integral shall equal the product of the function and its double integral, is evidently that in which the integral is similar to the function (*sic*) that is the sine curve."

By the substitution of $f(t) = \sin t$ in the last expression, we get a fallacy, to wit:

$$\Big[\cos^2 t\Big]_0^T = -\Big[\sin^2 t\Big]_0^T \quad . \quad . \quad . \quad . \quad (1)$$

The limits 0 to T, if T be the period, render (1) true, inasmuch as $0 = 0$, but the members are not equal for any other limits. As a matter of fact, the general solution of the equation for efficiency does not admit of any periodic function whatever, as the value of $f(t)$, no matter what constants are inserted.

Thus, if we let

$$\iint f(t)\,dt\,.\,dt = x,$$

whence

$$\int f(t)\,dt = \frac{dx}{dt}$$

and

$$f(t) = \frac{d^2x}{dt^2},$$

we have by substitution in Mr. Dunbar's last equation

$$\left(\frac{dx}{dt}\right)^2 = x\frac{d^2x}{dt^2},$$

$$\therefore \frac{1}{x}\frac{dx}{dt} = \frac{\dfrac{d^2x}{dt^2}}{\dfrac{dx}{dt}}.$$

Integrating this we have

$$\log x = \log C_1 \frac{dx}{dt},$$

$$\therefore x = C_1 \frac{dx}{dt}.$$

Whence

$$dt = C_1 \frac{dx}{x},$$

and integrating we have

$$t = C_1 \log x + C_2,$$

whence

$$x = C_3 e^{\frac{t}{c}}, \ \&c.$$

Now this gives $f(t)$ in Mr. Dunbar's equation equal to e^t, which upon substitution satisfies equality. But this value, far from being a sine function, is *not even periodic.*

It is hardly necessary to discuss the assumptions which were made upon the fallacious solution of the above equation, and used in connection with what have been well called "ironless analogies."

The importance of the subject is shown by the fact that the discussion lasted several months, and that contributions were made by a large number of practical engineers. In such questions, we have to balance cost and design against efficiency of operation, and it would appear that there are cases where variations in wave form introduce immense differences in efficiency of apparatus in circuit. Besides this there are other considerations aside from actual efficiency. For instance, Prof. Ayrton has spoken of several specific disadvantages of peaked waves of potential difference. In these waves there is generally such a great difference between the value of the volts as read by a Cardew or an electrostatic instrument and the maximum value of the volts, that rules for insulation thickness and for spark-gap values cease to hold. This is of especial interest in the controversy, because, while a peaked wave of potential difference may in some cases be the best with regard to the efficiency of the apparatus worked, the necessarily increased cost of insulation may not justify the use of the wave.

It is really necessary to deal with the various effects of current waves and waves of induction separately, as well as the form of the electromotive force wave, and we will consider all three in this article.

Of all periodic apparatus the induction motor is perhaps the most materially affected by the form of wave of the impressed electromotive force. Broadly speaking, the general conclusion arrived at is that the sine curve is the best wave form for the motor, as will be seen by reference to the work of some eminent investigators of the subject. Mr. Kennelly, speaking with reference to power transmission in the *Electrical World* of August 18, 1894, says "deviations from the sinusoidal form of E.M.F. wave become deleterious . . . principally owing to the reactions set up in the induction motors by the virtual harmonics present in the sinusoidal form of E.M.F. whenever rotary field motors are employed." No direct experimental evidence is cited in this letter to vindicate the above statement.

Mr. Scott, however, has instanced the case of a two-phase motor, which when driven from a certain dynamo heated badly and had more "armature slip" than was expected. It was found that the curve of this dynamo was irregular and that the third harmonic was prominent. Being supplied with a sine electromotive force the same motor ran efficiently and well. Mr. Scott remarked that in a motor of this sort the third harmonic tended to turn the armature in a direction opposite to the "primary wave." It would be interesting to know the exact shape of this wave referred to as of "irregular form," for it might then be possible to suggest another wave shape before deciding that the sine wave is the best. Prof. Ryan, in a letter to the *Electrical World* of August 25, 1894, says that "it has been found that the synchronous motor works best when it produces a motor E.M.F. that has the same wave form as the generator that supplies it with power." The same applies, he says, to rotary transformers. Another point is then here brought out, but it still remains to decide which is the best wave form for the motor and generator to possess. Dr. Louis Bell, in the *Electrical World* of September 1, 1894, has also come to the conclusion that the sine wave is the best for induction motors. Dr. Bell tested a three-phase induction motor with two independent sources of power, to see which gave the best results when applied to the motor. One source gave a "very close approximation to a sine wave," and the other was an ironclad alternator, the curve of which "was never exactly a sine wave, and which was deliberately distorted by weakening the field." Mr. Kelly, in the *Electrical World* of August 11, 1894, has made a very similar test on a motor which, when driven by a "generator giving approximately a sine wave," developed 40 H.P., but was "practically inoperative . . . when working with an alternator of the same normal frequency, but with very irregular waves."

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Prof. Ryan's point, that the motor and generator should give the same potential difference wave form, seems to have been overlooked in both these last two experiments. For one could hardly expect the same motor to work equally well on waves differing widely in shape. The motor, no doubt, works best when supplied with power from the generator giving the potential difference wave that most nearly approaches its own, and it is, therefore, very important to know exactly the wave form of the motor, for then we would know the best shape to give to the impressed potential difference. In both the experiments of Dr. Bell and Mr. Kelly one is again left to surmise the actual form of the wave referred to as "very irregular." It is hard to accept the verdict for the sine wave before a few other wave forms of perfectly definite shape have been tried. It seems also probable, when experimenting in this manner with two generators, that defects inherent in one or the other might seriously affect the value of the results.

Wave form is also of importance in the working of transformers. The efficiency at full load has by this time been raised to such a high value that it is not to be supposed that variations in the shape of the applied electromotive force wave can improve it much—probably not ½ per cent. at the outside. But with regard to open-circuit losses the variation with wave form becomes more important. Mr. Steinmetz has observed variations up to 13 per cent. in the iron losses of a transformer when tested with different shapes of applied electromotive force waves, and Mr. Kelly also has noted variations of 10 per cent. In the case of electrical distribution for lighting purposes in which a transformer is placed in each house it is very important to balance between the losses in the transformers and the mains. In such cases the transformers are seldom worked with a higher load factor than 10 per cent., and low-load working is by far the most important consideration. Now the mains loss depends only on the current, whereas the transformer loss depends also on the power factor, and it is evident that if the factor is increased while the transformer loss remains constant there will be a gain in the efficiency of the mains. Thus, in the question of the best electromotive force wave form for use with transformers, the power factor is quite as important as the consideration of the true watts lost. Thus, in the case of a long-distance transmission it might be better to use a wave form giving greater iron loss in the transformer than others, if the *apparent watts* were less, not only because of the loss in the mains, but because, if the power factor is low, more machines may have to be run than would be necessary for the actual true output required to avoid heating in the armatures. In the study of transformer losses with different applied electromotive force wave forms, what we really require to know is, therefore, the shape and phase of the primary current wave produced by each. A very good idea of these different current waves produced in a given transformer can be got by Dr. Sumpner's method, given in the *Phil. Mag.* in 1887. But, to quote Dr. Fleming, "this is a question which can only be settled by an experimental comparison of the no-load losses of transformers tested off alternators of which the electromotive force curve is at the same time ascertained." In order to come to any definite conclusion on the point at issue it would, therefore, be necessary to have access to a number of alternators giving a great variety of electromotive force wave forms. In this Paper we show a method by which it is possible to produce any wave form at will from one alternator, and in this way we can make a very complete set of experiments with even a greater variety of wave forms than are at present in use for alternating-current work.

It is general to speak of the total hysteresis loss as being dependent upon the highest value attained in the current wave. This is not true for wave forms having several maxima. It has been shown by Dr. Sumpner (in the *Phil. Mag.*, Vol. XXV., p. 466, 1885) and others that if, during the Ewing cycle, the current suddenly goes back to a value previously passed, and then resumes its former rate of sinking or rising, we get a loop in the hysteretic curve. Hence it follows that the waste work done in hysteresis will be greater per period the more points of inflection we have in the current wave for a given highest maximum. Thus we see that the magnetising current wave should be *smooth*. But as there is an indefinite number of "smooth" wave shapes this is not sufficient to indicate which particular form will give the least hysteresis loss for a given number of lines developed per cycle in a given magnetic circuit.

Considering the case of alternate-current arc lighting, the most interesting effects yet published are contained in the Paper read before the Verband der Electrotechniker Deutchlands last year by Herrn Rössler and Wedding. In this case the current wave is the important point, and the questions to be considered are the efficiency of the arc itself and the working of the regulating device. The experiments were carried out with only three wave forms, and although these were typical shapes, it is difficult to draw any definite conclusions from so few. If a series of waves could be taken with some intermediate and some even more marked forms, there is no doubt that some very valuable information could be obtained on this subject, which, though very important, has probably, through want of facilities, received very little attention. The importance of the subject is well shown by the results of the above Paper, namely, that the lamp tested gave 44 per cent. more light per watt with the Wechsler machine (approximately a sine wave) than with the Ganz (peaked wave). With the Siemens machine (flat-topped wave) the results are ever better, and the authors suggest that the rectangular shape is the best. It would be extremely interesting to make some experiments with forms approaching this shape as nearly as possible. Herrn Rössler and Wedding note that the *noise* is also bad with a peaked wave, but what seems really necessary is to find the best form of current wave to use for the arc itself, and to suit the mechanism to this form and not the form to the mechanism.

Drs. Crehore and Bedell, in their recent treatise on alternate currents, point out that a difference in shape between the upper and lower half waves in a period, although the areas of the two may be equal, can cause a great difference in the root-mean-square values of the positive and negative impulses. And they go on to say that such a current wave would account for unequal consumption of the carbons of an alternate-current arc lamp. This case of waves of dissimilar contour above and below the zero line, though quite outside the "sine controversy," gives us another practical instance of wave form effect which adds something to the general importance of the subject. These waves are included in the work of this article. In most cases, as in the above, the important point to be considered is the value

$$\frac{1}{T}\int_0^T i^2\,dt,$$

so that equality of current wave area with regard to the zero line tells us nothing. However, there is one case with alternate currents in which the value

$$\frac{1}{T}\int_0^T i\,dt$$

is the important point, viz., alternate-current electrolysis. This has little practical importance, as there is no application of the principle. However, a number of compounds are changed by alternate electrolysis, and if a change of current wave shape is made without alteration of areas, there would be no change of effect as in the case of operating instruments and other apparatus by unbalanced root-mean-square values.

Another instance of wave form effect has recently been brought out in the working of the Phonophore system, in which a rapidly changing intermittent current is generally employed. The wave now used may in some cases cause a disturbance in telephone lines, but by the use of an equally strong alternate current having a wave of smooth contour, noise due to inductive disturbance is rendered *nil*.

We have thus far shown the more practical aspect of the study of wave forms, and now come to the general methods of attacking the problems involved. The idea of regarding irregular wave forms in electrical work as "fundamental sine shapes possessing superimposed harmonics" (that is sine curves of intermediate period) "with lag and lead," is of recent development. It is the application of Fourier's theorem. This proposition shows that any periodic curve whatever, which represents a function of time, may be built up by adding

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together a number of simple sine curves. Thus we start with a true sine curve and have, say, for the electromotive force of an alternator,

$$E = E_1 \sin p\,t.$$

And if the wave is a deviation from this fundamental shape we have

$$E = E_1 \sin p\,t + E_2 \sin 2\,p\,t + E_3 \sin 3\,p\,t + E_4 \sin 4\,p\,t + \ldots$$
$$\ldots + E_1^1 \sin\left(\frac{\pi}{2} - p t\right) + E_2^1 \sin 2\left(\frac{\pi}{2} - p t\right) + E_3^1 \sin 3\left(\frac{\pi}{2} - p t\right) + \ldots$$

&c., the number and order of the terms remaining in the expression depending upon the shape and dimensions of the wave represented. The signs and magnitudes of the coefficients $E_1, E_2, E_3, E_4, \ldots\ldots E_1^1, E_2^1, E_3^1, E_4^1, \ldots\ldots$ determine the lag or lead and amplitude values of the several harmonies with regard to the zero of the irregular wave. *Each harmonic sine curve is the resultant of each corresponding pair of terms* in the above expression, such as $E_1 \sin p t$ together with $E_1^1 \sin \left(\frac{\pi}{2} - p\,t\right)$ or $E_n \sin n\,(p\,t)$ together with $E^1_n \sin n \left(\frac{\pi}{2} - p\,t\right)$.

It is possible to construct an instrument which, when its stylus is traced over any periodic curve, will give the values of the amplitudes of the pairs of component sines which make up the "harmonics" present in that curve. Lord Kelvin, in 1876, was the first to suggest such an instrument, and two of his proposed form have been made.

These instruments were very cumbersome and complicated, and no practical improvements were made until last year, when Prof. Henrici brought out a simple and most accurate harmonic analyser. This instrument was designed by Mr. Archibald Sharp, of the engineering department of the Central Technical College, and made by Coradi, of Zurich. It is fully described in the *Phil. Mag.* for July, 1894. The harmonics present in the curves given below were obtained by the use of the latter instrument through the courtesy of Prof. Henrici. The instrument gives the first five consecutive pairs of terms for the harmonics by one tracing around curve. Another instrument having relation to a wave form work is the Harmonic Synthesyser, recently invented by Mr. Sharp. When rolled vertically across a flat sheet of paper, this instrument automatically draws in lead pencil or ink the wave form which is made up by any harmonics for which the elements are set.

Harmonic analysis being of such importance in the general study of alternate-current wave form, practical development has led to several purely electrical methods for resolving the wave shapes into their components. Profs. Ayrton and Perry, some years ago, used a Siemens dynamometer, through the movable coil of which was passed the current to be analysed. A current of constant value having a pure sine form and a frequency which could be varied at will, without altering this constant value, was passed through the fixed coil. The latter alternating current was obtained by the use of a revolving liquid commutator which has since been used by Prof. Ewing and Mr. Lamb, and used also in America by Dr. Louis Duncan. The frequency of the known sine wave, beginning at a low value, was gradually increased until the first critically-marked deflection was observed. This gave the fundamental sine wave, and the magnitude of the attraction gave the amplitude of the component. The frequency was then gradually increased until an attraction was again observed between the dynamometer coils from which the frequency and amplitude of the first higher harmonic was determined, and so on for all other components.

Dr. Pupin, of Columbia College, New York, has recently brought out an analogous method of analysis involving the use of an electrometer. The components are in this method separated by successive resonant effects. Other physical methods of harmonic analysis have been used with success.

(To be continued.)

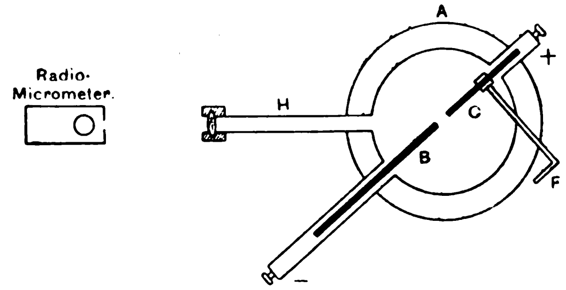
Electric Lighting by Wind Power.—The electric light plant at Sunnyside Asylum, Dundee, derives its motive power from a Blyth windmill of about 10 H.P. The mill is said to be giving very satisfactory results. The Blyth windmill is constructed to move in a horizontal plane about a vertical axis.

ON THE EFFECT OF PRESSURE OF THE SURROUNDING GAS ON THE TEMPERATURE OF THE CRATER OF AN ELECTRIC ARC LIGHT.*

BY W. E. WILSON.

Of late years it has often been assumed that the temperature of the crater forming the positive pole of the electric arc is that of the boiling of carbon. The most modern determinations give this point as about 3,300°C. to 3,500°C. Solar physicists have thought that the photosphere of the sun consists of a layer of clouds formed of particles of solid carbon. As the temperature of these clouds is certainly not below 8,000°C., it seems very difficult to explain how carbon can be boiling in the arc at 3,500deg., and yet remain in the solid form in the sun at 8,000deg. Pressure in the solar atmosphere seemed to be the most likely cause of this, and yet, from other physical reasons, this seemed not probable.

In order to investigate whether increased pressure in the gas surrounding an electric arc would raise the temperature of the crater, I had an apparatus made by the Cambridge Instrument Company. It consists of a strong cast-iron box, which was tested by hydraulic pressure to 2,000lb. per square inch. In the following plan, A is the box, B and C are the two carbon poles enclosed in steel tubes. The negative carbon was kept in position against a copper ring by a spiral spring behind it. The positive carbon was hand fed by a friction roller, which was moved by a handle F outside the box. A steel tube H was screwed into the box at such an angle that, by looking down it, we could see well into the crater of the positive pole. The end of this tube is closed by a glass lens, which formed an image of the crater at a distance of 80cm. A Boys' radio-micrometer, with its aperture reduced to about 2mm. diameter, was so placed on the pier in the laboratory that the image of the crater fell on its small aperture. The instrument thus gave deflections proportional to the radiation coming from the crater. The



current was supplied from a battery of accumulators, giving an E.M.F. of 110 volts. Suitable resistances of platinoid wire were put in the circuit, so that the current could be varied from 40 to 10 amperes. An ammeter was also in circuit, and the poles of the arc were connected to a voltmeter.

The gas used was nitrogen, and the pressure was got by connecting the box by a copper pipe with the valve of a 20ft. steel cylinder filled with the gas at a pressure of 120 atmospheres. A T-joint on the copper pipe was connected with a Bourdon pressure gauge, which showed the pressure in the box at any moment.

The method of experimenting was first to start the arc with the pressure in the box at that of the atmosphere. The image of the brightest part of the crater was thrown on the aperture of the radio-micrometer, and a series of observations taken of the deflections of the instrument. The pressure was then gradually increased, and the maximum deflections observed. As the pressure rises the resistance of the arc increases, and, in order to keep the same current flowing, the resistance in the circuit was reduced. It soon became evident that, even with moderate pressures of about five atmospheres, the temperature of the crater had fallen. This was not only shown by the reduction in the deflections of the radio-micrometer, but also by the fall in brilliancy of the image of the crater to the eye. The pressure was then increased to about 20 atmospheres, and the brilliancy of the crater fell to a dull red colour. These experiments were repeated several times, and always with the same results.

I then tried the effect of reducing the pressure in the box by means of an air pump, but as some of the glands in the box were only intended for an internal pressure, I found it impossible to get a good vacuum; yet by keeping the pump at work, and thus getting a moderate vacuum, I found the radiation of the crater to be much greater than at the atmospheric pressure.

The temperature of the crater seemed very sensitive to any sudden diminution of pressure in the gas. If the blow-off valve was suddenly opened, the brilliancy of the crater fell so much

* Paper read before the Royal Society. Preliminary notes of observations made at Daramona, Streete, co. Westmeath.

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that it became nearly invisible. When the box was being exhausted by the air pump, although the temperature of the crater was rising as the vacuum improved, yet at each stroke of the pump the eye could see a distinct falling off of brilliancy in the image. It was thought that the diminution of brilliancy might be due to smoke inside the box, but on looking through the window everything was seen sharply defined, also the gas as it issued from the blow-off was perfectly clear. The arc was also kept burning for some time in the box at the atmospheric pressure, but the image remained quite clear, and the inside of the box seemed quite free of smoke.

From these experiments it would seem as if the temperature of the crater, like that of a filament in an incandescent lamp, depends on how much it is cooled by the surrounding atmosphere, and not on its being the temperature at which the vapour of carbon has the same pressure as the surrounding atmosphere. That carbon volatilises in some form at comparatively low temperatures seems likely, from the way in which the carbon of incandescent lamp filaments is transferred to the glass. The pressure of the vapour of carbon in the arc may consequently be very small, and further it would seem that the supposition of high pressures in the solar photosphere, which has been referred to in the beginning of this Paper, is not borne out by these experiments, and that carbon may exist there in the solid form at very high temperatures, although the pressures are comparatively low.

The experiments on high pressures were conducted on several occasions. On the last occasion, in addition to repeated former experiments, the experiments on reduced pressures were performed, and I then had the great advantage of the presence, advice, and assistance of my friends Prof. Minchin and Prof. G. F. Fitzgerald. The later series of experiments entirely confirmed my former ones.

PHYSICAL SOCIETY.

At the ordinary meeting of this Society, held on June 14, 1895, Captain W. de W. Abney, President, in the chair,

Mr. Burstall continued the reading of his Paper on

"The Measurement of a Cyclically Varying Temperature."

Three sizes of platinum wire have been employed for the thermometers in order that some idea might be formed as to the magnitude of the error caused by the lag of the temperature of the wire behind that of the gases. The constants of the platinum thermometers were determined either by comparison with a standard Callender platinum thermometer or by means of ice, boiling water, and boiling sulphur. In most cases the thermometer constants were determined after the wire had been exposed to the action of the hot gases for about half an hour. One wire, however, was calibrated before being used, and an unusually high value was obtained for the coefficient δ. After this wire had been exposed to the hot gases the value of δ fell, however, to the normal. The author thinks the abnormal value may have been due to the formation of a gold platinum alloy during the process of attaching the wire to the leads, and that this alloy was subsequently swept off by the hot gases. The Paper includes a number of tables and curves which embody the numerical results, and show that concordant results can be obtained on different days and with different thermometers.

Prof. PERRY said that an instrument for quickly recording varying temperatures was greatly required by engineers. The temperature just inside the cylinder walls was, however, the most important to determine, and a knowledge of how the temperature from one to two millimetres inside the walls varied would be of the greatest importance. He would like to ask the author if the observed temperatures agreed with the values calculated on the assumption that the gases in the cylinder behaved as a perfect gas, and that $\frac{PV}{T}$ was constant during the whole stroke. Differences between the observed and calculated values might be due to dissociation, and not entirely to lag in the thermometers. It was astonishing that even the fine wires employed were able to follow the rapidly varying temperature, and he would like to see some special experiments made to test this point.

Prof. CAPPER showed a diagram giving the values calculated on the assumption that $\frac{PV}{T}$ = constant. In such a calculation it was necessary to assume some temperature as a starting point, and in general this temperature was obtained from an analysis of the exhaust gases, so that the calculated curve is most likely to depart from the truth at the commencement of the stroke. He (Prof. Capper) hoped that the author would be able to accurately determine the temperature of some one point of the stroke, and he suggested that the point where the observed curve crossed the theoretical curve would be the most suitable one for this purpose. Such a point must exist, since at the commencement of the stroke the lag causes the observed temperature to be too low, while at the end of the stroke the observed temperatures are too high. Mr. Burstall finds a curious bump in his curves, and it is curious that a similar bump exists in the calculated curves. From the constancy with which this bump appears it would seem that it must have some physical meaning. It was important to remember that the expansion in the gas engine cylinder is not adiabatic, for heat is both abstracted and generated during the stroke.

Mr. BLAKESLEY suggested that, since the temperatures dealt with were sufficient to make the wire red hot, the question of lag might be investigated by the wire being examined by means of Becquerel's phosphoroscope at a known interval after the removal of the source of heat.

Mr. GRIFFITHS said he considered an important source of error was the large thermal capacity of the leads when the working wire was so very short. He thought it would be possible to standardise the thermometers under conditions somewhat similar to those which occur in the engine cylinder. Thus, perhaps, alternate gushes of air at 0°C. and 100°C. might be used. The use of gold to attach the fine wire to the leads was objectionable, since the gold must permeate the platinum for quite an appreciable fraction of the whole length of the wire. He would like to know whether the change in δ alluded to by the author occurred with the first explosion, or whether it was a gradual one.

Mr. ENRIGHT pointed out that the nature of the working substance in a gas engine varied during the stroke.

Prof. PERRY said that the change in the specific volume of the gases before and after combustion did not amount to more than 1·25 per cent.

Mr. E. WILSON said he thought it was most important to shorten the time of contact, since at present the galvanometer readings corresponded to the mean temperature over a range of about 5 per cent. of the whole stroke. It might be possible to make use of a condenser to get over this difficulty.

Prof. RUCKER said that the Kew Observatory were making arrangements to undertake the testing of platinum thermometers.

Mr. ENRIGHT suggested that with a very short contact induced currents might cause errors.

The author, in his reply, said the only chemical action on the wires he thought probable was the formation of a carbide. After several hours' use, however, the wires appear quite bright and clean.

A Paper on "An Electromagnetic Effect," by Mr. F. W. Bowden, was postponed till the next meeting.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

WEDNESDAY, June 26th.

Society of Arts.

4 p.m. Annual General Meeting.

THURSDAY, June 27th.

University College, London.

8.30 p.m. Annual conversazione.

FRIDAY, June 28th.

Physical Society.

5 p.m. Meeting at Burlington House. Papers to be read: (1) "An Electromagnetic Effect," by F. W. Bowden; (2) "On Synchronous Motors," by W. G. Rhodes; (3) "The Electrical Properties of Selenium," by Shelford Bidwell, F.R.S.

The Electrical Equipment of the "Terrible."—The electric machinery for generating the current for internal lighting, search-lights, motors, &c., on board the new cruiser "Terrible" consists of three large sets of condensing engines and dynamos. The engines, says *Engineering*, are of the open-fronted compound type, mounted on the same bedplate, and coupled direct to direct-current dynamos, each capable of generating 600 amperes at an electromotive force of 80 volts, at 300 revolutions per minute. Two of these sets are placed in a compartment adjacent to the main engine-room and under the protective deck, the third set being placed on the main deck amidships. The electric light installation consists of about 800 50-c.p. and 16-c.p. lamps, laid out on the double-wire, water-tight distributing system. In addition to the lighting up of the interior spaces, including coal bunkers and magazines, the decks will be illuminated by powerful lights suspended from the rigging. The compasses, telegraphs, mast-head, side lamps, signal lanterns, semaphores, and military tops are all separately lighted and under the immediate control of the officer on deck. Six search lights are fitted up—two on the forward bridge, two on the after bridge, and one on the top of each mast. Electric motors are to be used throughout in lieu of the usual hydraulic appliances—and this applies not only to the training and elevating of the large guns, but also for the ammunition hoists, &c.

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The Electrician.

(The Oldest Electrical Journal, 1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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'THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices.*

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SPECIAL NOTICE.

Owing to the growth of the electrical and allied industries the demands for space in "THE ELECTRICIAN" are, for the greater part of the year, so pressing that a permanent increase in the size of the journal has become necessary. To meet the increased cost involved by this step, and by other improvements, such as heavier paper and more numerous illustrations, the price of "THE ELECTRICIAN" has from May 3rd been advanced to 6d.

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POLYPHASE PATENT LITIGATION.

It has often been asked, Why has the transmission of power by polyphase currents made so little progress in this country, in comparison with its use on the Continent and in America? This difference cannot be wholly attributed to ignorance on the part of British manufacturing firms, nor even to a natural conservatism tinged with the feeling that the advantages of polyphase motors have been somewhat overstated. The cause of the delay in this country has, we think, to a large extent been due to the uncertainty that exists as to what claims would be made by the owners of certain patents, and as to the ground that they considered covered by those patents. British firms have hardly yet sufficiently recovered from the costs and expenses incurred in litigation over compound winding, over incandescent lamps, and over telephones, to wish again to embark without due consideration on the troubled waters of the law. Nor is that feeling unjustified in view of the position which affairs have now assumed in America. The Westinghouse Electric Company, which controls the patents and inventions of NIKOLA TESLA, have instituted suits against the General Electric Company of America, and against the Stanley Manufacturing Company, for alleged infringements of TESLA's patents, claiming, as their advertisements state, that these patents cover broadly any system of polyphase alternate current distribution of power. It is interesting to note, as showing how broad is the ground

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claimed, that neither in the "monocyclic" system of the General Electric Company, nor in the two-phase system of the Stanley Manufacturing Company, are the motors simple rotary field motors, but modifications which have the appearance of being expressly designed to avoid any claim on behalf of the owners of TESLA's patents. The results of these actions will be regarded with interest in Europe, as it is only to be supposed that if successful in America a similar line is likely to be taken in this country and elsewhere where TESLA's patents are in force. That this question is not lightly regarded by the owners of the TESLA patents is evident from the fact, that the valuation of the TESLA patents is said to have been the point at which the recently negotiated "combine," as to patents, between the General Electric Company and the Westinghouse Company, came to a deadlock.

The ground on which the priority of TESLA's patents is likely to be contested, is probably the, till recently, forgotten rotary field motor of BAILY (1879), and the motors of FERRARIS; but these do not appear to entirely touch the issue. In the first of these the rotary field was produced by commutating a continuous current; in the second, by splitting a single-phase alternating current into two phases by proper arrangements of self-induction or condensers. This is a different thing from the reproduction in a motor of a rotating magnetic field, the image or reflection if the term may be used, of an existing rotating magnetic field, produced in a dynamo with multiple coils, connected to similar coils in the motor. This is the kernel of TESLA's inventions, and it remains to be seen whether his patents of 1888 will withstand the fire to which they will now be exposed. The Westinghouse Company, in any case, can claim little credit for the practical introduction of polyphase motors, for whilst the patents date back to 1888, for some years after this no definite information as to the results that had been obtained by their use was forthcoming, whilst even as late as 1894, the current lists of the Westinghouse Company, only described and showed their use, like FERRARIS' motors, on single phase transmission plants for starting up synchronous motors. The credit of showing what it is possible to effect with polyphase transmission will always be connected with the names of C. E. L. BROWN and DOLIVO-DOBROWOLSKI. It is to be hoped, in the interests of all parties, that this question will be settled shortly and decisively, as until its conclusion a cloud will necessarily hang over a system which, in many cases, may prove of considerable value.

Meanwhile it is interesting to note what is the real position now to be assigned to polyphase power transmission and distribution, in what respects it is superior to continuous current systems, in what respects it is inferior. The answer in general terms is this, where the transmission or distribution is satisfied by motors running at a constant speed, and not requiring a turning moment greater than, say, 50 per cent. above the full load running moment, no system can beat the polyphase, either in economy in first outlay, simplicity of working or efficiency. But where variations of speed are required, or a largely increased turning moment is necessary, either at starting or when running, polyphase plant is not applicable. Great loss of efficiency always occurs when a polyphase motor revolves at a speed differing considerably from the speed of the revolving field, and the turning moment appears at any speed to have a maximum beyond which a reduction of speed decreases instead of increasing it, thus producing instability. These generalisations omit the consideration of the possibility of using higher pressures owing to the power of transforming alternating currents with simple apparatus. It may, therefore, be taken that with polyphase motors as at present made, they will be used for transmission of power in manufacturing, but for mining, for traction, for lifts, and analogous purposes, continuous current machinery may be expected to hold its own.

NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(Continued from page 231.)

44. **Loop Tests.**—Where duplicate cables exist, a fault in either one of them can be localised with considerable accuracy by one of the loop tests. The faulty cable is joined or looped to the good cable at one end, thus forming one continuous circuit. There are, therefore, two cable ends at the testing station to put on to the bridge.

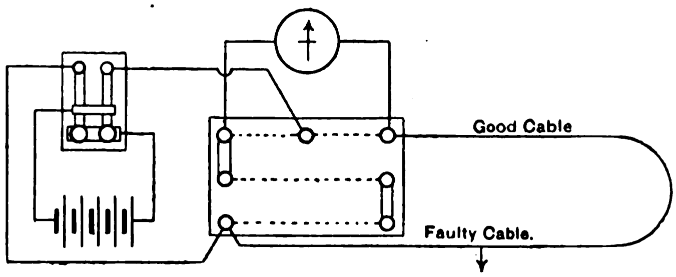

FIG. 124.—Metallic Circuit.

In Varley's loop test the end of the faulty cable is joined to the earth terminal of the bridge, and the end of the good cable to the line side. The metallic circuit is first measured—that is, the copper resistance of the looped cables, irrespective of the presence of a fault. For this test the earth side of the key is connected to the bridge (as in Fig. 124), instead of to earth, so that the fault does not form part of the circuit tested. The earth side of the key is then disconnected from bridge and put to earth (Fig. 125), and a set of readings taken with zinc and copper. The fault being in the battery circuit, no change in its resistance affects the result. The resistance unplugged, added to that of the short length of cable up to fault, is equal

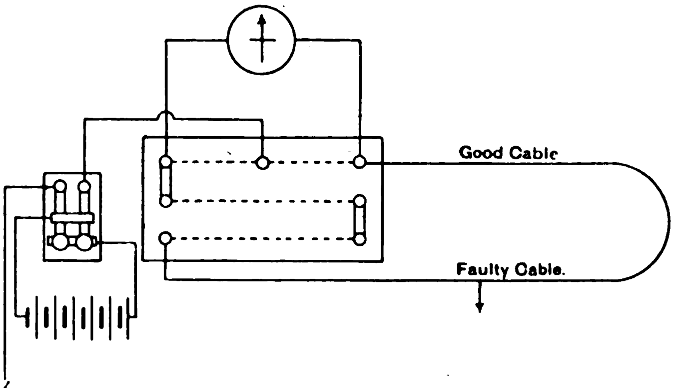

FIG. 125.—Varley Loop.

(when balance is obtained with an even ratio in the bridge) to the resistance of the rest of the cable. That is, the resistance is equal on each side of the fault, and the distance of the fault in ohms is, therefore, half the difference between the resistance of the looped cables (or metallic circuit) and the unplugged resistance.

In Murray's method the cable ends are connected direct to the bridge ratios without an added resistance. One of the bridge ratio coils is usually fixed and the other adjusted to balance. The only changes from the Varley connections are to reverse the cable ends, and shift one connection of the galvanometer and one of the keys. We then have the connections shown in Fig. 126, the fixed arm *a* being a low resistance (usually the 10-ohm coil), on account of being next the shorter length of

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cable to the fault. If μa is the resistance unplugged in the box to balance, we have the distance of fault in ohms equal to—

$$\frac{\text{Metallic circuit resistance}}{\mu + 1}.$$

Thus, with a metallic circuit of say 6,250 ohms (measured as in Fig. 124), the arm a 10 ohms, and the unplugged resistance say 1,240 ohms, we have $\mu = 124$, and distance to fault—

$$\frac{6{,}250}{125} = 50 \text{ ohms.}$$

Duplicate cables, when in good repair, should be periodically looped and tested, in order to keep a record of the position of the "resultant fault," as a correction can then be applied to the determined position of an actual fault. With the high resistance faults now prevalent this correction should be applied

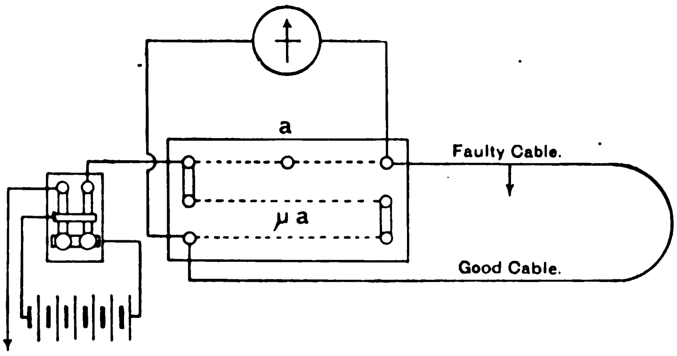

Fig. 126.—Murray Loop.

where possible. Kempe embodies this correction in the following formula* :—

$$\text{True distance of fault} = \frac{\beta P - a I}{P - I},$$

where β = distance in ohms of fault, as determined in ordinary way by loop test,
a = distance of resultant fault from same end of looped cables,
P = insulation resistance of looped cables at the time resultant fault was determined,
I = insulation resistance as lowered by presence of fault.

The above may be simplified by calling n the ratio of $\frac{P}{I}$, when true distance of fault $= \frac{\beta - a}{n - 1}$ ohms.

For example, suppose the resultant fault to be 3,200 ohms distant, and the apparent distance of the fault determined by the loop to be 2,700 ohms ($\beta - a = 500$); also that the insulation was 1,185,000 ohms at the time the resultant fault was determined, and 100,000 ohms when the fault came in. Then $n = 1{\cdot}185$, and true distance $= \frac{500}{0{\cdot}185} = 2{,}740$ ohms. In looped cables of perfect or uniform insulation throughout, the resultant fault is situated in the centre, where the cables are joined; but when a fault is present the location of the resultant is shifted from the centre towards the faulty side.

45. Tests of Cable in Tank.—After a repair there are a number of short lengths to be spliced up and tested. The piece containing the fault is coupled up to the test room, and the position of fault located. The faulty piece is then cut out, labelled, and kept for reference. The measurements on these short lengths are very low, and consequently low resistances have to be used in the bridge arms for the various free and earth tests described above. The loop test is specially applicable to the location of faults in short pieces, and the following two methods have been devised to give conditions of maximum sensitiveness.

Mr. Kingsford has proposed a second observation of the Varley loop, with cable ends reversed (*The Electrician*, Vol. IX). The connections are the same as in Fig. 125, using a bridge ratio of 10/1,000. The first observation gives

$$\frac{10}{1{,}000} = \frac{x}{A + y},$$

* "Handbook of Electrical Testing," p. 268.

and the second

$$\frac{10}{1{,}000} = \frac{y}{B + x},$$

where x is the distance in ohms to the fault from one end, y that from the other, and A and B the resistances unplugged to balance in each observation.

From the above expressions we have

$$x = \frac{100\,A + B}{9{,}999} \text{ ohms,}$$

and

$$y = \frac{B + x}{100} \text{ ohms.}$$

In J. J. Allen's modification of the Murray loop the usual places of the galvanometer and battery are interchanged, and

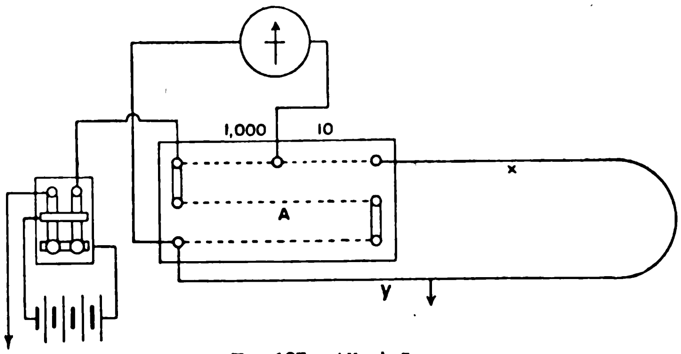

Fig. 127.—Allen's Loop.

a ratio of 10/1,000 is used (*The Electrician*, Vol. XV., page 350). With the cable ends as in the illustration (Fig. 127) we have

$$\frac{x + 10}{1{,}000} = \frac{y}{A},$$

and on reversing the cable ends we have

$$\frac{y + 10}{1{,}000} = \frac{x}{B};$$

whence

$$x = \frac{10\,B\,(A + 1{,}000)}{1{,}000{,}000 - A\,B},$$

and

$$y = \frac{(10 + x)\,A}{1{,}000}.$$

Cable coiled in a tank possesses self-induction—that is, a magnetic field is set up within the coils upon a current being sent through the cable, which retards the starting, stopping, or

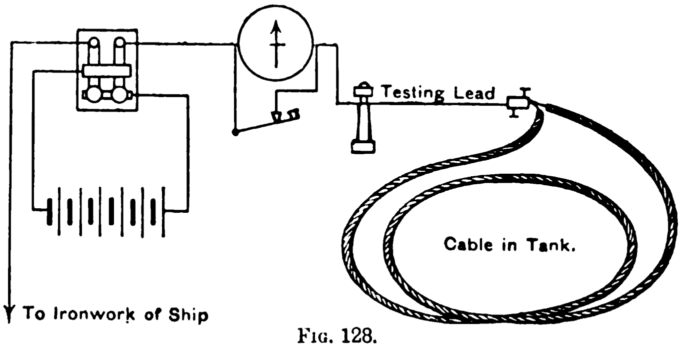

Fig. 128.

any change in strength of that current. This field is set up in all straight wires and cables through which currents are passed; but, as is well known, the magnetic effect is inappreciable and negligible. When the cable is coiled, however, the magnetic field is intensified by every turn of the cable, and also by the iron of the tank. The effect on the bridge is that, when first the current is applied, the resistance measured appears higher than its true value, because the E.M.F. of self-induction opposes the current like a resistance. As the current is kept on the opposing E.M.F. gradually falls to zero, the current rising the while to its full value. It is therefore necessary to wait till the current has been on for a few seconds, especially when testing long lengths, before finally

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adjusting the resistance to balance. Even if the correct resistance has been unplugged in the bridge, and then the current put on, and the galvanometer key opened too soon, the deflection will show "more resistance wanted." This deflection will, however, creep back to zero in a second or two.

The effect is just the opposite to that experienced with laid cables. There the electrostatic effect predominates, and the current on first being applied rushes into the cable (on account of its electrostatic capacity) with great strength, making the resistance appear less than it actually is. If the galvanometer key is opened too soon there is a deflection indicating "less resistance wanted." This deflection comes back to zero in a few seconds like that due to self-induction mentioned above, and in both cases the balance is only correct when taken some few seconds after the current has been on.

Another disturbing effect on board ship is the current set up in the cable in tank due to the rolling of the ship. This makes good copper resistance tests difficult to obtain, and it is next to impossible to obtain good results with discharge tests on cable in tank. In tanks on shore there is only the self-induction effect to take into account, which is completely got over by allowing a few seconds before opening the galvanometer as described above; but when the tank and cable are rolling about at sea there are disturbing currents produced in the cable due to its moving relatively to the earth's magnetic field. In fact, it is well known that cable in tank tests much steadier on shore than at sea.

When testing for insulation resistance the effect may be got over by the simple expedient of taking both ends of the cable to the bridge, as in Fig. 128. The current then enters the cable in opposite directions, and no magnetic field is produced, and there is also no self-induction.

(To be continued.)

POLYPHASE MOTOR CALCULATIONS.*

BY HERMANN CAHEN.

Practical applications of the three-phase current to motors has recently been very much extended; but, in spite of that, the theory still presents numerous deficiencies. This may, in a great measure, be assumed, that the practical experiences of alternate-current plants in many cases are directly to be transferred to the three-phase current. On the other hand, particular details are still wanting on finished plants, without which the completion of a theory cannot be carried out. The most modern works in this branch are those of Dr. Behn-Eschenburg (No. 13) and of A. Heyland (No. 41 of the *Electrotechnische Zeitschrift*, 1894). In the former work it is proved, as in many other works on the alternate current, that the purely analytical mode of reckoning leads to little obvious results. The second treats the problem in a purely graphical way. Here the survey of the results certainly leaves nothing to be desired; but an analytical treatment is only possible when the results are expressed in the most simple terms.

In the following we will, therefore, endeavour to combine both methods, as it were, together. The diagrams are to be used for the derivation of more simple and handy formulæ, which allow of a calculation of the proportions of work of the motor.

We assume that all variables follow the sine law, and apply the following expressions:—

p_1 = Frequency of the exciting current (equal to the angular speed of the rotary field).
p_2 = Angular speed of the armature.
c_1 and c_2 = Number of spools of the exciting and armature systems respectively.
w_1 and w_2 = Number of windings in each spool of the exciting and armature systems respectively.
r_1 and r_2 = Resistance of one spool of the exciting and armature systems respectively.
E_1 and E_2 = Total electromotive force of the exciting and armature systems respectively.
I_1 and I_2 = Current of the exciting and armature systems respectively.
W_1 and W_2 = Supplied and useful energy respectively.
V_1 and V_2 = Loss in the exciting and armature systems respectively.
N_1 and N_2 = Number of lines of force of the exciting and armature systems respectively.
$E = w_1 p_1 N_1$ = Induced counter-electromotive force in the exciting current.
S = Angle of lag between E_1 and I_1.
$\frac{\pi}{2} + \psi$ = Angle of lag between I_1 and I_2.
L_1 and L_2 = Coefficients of self-induction.
M_1 and M_2 = Coefficients of mutual induction.
$\gamma = \frac{W_2}{W_1}$ = Efficiency of the motor.
z = Torque of the motor.

L_1 and M_1 shall be so defined that an exciting polyphase current, I_1, produces a rotary field equal to $\frac{L_1}{w_1} I_1$ lines of force in the exciting system, and equal to $\frac{M_1}{w_1} I_1$ lines of force in the armature. (In the same way L_2 and M_2.)

Then the following relations occur:—

$$L_1 : L_2 = c_1 w_1^2 A_1 : c_2 w_2^2 A_2.$$
$$M_1 : M_2 = c_1 : c_2.$$
$$M_1 M_2 = (1 - \sigma) L_1 L_2.$$

Here σ has a value which depends upon the waste field, while A_1 and A_2 are determined by the construction of the motor and only differ very little from each other.

In the following we may put approximately $A_1 = A_2$, and regard the values L, M and σ as constant.

The rotary field caused by the current I_1 and having the angular speed p_1 induces in the armature a polyphase current with the period $p_1 - p_2$. The latter produces in the armature a rotary field with a speed $p_1 - p_2$, and if we add to this the speed p_2 of the armature, we shall again get p_1 as the resulting speed for the induced rotary field.

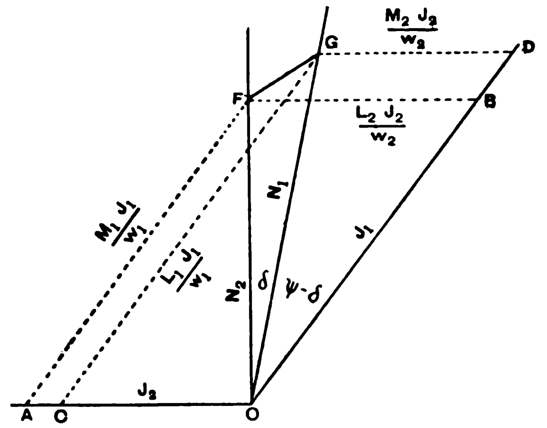

FIG. 1.

Both fields, which rotate with the same velocity, adjust themselves to the actual existing field. The latter consists, therefore, of:—

(1) The number of lines of force N_1 in the exciting system; (2) the number of lines of force N_2 in the armature, and (3) the waste field $N_1 - N_2$.

Fig. 1 shows the diagram for these expressions. In the diagram it is as follows:—

$$O A = \frac{L_2 I_2}{w_2}$$

and

$$O B = \frac{M_1 I_1}{w_1},$$

$$O F = N_2;$$

further

$$O C = \frac{M_2 I_2}{w^2} = O A \sqrt{1 - \sigma},$$

and

$$O D = \frac{L_1 I_1}{w_1} = \frac{O B}{\sqrt{1 - \sigma}},$$

$$O G = N_1,$$
$$O F = N_2,$$
$$F G = N_1 - N_2.$$

If we call the angle between N_1 and N_2 δ, we shall still get the following references—

$$\tan \psi = \frac{(p_1 - p_2) L_2}{r^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$\tan \delta = \sigma \tan \psi \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$\frac{N_2}{N_1} = \cos \delta \sqrt{1 - \sigma} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The rotary field in the armature is then, owing to the loss of lines of force, distorted in reference to the exciting field as much

* From the *Electrotechnische Zeitschrift*, January 24, 1895.

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as δ. The introduction of the angle δ contributes much to the simplification of the formulæ.

Fig. 2 shows in a well-known way the decomposition of the exciting E.M.F. E_1 in the induced counter E.M.F. $E = p_1 w_1 N_1$ and $I_1 r_1$. We take from this the references of the so-called "empty current" (or "wattless current") and the useful current (or "watt current"). The first falls with the direction of the lines of force N_1 together, whilst the second stands perpendicular to it.

Wattless current:

$$I_1 \cos(\psi - \delta) = \frac{E_1}{r_1} \cos(\psi - \delta + \phi).$$

Useful current:

$$I_1 \sin(\psi - \delta) = \frac{M_2}{L_1} I_2 \cos \delta = \frac{c_2 w_2 N_2}{c_1 w_1 N_1} \cdot I_2.$$

(Refer to (3).)

By aid of these references, the proportions of work of the motor are represented as follows:—

The energy to be spent for the overcoming of the counter E.M.F. in the exciting system is

$$c_1 p_1 w_1 N_1 \times \text{useful current} = c_1 p_1 w_1 N_1 I_1 \sin(\psi - \delta),$$

that would be, according to the former,

$$= c_2 p_1 w_2 N_2 I_2.$$

The last expression then represents all the quantity of energy absorbed by the armature.

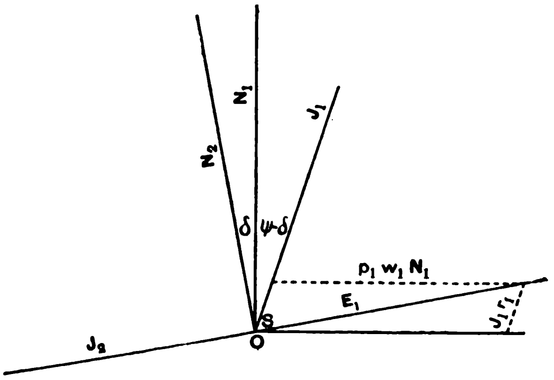

FIG. 2.

The heat in the armature due to the current is

$$c_2 E_2 I_2 = c_2 (p_1 - p_2) w_2 N_2 I_2.$$

If we subtract the latter from the supplied energy, the useful mechanical effect remains equal to

$$c_2 p_2 w_2 N_2 I_2.$$

The above, put together, gives:—

1. Supplied energy:
$$W_1 = c_1 E_1 I_1 \cos \phi.$$
2. Loss in the exciting system due to the current heat:
$$V_1 = c_1 I_1^2 r_1.$$
3. To the armature-system transmitted energy:
$$W_1^1 = c_1 (E_1 I_1 \cos\phi - I_1^2 r_1) = c_2 p_1 w_2 N_2 I_2.$$
4. Loss in the armature, due to current heat:
$$V_2 = c_2 I_2^2 r_2.$$
5. Useful energy:
$$W_2 = c_2 p_2 w_2 N_2 I_2.$$

Through a simple transformation of these formulæ, we get

$$\frac{W_1^1}{W_1} = \gamma' = \tan(\psi - \delta) \tan\phi,$$

$$\frac{W_2}{W_1^1} = \gamma'' = \frac{p_2}{p_1},$$

and, consequently, the efficiency of the motor:

$$\frac{W_2}{W_1} = \gamma' \gamma'' = \gamma = \frac{p_2}{p_1} \tan(\psi - \delta) \tan\phi. \quad . \quad . \quad . \quad (4)$$

Expressed in words: The relation between the loss in the armature, due to the heat, and the energy transmitted to it, is equal to the slipping of the motor, *i.e.*,

$$\left(= \frac{p_1 - p_2}{p_1}\right).$$

The last is most important, because it is to be applied for any polyphase motor with changeable permeability and hysteresis. In order to prove this, we regard the useful work of the motor to be a product of the angular speed p_2, and the torque Z (referred to the radius = 1). These are determined from the electrical and magnetic properties as follows:—

Let us consider the rotary field, which rotates with the velocity p_1 to be stationary, whilst the armature revolves with the velocity $(p_1 - p_2)$. Hereby must not only the same torque take place as in the motor, but the electrical and magnetic phenomena are the same. The heat V_2 produced in the armature, coming from currents or magnetic friction, is in all cases equal to the mechanical energy, which is able to turn the armature against the torque Z with the velocity $(p_1 - p_2)$; thus

$$V_2 = (p_1 - p_2) Z.$$

Now $\qquad W_2 = p_2 Z.$

thence, $\qquad \dfrac{V_2}{W_2} = \dfrac{p_1 - p_2}{p_2}$

as above.

Hence, it is at the same time proved that for any polyphase motor the efficiency must always be less than $\frac{p_2}{p_1}$.

If we call the loss due to hysteresis H, we get as a general valid formula

$$\gamma = \frac{p_2}{p_1} \cdot \frac{W_1 - I_1^2 r_1 - H}{W_1}. \quad . \quad . \quad . \quad . \quad . \quad (5)$$

For the experimental determination of γ, only one watt-meter and one ampere-meter are needed, because we only need to know H approximately, which can be calculated from the dimensions and properties of the iron.

We had for the useful energy

$$W_2 = c_2 p_2 w_2 N_2 I_2,$$

or after some transformations

$$W_2 = p_2 \frac{c_1 w_1^2}{L_1} N_1^2 \frac{\sin 2\delta}{2\sigma} (1 - \sigma).$$

Thus for the torque

$$z = \frac{c_1 w_1^2}{L_1} N_1^2 \frac{\sin 2\delta}{2\sigma} (1 - \sigma) \quad . \quad . \quad . \quad . \quad . \quad (6)$$

We can now, as may be shown further on, for good motors with constant tension at the terminals, also consider N_1 to be constant. Then the torque will have its maximum when $\delta = 45$deg. If we denote the maximum value by z_m, then we will get for another load,

$$\frac{z}{z_m} = \sin 2\delta \quad . \quad . \quad . \quad . \quad . \quad . \quad (6a)$$

Hence $\sin 2\delta$ represents the magnitude of the torque.

It remains now to observe the different expressions in their relation to the velocity p_2.

When running light, p_2 is only a little smaller than p_1. Thus ψ and δ are very small. I_1 would, in the diagram, theoretically fall nearly together with N_1 and N_2. In reality the difference is, owing to hysteresis, considerably larger.

ϕ is approximately equal to $\frac{\pi}{2}$.

If the load increases, p_2 decreases, ψ and δ increase in proportion

$$\frac{\tan\delta}{\tan\psi} = \sigma;$$

therefore δ increases more rapidly than ψ. The angle ϕ decreases at first, until it is a minimum at about normal load, although it is to be noticed that it never can be so small as in an alternate-current transformer, where, as it is known, ϕ, from a certain load, is practically equal to 0. A polyphase motor will always cause a noticeable lag between the volts and current, and this occurs on account of the proportionately large angle δ of the waste field.

We will now examine more closely these relations, with examples. For that purpose we observe the motor at the following characteristic loads:—

1. Light running.
2. The efficiency γ is a maximum.
3. The efficiency γ^1 of the exciting spools is a maximum (see equation (4)).
4. The lag between E_1 and I_1 is a minimum, *i.e.*, $\cos\phi$ is a maximum.
5. The useful work W_2 is a maximum.
6. The torque z is a maximum.
7. Starting.

For these seven loads we get the following values of $\tan\psi$, the derivation of which we leave out; it must, however, be observed that these are only theoretical values, *i.e.*, the losses in the iron are not taken into consideration:—

1. Light running:
$$\tan\psi_1 = 0.$$
2. γ = maximum:
$$\tan\psi_2 = -\frac{1}{\mu} + \sqrt{\frac{1}{\mu^2} + \frac{p_1 L_2}{r_2} \cdot \frac{1}{\mu}},$$

where $\qquad \mu = p_1 \left\{ \frac{L_2}{r_2} + \frac{L_1}{r_1} (1 - \sigma) \right\}.$

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3. γ' = maximum:

$$\tan\psi_3 = 1.$$

4. Cos ϕ = maximum:

$$\tan\psi_4 = \frac{1}{\sigma}\cdot\frac{r_1}{p_1 L_1} + \sqrt{\frac{1}{\sigma^2}\cdot\left(\frac{r_1}{p_1 L_1}\right)^2 + \frac{1}{\sigma}}.$$

5. W_2 = maximum:

$$\tan\psi_5 = -\frac{1}{\sigma^2}\cdot\frac{r_2}{p_1 L_2} + \sqrt{\frac{1}{\sigma^4}\cdot\left(\frac{r_2}{p_1 L_2}\right)^2 + \frac{1}{\sigma^2}}.$$

6. z = maximum:

$$\tan\psi_6 = \frac{1}{\sigma}.$$

7. Starting:

$$\tan\psi_7 = \frac{p_1 L_2}{r_2}.$$

For all seven occurrences, of course, after formula (1) there holds:—

$$\tan\psi = \frac{(p_1 - p_2) L_2}{r_2}.$$

These seven equations now show a constant increasing of $\tan\psi$ from 0 to the maximum value $\frac{p_1 L_2}{r_2}$. In reality, however, the values of $\tan\psi$ in the readings (1) and (2) have another position. For the light running, $\tan\psi > 0$, due to the friction in the bearings. Further, after formula (2) $\tan\psi_2$ must always be smaller than 1, and this corresponds, as will be seen from figures further on, to a small load. Thus, the influence of the inner and outer friction is proportionally large, causing the value of γ to be reduced, so far that (2) nearly coincides with (4). The other formulæ only change a little, so that we get, as a rule, for a useful motor, that the load (4) is the normal, and further that the maximum load (5) shall not be too far from the latter, as then the decreasing of the efficiency and of $\cos\phi$ would be too great. Finally, it is desirable, but not always necessary, that the torque at the starting be not too small.

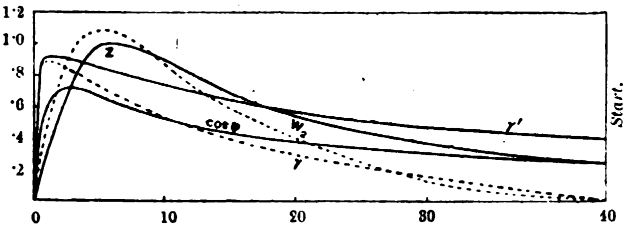

Fig. 3.

The last point is most simply obtained. Namely (formula (6a))

$$\frac{z_7}{z_m} = \sin 2\delta_7,$$

and (formula (2))

$$\tan\delta_7 = \sigma\tan\psi_7 = \frac{\sigma p_1 L_2}{r_2}.$$

If we now suppose that σ is limited between 0·2 and 0·4, it is easy to calculate how great $\frac{p_1 L_2}{r_2}$ must be in order that at starting the torque is a certain part of the maximum torque. If, for for example, it be equal to the maximum torque, so must

$$\tan\delta_7 = 1,$$

and

$$\frac{p_1 L_2}{r_2} = \frac{1}{\sigma}\ (=5 \text{ to } 2{\cdot}5).$$

It is now easy to show that such a consideration would lead to a very unpractical motor, as we know that the efficiency γ is always smaller than $\frac{p_2}{p_1}$. If we now suppose that the normal load coincides with (4), *i.e.* (cos ϕ equal to maximum), and we consider that generally speaking

$$\frac{p_2}{p_1} = 1 - \frac{\tan\psi}{\tan\psi_7},$$

then we shall get for the normal load

$$\frac{p_2}{p_1} = 1 - \frac{\tan\psi_4}{\tan\psi_7}.$$

Now (4) shows that approximately

$$\tan\psi_4 = \frac{1}{\sqrt{\sigma}}.$$

Thus we should get for the normal load

$$\gamma < 1 - \sqrt{\sigma}$$
$$< 0{\cdot}55 \text{ to } 0{\cdot}37.$$

With the object of getting a good efficiency, the torque at starting must not be too large. We now see from this that the state of the motor in reality is determined from both expressions σ and $\frac{p_1 L_2}{r_2}$. Still more distinctly is this to be seen from the following curves (Figs. 3 and 4). These are constructed on a free assumed scale and for the following relations:—

Fig. 3:

$$\sigma = 0{\cdot}17, \quad \frac{p_1 L_2}{r_2} = 43{\cdot}6, \quad \frac{p_1 L_1}{r_1} = 30{\cdot}8.$$

Fig. 4:

$$\sigma = 0{\cdot}24, \quad \frac{p_1 L_2}{r_2} = 30{\cdot}8, \quad \frac{p_1 L_1}{r_1} = 30{\cdot}8.$$

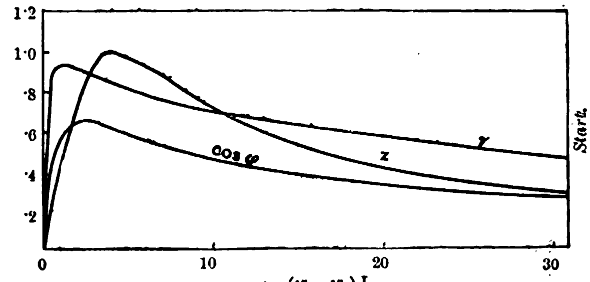

Fig. 4.

For the construction of the curves, a free-chosen value of $\tan\psi = \frac{(p_1 - p_2) L_2}{r_2}$ is at first taken.

Then it was successively placed:

$$\gamma' = \frac{1}{1 + \left(\frac{r_1}{p_1 L_1}\right)\frac{1 + \tan^2\psi}{(1-\sigma)\tan\psi}};$$

$$\frac{p_2}{p_1} = 1 - \left(\frac{r_2}{p_1 L_2}\right)\tan\psi;$$

$$\gamma = \frac{p_2}{p_1}\gamma';$$

$$\tan\delta = \sigma\tan\psi;$$

$$z = z_0 \sin 2\delta;$$

$$\cot\phi = \frac{\tan(\psi - \delta)}{\gamma'};$$

$$\frac{p_1 w_1 N_1}{E_1} = \frac{E}{E_1} = \frac{\sin\phi}{\cos(\psi - \delta)}$$

The values of the loads 2, 4, 5, 7, are now collected as follows:

Fig. 3.

—	2 γ = max.	4 cos ϕ = max.	5 W_2 = max.	7 Starting.
$\frac{p_2}{p_1}$	0·98	0·94	0·88	—
tan ψ	0·675	2·62	5·17	43·6
tan δ	0·115	0·445	0·877	7·41
γ'	0·92	0·90	0·83	—
γ	0·91	0·87	0·73	—
cos ϕ	0·49	0·75	0·68	0·[illegible]5
sin 2 δ	0·22	0·74	0·99	0·25
$\frac{E}{E^1}$	0·99	0·95	0·93	0·93

Fig. 4.

—	2 γ = max.	4_1 cos ϕ = max.	5 W_2 = max.	7 Starting.
$\frac{p_2}{p_1}$	0·98	0·93	0·88	—
tan ψ	0·76	2·18	3·68	30·8
tan δ	0·18	0·52	0·87	7·41
γ'	0·91	0·90	0·86	—
γ	0·69	0·84	0·75	—
cos ϕ	0·49	0·65	0·62	0·30
sin 2δ	0·35	0·82	0·99	0·25
$\frac{E}{E_1}$	0·99	0·96	0·95	0·96

In the diagrams two kinds of curves are distinguished. The first (γ', z, and cos ϕ) are full lines, these are not affected from

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the position of the starting line; the second sort (γ, W_2 and W_1, shown dotted) depend mostly upon this. If the starting line is shifted to the left, then the torque at starting is larger, but the efficiency for normal load smaller (*i.e.*, $\cos\phi$ = maximum). At the shifting to the right, the contrary takes place. In both diagrams the assumption was, that the torque at starting was a quarter of the maximum; this seems still to be too much for the attainment of a good efficiency. The torque at starting is, however, due to hysteresis, in reality a little larger.

Fig. 5 shows the curves of Fig. 3 to an enlarged scale, and embraces about that part which comes into question when using the motor.

The hysteresis changes the curves, especially in the beginning. γ is, as already noticed, somewhat lowered, and reaches the maximum value later than theory dictates. The values of $\cos\phi$, on the contrary, are, especially in the beginning, somewhat larger. The maximum load coincides nearly with the maximum torque.

The tables explain the influence of σ. It is true that, at an increasing waste field, $\cos\phi$ is smaller in relation to the efficiency, whilst, on the contrary, the torque at normal load increases. This is to be seen in the diagrams from the approaching of the normal and maximum loads.

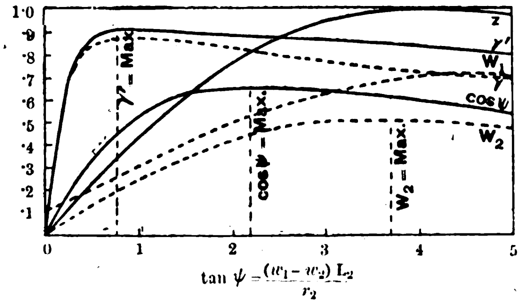

FIG. 5.

We will now describe an approximate way of fixing the lapse of the curves for any motor in advance. By this we only take into consideration the normal, maximum, and starting load.

In the first approximation we may now say:—

For the normal load, $\tan\psi = \frac{1}{\sqrt{\sigma}}$,

For the maximum load, $\tan\psi = \frac{1}{\sigma}$.

[NOTE.—This expresses in reality the maximal torque. If for the starting $\delta = \delta_\gamma$, then it is for the maximum load

$$\tan\psi = \frac{1}{\sigma}\tan(\tfrac{1}{2}\delta_\gamma)$$

to produce a high efficiency; δ_γ is, as a rule, nearly equal to $\frac{\pi}{2}$.]

For the starting load, $\tan\psi = \frac{p_1 L_2}{r_2}$.

We get, on this supposition, for the normal load

$$\gamma' \cot\phi = \frac{1-\sigma}{2\sqrt{\sigma}}$$

and

$$\frac{z \text{ norm.}}{z \text{ maxim.}} = \frac{2\sqrt{\sigma}}{1+\sigma}.$$

In the following table these values are put together:—

$\sigma =$	0·1	0·2	0·25	0·3	0·35	0·4
$\frac{z \text{ norm.}}{z \text{ maxim.}} =$	0·56	0·75	0·80	0·84	0·88	0·90
$\gamma' \cot\phi =$	1·42	0·895	0·75	0·64	0·55	0·475
i.e., for γ' = 0·9 respectively for γ' = 0·8						
$\cos\phi =$	0·85	0·71	0·64	0·58	0·52	0·47
$\cos\phi =$	0·87	0·75	0·70	0·62	0·57	0·51

Since the efficiency is always smaller than γ', we see that a motor with a waste field $\sigma > 0·1$ already works under bad conditions, because either ϕ is too great or γ' too small. (In regard to this, the so-called one-phase motors are somewhat more profitable.)

We will now, by the aid of these formulæ, calculate a polyphase motor, which will produce normally 10,000 watts at an E.M.F. of 200 volts (eff.) and 50 periods. Thus,

$$W_2 = 10{,}000.$$

Experience teaches that by using machines of this type an efficiency of

$$\gamma = 0·83$$

and a coefficient of waste field

$$\sigma = 0·2$$

may be expected. The absorbed energy is thus

$$W_1 = \frac{W_2}{\gamma} = 12{,}000.$$

The motor may be constructed with two poles. The velocity is then

$$p_1 = 2\pi \,.\, 50 = 314.$$

In reality, we should choose about six poles for this; the method of calculation is, however, the same.

We assume now $\gamma' = 0·9$

if we allow 2 per cent. for hysteresis and friction, and 5 per cent. for slipping, thus:—

$$\frac{p_2}{p_1} = 0·95.$$

The former table shows now that for $\gamma' = 0·9$ and $\sigma = 0·2$,

$$\cos\phi = 0·71.$$

We now get the current

$$I_1 = \frac{\frac{1}{3} W_1}{E_1 \cos\phi} = 28·2 \text{ amperes (eff.)},$$

and the resistance

$$r_1 = \frac{E_1}{I_1}\cos\phi\,(1-\gamma') = 0{,}505\ \Omega.$$

Now we have

$$\gamma' = \frac{1}{1 + \left(\frac{r_1}{p_1 L_1}\right)\frac{1+\tan^2\psi}{(1-\sigma)\tan\psi}};$$

thus, in our example, as $\tan\psi = \frac{1}{\sqrt{\sigma}}$,

$$\frac{p_1 L_1}{r_1} = \frac{1+\sigma}{(1-\sigma)\sqrt{\sigma}} \cdot \frac{\gamma'}{1-\gamma'} = 30·3,$$

$$L_1 = 0·048 \,.\, 10^9.$$

We get, further, from Fig. 1

$$w_1 N_1 = L_1 I_1 \frac{\cos\psi}{\cos\delta},$$

or, as we here have

$$\tan\psi = \frac{1}{\sqrt{\sigma}} \text{ and } \tan\delta = \sqrt{\sigma}$$

$$w_1 N_1 = L_1 I_1 \sqrt{\sigma} = 0{,}615 \,.\, 10^8.$$

We had, of course, been able to find this value direct from the formula

$$p_1 w_1 N_1 = E_1 \frac{\sin\phi}{\cos(\psi - \delta)}.$$

We get a controller for the calculation in the expression

$$p_1 w_1 N_1 = E,$$

as this is only allowed to differ from E_1 a few per cent. In fact

$$p_1 w_1 = N_1 = 193.$$

The last formulæ have only a partial practical value, as it may be impossible to determine with sufficient accuracy the dimensions of the iron frame from the expressions L_1, r and $w_1 N_1$ in connection with a supposed permitted induction (about 4,000 to 8,000). This occurs still more in the construction of the armature. We, however, can always get a datum about the relation $L_1 : L_2$.

From

$$\tan\psi = \frac{(p_1 - p_2) L_2}{r_2}$$

we have

$$\frac{p_1 L_2}{r_2} = \frac{1}{\sqrt{\sigma}} \cdot \frac{p_1}{(p_1 - p_2)} = 44·7.$$

This is, however, to be considered as an entirely approximate value; as if the slipping, for instance, changes only 1 per cent., then the changing of $\frac{p_1 L_2}{r_2}$ already reaches 20 per cent.

We get a better datum if we consider the torque at starting. This may be one-fifth of the maximum, or (as the normal torque is 0·75 of the maximum) equal to 0·27 of the normal.

Thus it is for starting,

$$\sin 2\delta = 0·2,$$

$$2\delta = 168°$$

(2δ must, of course, lie in the second quadrant),

$$\delta = 84°,$$

$$\frac{p_1 L_2}{r_2} = \tan\psi = \frac{1}{\sigma}\tan\delta = 44·6.$$

As this differs only 6 per cent. from the former calculated value, this consideration is in agreement with the above. If we had arrived at a more serious difference, we should have been obliged to calculate the motor afresh, for a slipping, corresponding to the new value.

For controlling, the expressions for the motor at maximum load are now to be determined.

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The results obtained thus far are as follows :—

$$W_1 \max = 16{,}500 \text{ watts},$$
$$W_2 \max = 12{,}000 \quad ,,$$
$$I_1 = 43{\cdot}7 \text{ amp.},$$
$$\gamma' = 0{\cdot}825,$$
$$\gamma = 0{\cdot}725,$$
$$\frac{p_2}{p_1} = 0{\cdot}88,$$
$$\cos\phi = 0{\cdot}63.$$

Besides, we get the current at starting

$$I_1 = 63{\cdot}5 \text{ amp},$$

and $\cos\phi = 0{\cdot}25.$

Thus, the absorbed energy at starting

$$W_1 = 9{,}500 \text{ watts}.$$

By this example I hope to have proved the usefulness of the formulæ.

ELECTRIC WELDING IN BOILER REPAIRS.

Speaking in the discussion of a Paper on "The Application of the Electric Arc to Machinery and Boiler Repairs," which was read a short time ago at the North-East Coast Institution of Engineers and Shipbuilders, by Mr. Henry Foster, Mr. Mountain gave some interesting and useful particulars of this branch of electrical industry. The Bernardos process, he considered, was handicapped by the heavy royalty charged by the firm now holding the patents, but he stated that this firm were now offering very much more favourable conditions. From his own experience he had found for welding, or in other words, melting up defects in steel castings, and also for repairing forgings, &c., that it was impossible to do good work with a current of less than 300 amperes, and to cope with whatever work might crop up in a steel foundry he considered that the dynamo should be capable of giving 500 amperes at the very least. He was quite sure if dynamos of this size were used instead of the machines for 100 or 150 amperes, which were put down in some of the steelworks in Sheffield and elsewhere, that they would not hear of the defects in the heating which were so frequent. If a small machine giving a current of only, say, 150 amperes, were used, it was impossible to get sufficient heating effect to more than just locally heat the spot where the current was applied; but having a larger current the heat was spread all round the defect, with the result that a solid weld or melt was obtained. In Sheffield he saw an attempt being made at a works, to whom his firm had supplied a welding plant, to weld up the defects in a stern frame with their old plant, which gave 100 amperes, and they might just as well have applied a match as attempted welding satisfactorily with the arc they obtained from the machine. He attempted some time since to weld up boiler flues prior to flanging, and they had a great difficulty in getting the steel to stand the flanging, as it was apparently to some extent burnt; and he gave a statement of some actual tests made upon welded wrought-iron boilers for greenhouses and for domestic purposes. The object in conducting these tests was to be able to ascertain whether the process was likely to supersede hand welding and the table would be interesting inasmuch as it gave pretty conclusively the length of steel which could be welded at a time, together with the time occupied in doing it.

Result of Tests made on June 11, 1892, in welding two Steel Boilers; thickness of steel, ⅜in.

Volts at battery.	Volts at arc.	Current in amperes.	Time of each heat.	Length heated in inches.
			Min.	
130	...	370	2	2
115	...	400	1½	3
120	...	350	1½	3
115	...	350	1¼	2½
113	75	350	1½	3
115	85	350	1½	3
118	65	250	1¼	2
122	85	300	1¼	2
122	85	350	1½	3
122	75	250	1½	last weld

Total length welded, 100in. in 85min., 1in. in 51sec.

Iron 5/16 thick.

116 ... 75 ... 300 ... 45sec. ... 2½

These tests proved pretty conclusively that to weld a steel plate ⅜in. thick required a current of not less than 300 to 350 amperes, whereas prior to the experiments being made it was considered that a current of 100 amperes could be employed.

He thought that some distinction should be made between what might be called electric melting and electric welding. To melt, it was only necessary to have an electromotive force of about 75 volts at the dynamo terminals, and of course a resistance must be placed in circuit to steady the arc; but to weld—that is to say, to join together two pieces of rolled or hammered steel or iron—it was necessary to have an electromotive force of 115 to 120 volts, and to have a very long arc, which could be used in the same way as a blow pipe, the arc being rapidly moved over the surface of the plate, so that it was not allowed to impinge for any length of time on one spot and melt the metal. He had found this to be necessary in connection with the plant which he supplied for electric welding of barrels, and the results had been very satisfactory. From his own experience he could most unhesitatingly state that if electric welding plants were made large enough, that is to say, that the current per arc was not less than 350 to 400 amperes, very excellent work could be done, and there was no doubt that the defects welded up in steel castings or in forgings repaired in this manner were a thoroughly good job; but it was nearly certain that when electrical plants were put down too small for the work a proper adhesion was not obtained between the casting and the piece of steel melted into it, and they then heard of the bad work that had caused this process to be condemned to a great extent by the Admiralty, &c.

THE JONAGE CANAL ELECTRIC SUPPLY WORKS.*

This undertaking was declared officially to be of public utility in the year 1893. A concession was granted for the carrying out of the works to the Société Lyonnaise des Forces motrices du Rhône, and the realisation of the enterprise had for its object the distribution in the city of Lyons and its suburbs of a force of 20,000 H.P. This powerful motive force was obtained at Cusset-Villeurbaune by drawing upon the resources of the Rhône. At the Exhibition of Lyons visitors had the opportunity of inspecting a plan in relief of the Jonage Canal, and numerous designs and drawings of the different works in connection with the whole scheme. It was M. I. Raclet, an engineer well known in Lyons, and the administrator of La Société Lyonnaise, who planned out the general lines and distinctive features of this important work. By the cut or deviation of a part of the Rhône at Jons, not only is the navigation improved, but a fall is provided near the Grand-Camp, which is capable of supplying to the industry of Lyons a minimum force 12,000 H.P. Many attempts had been previously made to establish canals of irrigation in connection with the Rhône on the up-stream boundaries of Lyons, but opposition founded, rightly or wrongly, upon the injury to the navigation, had always been too strong for them and their promoters. But the Jonage scheme, instead of injuring the navigation, greatly improves it for a distance of at least 10 miles, and maintains that portion of the river in a navigable condition the whole year round, even when the water is at its lowest. In an industrial point of view the great water power of the Rhône has been—similarly to the neglect of our own rivers—very little used in France, but in Switzerland, the town of Geneva, with a population of only 70,000, has very materially utilised a deviation or small branch of the same river in obtaining a fall affording a force of 2,500 H.P. The total length of the new Jonage cut is 11½ miles, and comprises three distinct parts. The first, or supply canal, takes off from the left bank of the Rhône opposite Jons. At this point in its course the river has a slight bend, and the levels of the bed of the river and of the bed of the canal have been so adjusted that all silting up will take place in the direction of the river channel and not in that of the canal. The discharge or escape canal has a total length of a couple of miles, and the width of both the supply and the discharge canal is nearly 200ft. About half way along the canal a compensating reservoir, containing a million and a-half tons of water, has been constructed. It possesses the especial advantage of always maintaining the water of the canal at a fixed level, so that if at any time the turbines threatened to lower the water level of the canal, a fresh supply would immediately flow in from the reservoir, and compensate for any slight temporary deficiency.

Among the more important works which characterise this enterprise now in progress, may be included the dam which regulates the discharge of the canal. At low water the minimum volume amounts to 22,500 gallons per second, which can be augmented to 33,750 gallons, when the supply from the Rhône equals 135,000 gallons. The dam consists essentially of a protective wall, having a total length of 456ft. The height of the wall is 33ft., and it is 8ft. wide at the top, which is carried up to a level of 3ft. above high water. In the dam itself circular openings are constructed, which are fitted with sluices of a circular section for the purpose of regulating the delivery. The apparatus for working the sluices is placed on the top of the wall. Attached to the wall of the dam is a lock, which at high water provides for a difference of level of

* Abstract from the *Engineer*.

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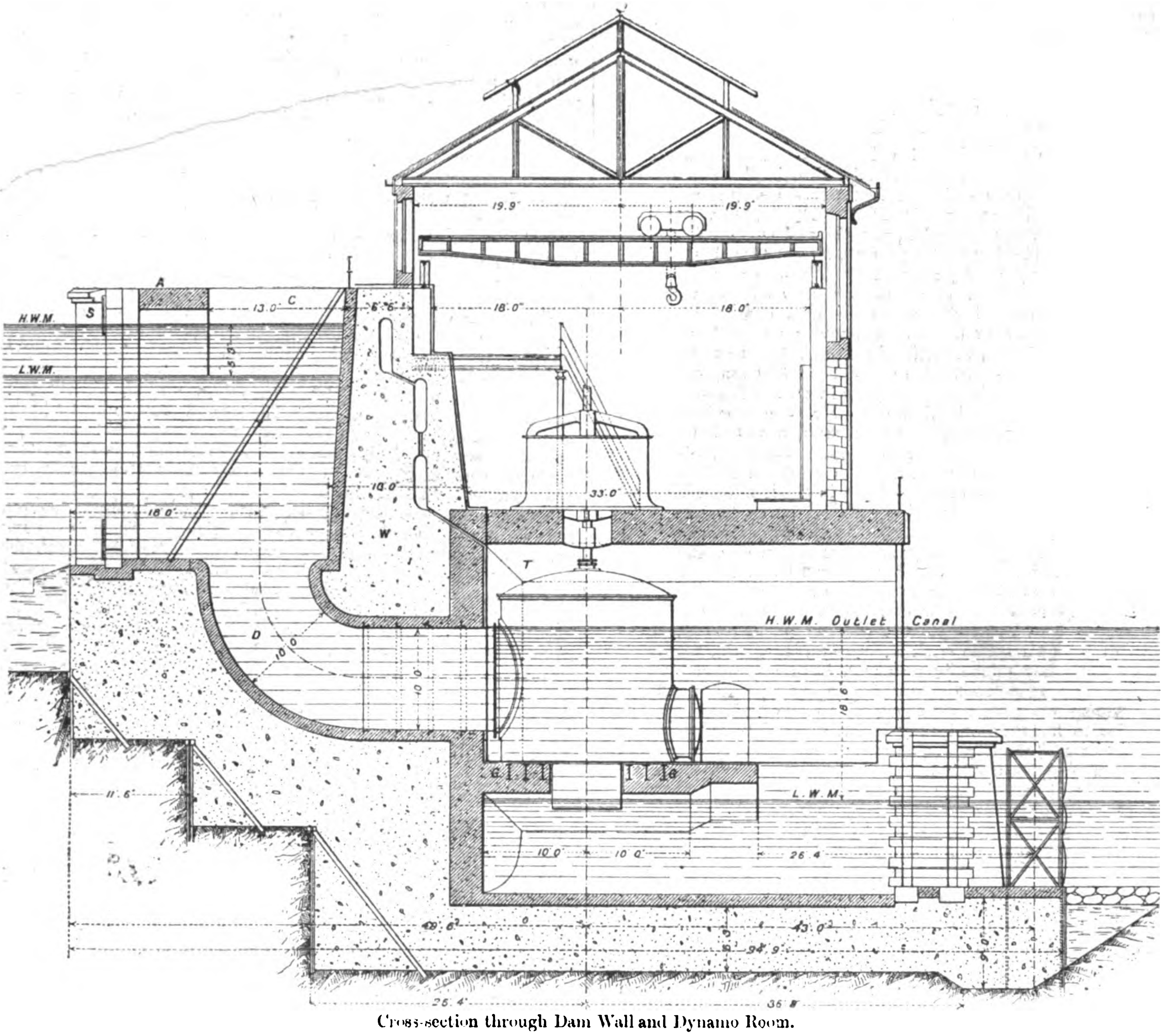
13ft. between the up and down stream faces of the work under notice.

The contract for the works was divided into two sections, one being allotted to MM. Vigner et Roux, and the other to MM. Audhert, Alméras et Jubin. On both sections the operations are carried on with the greatest activity. Dredgers and excavators are hard at work, and a couple of branch lines connect the site with the railway to Lyons, and bring the materials on the ground. Under ordinarily favourable conditions, the contractors expect to complete their engagements in the early months of 1897.

Another work in connection with this undertaking is of equal importance with that already described. It consists of a dam wall, the installation of dynamos, turbines, and the arrangements for collecting the water power, transmitting and utilising it. The installation provides for the employment of 20 units of 1,000 H.P. each. It consists chiefly of a retaining wall, which collects the water which passes into the turbine chambers. This wall abuts against the building wherein the turbines and dynamos are placed, as represented in the figure by W. In it are built the collecting or receiving chambers or recesses C. This figure is a cross-section through both the dam wall and dynamo building. The form of the water chambers in plan is semi-elliptical, and the face slightly battered. These chambers are separated from one another by solid projections or buttresses, 10ft. in thickness, and terminating in the face of the wall by cutwaters or starlings. From cutwater to cutwater is thrown a series of arches, A, built of cement béton, 6ft. 6in. in width and 1ft. 8in. in thickness. Besides helping to strengthen the wall these arches serve to provide a footbridge along the whole length of the dam. In front of these arches chases are cut in the ashlar work to receive the gate or door frames. A solid foundation 40ft. in width has been provided for the wall, and in it are constructed conduits D of bent form. They have a diameter of 10ft. internally, and serve to convey the water, which they receive through a horizontal inlet from the receiving chambers C into the turbine chambers T by a vertical outlet as shown in the figure. The turbine chambers are arched, and are each 18ft. in width and 34ft. in extreme height, and are separated by partition walls 8ft. 4in. thick. Between these partition walls spring the arches which support the turbines, and to render them perfectly secure they are further strengthened by iron girders laid in the body of the masonry and marked G.

Above the turbine chambers is erected the building in which the dynamos are situated, represented in cross-section in the figure. It has a width of 33ft. at floor level, and a total length of 528ft. The dynamos and turbines are adjusted in position in such a manner that the shaft of each separate turbine is connected with and works only its corresponding dynamo. Upon the left bank of the canal are the repairing shops, which are connected with the installation buildings, as are also the houses for the accommodation of the staff and workmen. All the arches, partition walls of the turbine chambers, the backing of the wall and the lining of the conduits are built with cement concrete. Cut stone has been used in both the up-stream and down-stream façade of the machinery building, and dressed ashlar for the grooves or recesses in the buttresses and starlings. In the wall itself on the up stream side of the houses ordinary masonry is employed.



Cross-section through Dam Wall and Dynamo Room.

On the right bank of the canal, close to the installation works, there is a double lock similar in design and construction to that already described, and of the same dimensions. By means of this lock a difference of water level in the supply and outlet canals of 29ft. 6in. is obtained at high water, and of 37ft. at low water. The intake of the bent conduit pipe in the receiving chambers is placed at a level of 17ft. 9in. below that of low water in the upper or supply canal, and the total height of the whole building in which the machinery is housed is 94ft. from the bottom of the foundation trenches to the bridge. The director of the works is M. A. Gotteland, Engineer-in-chief of the Ponts et Chaussées.

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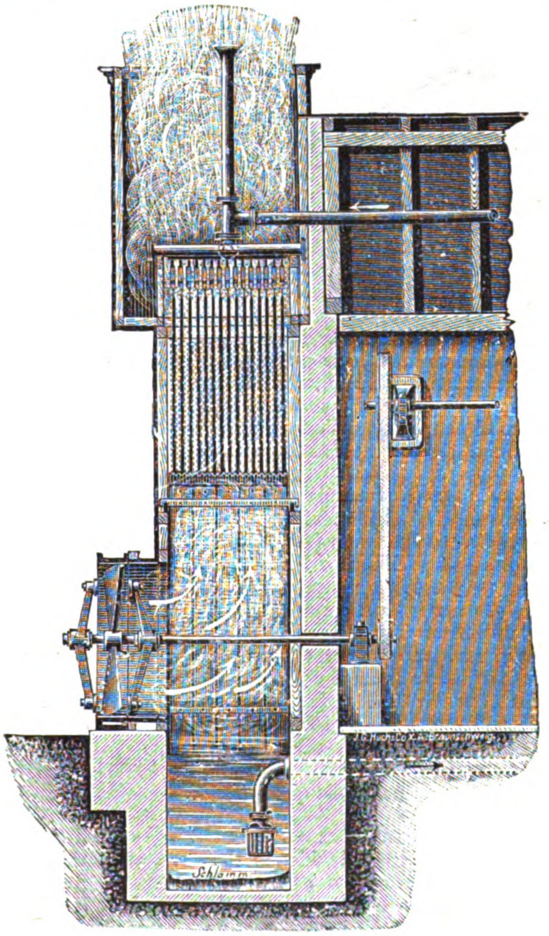
A CONDENSING WATER COOLER.

Klein's cooler for cooling condensing water in a very cheap way is a new apparatus introduced into this country by Mr. E. Larsen. As will be seen in the accompanying illustration, the apparatus consists of a number of wooden plates hanging side by side; and when the water is pumped to the top of the apparatus it will by a very simple arrangement flow slowly down over the extensive surface of the plates and, by the forced or natural draught of air through the apparatus, be cooled not only to the temperature of the air, but, because of a slight evaporation during the process, even as much as 20deg. below this temperature. It will thus be seen that by help of these coolers it is possible to use the same condensing water over and over again. The condenser vacuum can be kept on 25-27in., and the coolers can be worked as well for jet condensers as for surface condensers. Of course, a higher vacuum could be



obtained, but this would not be in good proportion to the cost. Some results from actual working may be of interest, and are given below :—

—	Deg.	Deg.	Deg.
Temperature of air	86	68	46
„ heated water	122	113	107
„ cooled water	77	71	63

It will be understood that this is not the lowest possible degree of cooling in these cases, but it is sufficiently low cooling for condensing purposes. The apparatus makes it possible (the same water always being used) to use any amount of condensing water without increasing the water bill very materially. To show results obtained for low cooling the following are results taken from actual working :—

—	Deg.	Deg.	Deg.
Temperature of air	86	68	46
„ hot water	71	68	60
„ cooled water	59	53	39

Where room is scarce the coolers can be worked with a fan attachment, in which case they take up much smaller space for the same effect than with natural circulation. These coolers have been constructed up to very large dimensions, and the largest working is cooling water from steam engine of 3,000 H.P. At one place on the Continent, where the apparatus is at work, for some time the weekly consumption of water was, it is said, reduced from 1,125,000 gallons to 80,000 gallons, equal to a saving of not less than 1,045,000 gallons per week, and at 6d. per 1,000 gallons this would be equal the £26 weekly.

THREE-PHASE PLANT AT WINOOSKI, VT.*

The Westinghouse three-phase power plant which has been installed for the Vermont Electric Company, Winooski, Vt., for supplying the city of Burlington with electric power, presents many points of interest. The electrical equipment of the power house consists of a Westinghouse generator, rated at 46 amperes at 2,500 volts, running at 450 revolutions per minute, and having a periodicity of 7,200 alternations. The machine over-compounds 10 per cent. at full load. It has 16 poles, with drum-wound slotted armature, and triangle construction for three-phase work. It can be belted direct from a turbine, or from a countershaft, which is in turn driven either by a turbine or steam engine. The exciter is driven from the shaft of the generator.

The transmission line, which is $2\frac{1}{2}$ miles long, consists of No. 0 weather-proof insulated wire. There is also, covering the principal business part of the city, a secondary network of No. 0 wire. The primaries are run on white glass insulators; the secondaries on green glass.

The secondary mains are fed by two banks of transformers in parallel, each bank consisting of two $18\frac{3}{4}$-kilowatt transformers installed in a brick vault. One vault, out of doors, has a removable tin-covered roof, and is provided with a trap door from which all the fuses may be reached. There are fuses on both the primary and secondary side of this vault. The second vault, which is located in the basement, is similar to the first, except that it has the primary fuses on a pole outside of the building. Both vaults are perfectly ventilated, and each has space for a third transformer when the load shall require it.

The motors are three-phase, with "cage"-wound revolving secondary and distributed primary windings. They are driving printing presses, elevators, and various manufacturing machinery. The service is excellent, and the demand for power is rapidly increasing. A large number of small industries in Winooski rely entirely on the electric power supply, and more than 100 H.P. in small motors is already connected to the set of secondary mains. Many motors in distant parts of the city have individual transformers. At present the transformation is effected by two instead of three transformers in a bank. Each motor has a fuse cut-out, a three-jaw switch, and a Shallenberger recording wattmeter. The local company and consumers have arranged to instal a meter at each motor, even when several motors are used by the same customer. It is proposed to equip another set of secondary mains in different districts of the city before long.

THE BROOK-GREEN INCANDESCENT LAMP WORKS.

We have recently had an opportunity of visiting the works of the Incandescent Electric Lamp Company, at Brook-green, London, W., where the "Robertson" glow lamp is manufactured at a rate, it is said, of from 3,000 to 4,000 per day. The Company took the works over in 1893, and commenced to erect the extensive plant necessary to maintain the present output, and at the same time to allow a considerable margin for a probable increase. The vacuum and compressed air services comprise many miles of tubing and accessories; and the installation generally, and the education of the hands, occupied a considerable time before the works could be said to be productive. This latter work was rendered necessary by the fact that the Company determined to employ British labour, and, as the construction of the "Robertson" lamp is peculiar to itself, a course of training was essential. Whatever experience in lamp making was possessed by some of the hands was useless, since the industry has practically been at a standstill in England since the establishment of the monopoly in 1888.

The factory is situated in the north-west corner of Brook-green, W., and consists of a large four-storied block, with special lighting arrangements; and, where the more risky operations are carried on, the floors and ceilings have been rendered fireproof. Immediately in front of the building there is a large courtyard and a roadway from Brook-green, at the entrance of which are the stores, offices, and a caretaker's residence. The whole of the

* Abstract from the *Electrical Engineer*, of New York.

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steam and electric generating plant, furnaces, engines, accumulators, carpenters' shop, and supplementary store-room are situated in the basement of the building, from which run the ramifications of the various installations. The electric services are led up to the switch room, which is on the first floor, in the centre of the works. From this point distributing wires are laid to the various departments, and, owing to the continual changing over and adjustment required, an attendant is always on duty, who is in telephonic communication with the engine room and the various other departments. Systems of roughing vacuum, fine vacuum, and air pressure for the blowpipes, &c., are also distributed throughout the workshops, the final or finishing vacuum being made *in situ* by a set of mercurial pumps.

The "Robertson" lamp is the invention of Mr. C. J. Robertson, who is the general manager of the works. Mr. Robertson possesses a unique experience in the practical manufacture of incandescent lamps, having commenced in the Lane-Fox department of the Anglo-American Brush Company, in charge of the testing room. Since that period he has assiduously followed the subject in a practical manner, and has studied on the Continent at some of the best works. The lamp which is the outcome of of this long and varied experience at home and abroad is different in structure, but not in appearance, from other lamps by other makers. The filament is prepared originally in a liquid form from a carbon-containing solution, and is then squirted through orifices under high pressure. The filament, after baking, possesses a brilliant surface, and will scratch glass. It is mounted in the grooves of the platinum conductors by what is known as the "burning-in" process, which consists in the deposition of carbon by electricity from an atmosphere or fluid containing carbon, the junction being heated by the passage of a current. The bulbs of the Robertson lamp are made of special crystal glass, and are blown in a mould to ensure each being exactly alike.

We were particularly struck with the spacious and comfortable accommodation which is afforded the employés at these works, especially in regard to the cleanliness and good ventilation of the workshops. We understand that upwards of 130 hands are regularly employed here, and in almost all the departments the work is undertaken largely by girls.

DEPENDENCE OF THE PHOTOELECTRIC CURRENT UPON THE AZIMUTH AND THE ANGLE OF INCIDENCE OF THE LIGHT.*

BY DR. J. ELSTER AND H. GEITEL.

After it had become evident that the intensity of the electric current started by illuminating the cathode in a rarefied gas depends upon the orientation of the plane of polarisation of the light with respect to the cathode surface,† we endeavoured to determine the particular conditions of this phenomenon. In this determination we followed the plan, indicated in the last Paper, of changing the angle of incidence as well as the azimuth of the polarised light.

The cathode employed was the sodium-potassium alloy used before, enclosed in a spherical exhausted glass vessel; the anode of platinum wire was fixed opposite. The vessels were 50mm. in diameter, and the size was chosen in such a manner that the surface of the alloy could be regarded as practically a plane surface in the middle. Perfect purity of the liquid metallic mirror is essential; an intense beam of light must not be reflected at all diffusively by the point of incidence; this point must remain perfectly invisible to the eye, which does not look along the reflected ray. The source of current employed was a battery of 100 to 400 zinc-sal-ammoniac-carbon elements with a total E.M.F. of 420 volts. The light was supplied by a small disc of zirconium rendered white-hot by an oxy-coalgas blowpipe flame. This was firmly clamped in the box of a magic lantern. The rays were collected by a condenser, made parallel by a second lens, and emerged into the darkened room. A beam of any smaller diameter could be picked out by means of a screen. The lantern was firmly connected with the lens and screen, and could be turned in a vertical plane without disturbing the arrangement of the parts, so that the ray could be given angles of 90° to 40° with the normal of incidence. Smaller angles of incidence were produced by reflection of the horizontal rays by a silver mirror movable about a horizontal axis. It was necessary to ensure that the ray of light always impinged upon the same point, viz., the centre of the cathode surface lying just under the anode point. In this case it is evident that the ray must cut the two walls of the spherical glass globe at equal heights before and after reflection. At these points the image of the slot on the glass (this was usually rectangular, with the longer side horizontal) was clearly recognisable, and the cell could be easily shifted, so that this image was at equal heights above the surface of the liquid metal on both sides. One of the cells, specially employed for verifications, we could just half fill with the liquid metal. When it was arranged in the manner indicated for the incident beam, the latter had to pass through its centre, and would, therefore, cut the glass surface perpendicularly at every point; hence the light incident upon the cell retained the same intensity for all azimuths of the plane of polarisation.

The current through the cell was measured by a scale-and-mirror galvanometer, taking care that the lamp serving to illuminate the scale was so distant as not to influence the cell.

If the beam of light, after passing through a Nicol prism, impinges upon the cathode surface at any angle exceeding zero, a periodically-varying current intensity is obtained on turning the prism, as in our previous experiments. The maxima are obtained when the principal section of the Nicol coincides with the plane of incidence, *i.e.*, when the plane of polarisation is perpendicular to the plane of incidence. The minima are obtained in a position normal to this. Designating the current intensity obtained in the first position by A, in the second position by B, and the angle through which the prism has been turned from the first position by a, the observed current intensity for every value of a may be expressed, within the limits of observational error, by the formula

$$J = A \cos^2 a + B \sin^2 a.$$

The angles of incidence below 40° were obtained, as described, by reflection from a silver mirror, the Nicol prism being introduced between mirror and cell. The method is in this case less accurate owing to a slight elliptical polarisation of the light reflected from the mirror. A rotation of the Nicol would therefore in itself produce a change of intensity in the transmitted light, and hence a corresponding change in the current intensity. We found, however, by photometric measurements, that this source of error has little influence in comparison with the inevitable variations of the zircon light. To eliminate these variations, the first position was returned to after each series of measurements, and only such series were retained as did not show a decided change in the light intensity.

According to our previous experiments the intensity of the electric current is, under similar conditions, proportional to the luminosity, *i.e.*, to the square of the amplitude. Hence the above formula simply implies that this ratio is different for light polarised in a plane perpendicular and parallel to the plane of incidence respectively. Let a be the amplitude of the polarised light, whose plane of vibration (not of polarisation) makes the angle a with the plane of incidence, then the amplitudes in the plane of incidence and normal to it are $a \cos a$ and $a \sin a$ respectively, and the intensities $a^2 \cos^2 a$ and $a^2 \sin^2 a$. If x is the ratio for the first, y for the second position, the total current intensity is

$$J = a^2 x \cos^2 a + a^2 y \sin^2 a,$$

and the ratio $\frac{x}{y}$ is given by the quotient $\frac{A}{B}$.

In general, the values of $A = a^2 x$ and $B = a^2 y$ are different; only with a vanishing angle of incidence they are, of course, identical. The former rapidly increases at first with increasing angle of incidence, until the latter attains about 60°, after which it decreases. B steadily decreases with an increasing angle of incidence, so that at an angle between 60° and 65° the ratio A : B becomes about 50 : 1.

The accurate determination of the angle for which the maximum current is generated by light polarised perpendicularly to the plane of incidence, is attended with great difficulties, chiefly due to variations in the intensity of the light. Hence the values found for this angle vary between 58° and 66°.

We consider it very probable that the higher photoelectric efficiency of the light polarised in a plane perpendicular to the plane of incidence is connected with the fact discovered by Herr Quincke,* that such light penetrates with much greater intensity in metallic layers than that polarised parallel to the plane of incidence.

If we regard a beam of natural light as composed of two beams polarised at right angles to each other of half the total intensity, it follows that, with the decidedly stronger photoelectric effect of the component normal to the plane of incidence, natural light must also show a maximum of current intensity at an angle of about 60°. This conclusion is confirmed by experiment.

It is natural to suppose that this angle of incidence near 60° is also the angle of polarisation of the sodium-potassium alloy for the electrically active, especially the blue rays. We have endeavoured to apply the method used by Knoblauch in his investigations concerning the elliptic polarisation of heat rays to this photoelectric determination. We allowed light polarised at an azimuth of 45° to fall upon the sodium-potassium surface, and to impinge vertically upon the solid sodium cathode of a photoelectric cell after reflec-

* Sitzungsberichte der Akad. der Wissenschaften, Berlin, XI., p. 209, 1895.

† *Ibid*, VI., p. 134, 1894.

* *Pogg. Ann.*, 129, p. 177, 1866.

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tion, and after it had passed through a second Nicol prism. This latter cell, therefore, only served for the measurement of the luminosities transmitted through the second Nicol, and took the place of the thermo-element used in the corresponding experiment with heat rays. From the luminosities found for the various azimuths of the second Nicol, the axes and the position of the ellipsis of vibration of the light reflected by the sodium-potassium surface could be determined by Knoblauch's method. The angle of polarisation could then be recognised by the fact of the ratio of the axes most closely approaching unity, while the direction of the major axis is normal, and of the minor axis parallel to the plane of incidence. The experiment proved that these characteristics appeared at an angle of about 65°, but it must be noted that this is also only a rough approximation. There seems, however, to be no contradiction to the supposition that the maximum of photoelectric current occurs with light polarised normally to the plane of incidence when the beam impinges upon the cathode at the angle of polarisation.

The results of this investigation may be summed up as follows :— If a is the azimuth of the polarised ray, counted from the position in which the plane of polarisation is perpendicular to the angle of incidence, and where, therefore, the electric displacements take place in the plane of incidence ; and if A and B are the intensities of the photoelectric current for $a=0$ and $a=90°$ respectively, the current intensity may be generally represented by the formula—

$$J = A\cos^2 a + B\sin^2 a.$$

A and B depend upon the angle of incidence. Except for the angle of incidence zero (for which A = B), A is always larger than B, and grows with the angle of incidence, until the latter, at about 60°, approaches the angle of polarisation, perhaps becomes identical with it, after which it decreases. B always diminishes with increasing angle of incidence, and appears to approach zero at skirting incidence.

With natural light there is also a maximum of photoelectric current with an angle of incidence about 60°.

All these results refer to the natural free surface of the sodium-potassium alloy, consisting of equivalent proportions of both, which is liquid at ordinary temperatures.

LEGAL INTELLIGENCE.

Kirsopp v. Hunter and Jack.

At the Linlithgow Sheriff Court the record has been closed in an action brought by Messrs. Hunter and Jack, electrical engineers, of St. Vincent-street, Glasgow, against Mr. Henry Kirsopp, of Bathgate, for £36. 4s. 7d., as balance for fitting up an electric light installation and supplying certain fittings incidental thereto in defender's premises. The defender raised a counter action for £34. 7s. 3d. in respect of loss and damages sustained through the breaking of a bracket on which one of the electric lamps was suspended, and pleads that in February, 1894, the pursuers contracted to complete an electric light installation in his premises at Bathgate, to be fitted up and left working to the satisfaction of the pursuer. In April, 1894, the defenders asked permission to put up, at their own expense, two small arc lamps outside pursuer's shop. This permission was given, and two Richardson arc lamps were put up, these being suspended from cast-iron brackets fitted into the wall. Some time after the pursuers asked the defender to take over the arc lamps, offering them at cost price. This was agreed to on the understanding that the lamps should be made to work satisfactorily. The lamps did not prove satisfactory, the light given being intermittent, and after several complaints the defenders agreed to replace them by two arc lamps of a different make. The Richardson lamps were taken away in October, 1894. On December 1st the defenders put—suspended from the same brackets—two new arc lamps of a different make, and very much heavier than the former lamps. In January last, when current was switched on, one of the cast-iron brackets from which the lamps were suspended broke, with the result that the lamp fell until caught by the wire carrying the current. The accident was due, it was alleged, to the carelessness of the defenders or to their foreman who superintended the installation, and for whose fault they are liable. The bracket was quite insufficient to bear the weight of the heavier lamp, and this should have been known to the pursuers. At the time of the damage injury was inflicted upon three persons who were looking into the shop windows, and the pursuers denied liability. Mr. Kirsopp paid £30 in settlement of the damages advanced by the injured persons, at the same time notifying Messrs. Hunter and Jack that he held them liable. This settlement was, it was contended by Mr. Kirsopp, a reasonable compromise of the claim for damages, and the pursuers were accordingly bound to repay the sum of £30 and also the sum of £4. 7s. 3d., the cost of replacing the plate glass window broken by the fall of the lamp, and Mr. Kirsopp retained the balance of the installation account pending the settlement of the claim.

Messrs. Hunter and Jack, in reply to the counterclaim, state that in order to contribute to the success of the inaugural ceremony of switching on the electric light and to increase the spectacular effect, offered to loan the two lamps, and that offer was accepted. The lamps were fitted up temporarily, and the cast-iron brackets were supplied by Mr. Kirsopp. Subsequently Mr. Kirsopp offered to purchase the lamps, and they accepted his offer. Subsequently they exchanged the said lamps for two others—known as "Solar" arc lamps—and these were suspended to Mr. Kirsopp's brackets. Having supplied the lamps they had nothing to do with them after, and no guaranty or warranty was given to Mr. Kirsopp. The brackets were lengthened by Mr. Kirsopp without consultation with them, and were subsequently removed to another point by Mr. Kirsopp without notice to them. The brackets were therefore, they plead, not part of their contract.

Fell v. Whittaker.

In the Ambleside County Court, Westmorland, last week, before Judge Steavenson, Messrs. R. H. Fell and Son sued Mr. Edward Whittaker, of Windermere, for the sum of £5. 6s. 9d. for the repair of damage caused by the breaking of a glass globe used in the plaintiffs' electric lighting system. A glass globe placed on the top of one of the lamp-posts between Windermere and Bowness was broken by an employé of the defendant. No notice had been given to the plaintiffs of the breakage, and their person in charge of that section of the installation had turned on the current at the usual time. After doing so, he found there was something wrong, and ultimately discovered the broken globe. Owing to the breakage of the glass, the rain was admitted, and prevented the current passing the lamp, with the result that the increased current had damaged several other lamps between it and the switch house. The defendant wrote the plaintiffs asking the amount of damage done. It was contended that the items put in the particulars were the direct consequence of the breaking of the globe, and that the plaintiffs were entitled to damages.

Mr. TILLY, for the defendant, submitted that the plaintiffs were without parliamentary powers, and really had no business to place the lamps in the position where the accident occurred. Before an action could be brought for the damage they must, he contended, prove they had a right to be there.

His HONOUR held that it was a serious thing if, by accidentally breaking a glass globe, a man was liable to pay £5. 6s. 9d., and asked why the plaintiffs could not have the lamps inspected immediately prior to turning on the current. For the plaintiffs it was contended that they had the necessary rights. They had utilised the old gas lamp-posts, and had an agreement with the Local Authority for the supply of power.

His HONOUR said there was no evidence produced that the lamps were lawfully there, and the objection taken by the defendant was right.

Judgment for the defendant.

Bocquet v. Frank Suter and Co.

In the Chancery Division, before Mr. Justice Romer, last week, the plaintiff in this action sued the defendants for carrying on processes known as "dipping" and "lacquering," from which fumes of a noxious and poisonous character were given off, and claiming an injunction to restrain the defendants from a continuance or repetition of the damage to her premises from the fumes, and also damages in respect of the nuisance complained of. It was explained that the defendants occupied premises immediately below those of the plaintiff.

Mr. Justice ROMER said a nuisance was caused to the plaintiff by the nitric acid fumes, and the defendants must stop that nuisance either by giving up the "dipping" process altogether, or taking further precautions. An injunction restraining the nuisance referred to, the defendants to pay the costs of the action, was granted.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s.

*The following New Books and Editions of "*THE ELECTRICIAN*" SERIES can be obtained of the Booksellers or direct from the Publishing Offices :—*

LABORATORY NOTES AND FORMS.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett (*now ready*). Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

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A Large-Sheet Table, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s. —each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

"Electro-Chemistry."—This useful work, by Dr. G. Gore, is still on sale, the price being 2s., post free.

"The Electrician."—A special notice concerning certain changes in the price, &c., of this journal will be found on page 262.

Tenders Invited.—The Electric Lighting Committee of the Corporation of St. Helens (Lancs.) invite tenders for the supply and erection of boiler and engine-house plant, switchboard and instruments, underground work (including cables, boxes, culverts, &c.), transformers and fittings, meters, and overhead crane for their electric lighting station. Tenders are to be sent in to Mr. W. J. Jeeves, Town Clerk, Town Hall, St. Helens, not later than Tuesday, July 2nd.

——— The Electric Light Committee of the Bedford Corporation invite tenders for the supply and erection of water-tube boilers, engines, and alternators. Tenders to Mr. T. S. Porter, Town Hall, Bedford, by Tuesday next, the 25th inst.

——— The Urban District Council of Clevedon require tenders for the public lighting of their district every night in the year from sunset to midnight. Tenders are to be for one, two, or three years, and must be sent in to Mr. H. C. Fry, Clerk of the Council, Clevedon, by July 1st.

——— The Corporation of Blackburn invite tenders for the wiring of the Town Hall. Tenders must be sent in by July 13th.

——— The District Committee of the Lanark County Council invite tenders for the electric lighting of the new hospital at Motherwell. Tenders must be sent in to Mr. J. F. Mackenzie, County-buildings, Hamilton, by July 1st.

——— The Belgian State Railway authorities invite tenders for the supply and erection of dynamos, switchboards, conductors, posts, lamps, &c., for the electric lighting of the railway station, carriage and waggon shops, and the locomotive shed at Schaerbeek-Nord, Brussels. Tenders must be addressed to the Administration des Chemins de Fer de l'Etat Belge, the Bourse, Brussels.

——— Tenders are invited until the 6th prox. by the General Direction of French Posts and Telegraphs for the supply of two lots of paper-insulated electric cables. Tenders must be sent in to the Direction Générale des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Tenders Accepted.—In our issue of May 31st particulars were given of several tenders accepted by the Hanley Town Council for plant and apparatus for electric lighting extensions. In addition to the contract secured by Messrs. W. H. Allen, Son and Co. for surface-condensing apparatus at £755, and for two Lancashire boilers and fittings by Mr. E. Danks, of Oldbury, at £1,178, tenders have been accepted from the British Insulated Wire Company for high and low-tension cables for £1,393. 8s. 4d., from the Brush Electrical Engineering Company for transformers with high and low-tension switches for £632. 2s., from Messrs. S. Z. de Ferranti for switchboard, &c., at £252. 10s., and from the Stanton Iron Company for 2in. cast-iron pipes at £4. 12s. 6d. per ton. The Council's decision as to the tenders for arc lamps and posts was deferred to the next meeting.

——— The Brighton Town Council, on the recommendation of the Electric Lighting Committee, have finally accepted the tender of Messrs. Hart, Son, Peard and Co. (Limited), of Birmingham and London, for the supply and delivery of 80 cast-iron and drawn-steel bracket posts for arc lamps for £2,600, of which notice was given in our issue of May 17th.

——— The Tunbridge Wells Town Council have accepted the tender of Messrs. Laing, Wharton and Down, for wiring and fitting up the municipal buildings for the electric light.

——— The Ayr Police Commissioners have accepted the tender of the Callender Company for electric cables for the extensions authorised at a recent meeting of the Commissioners, and which was referred to in our last issue.

Sales by Auction.—In July, Messrs. Fairbrother, Ellis, Clark and Co. will dispose of the patent rights and the goodwill of the business of the Wenham Company (Limited) at Upper Ogle-street, Fitzroy-square, London, W. The lease of the extensive factory and premises, with engines, boilers and fixed plant, will also be offered for sale early in July.

——— Mr. Wooller Jennings has been instructed by Mr. James Duff, the Receiver and Manager of Andrews and Preece (Limited), to sell by auction, at the Borough Mills, Manchester-road, Bradford, on Wednesday, July 3rd, at 11 o'clock, the whole of the valuable plant of engineers' tools and effects, stock-in-trade, &c. Detailed catalogues can be obtained seven days before sale from Mr. Jennings, 66, Thornton-road, Bradford. Some further particulars appear in our advertisement columns.

Appointment Vacant.—The Governors of the Northern Polytechnic invite applications for the post of principal. After the 25th March next the stipend will be at the rate of £500 per annum, and from September 29th next to March 25th at the rate of £300 per annum. Some further particulars will be found in our advertisement columns, and applications must be sent in to Mr. E. Griffiths, secretary, St. Mary's Vestry Hall, Islington, N., before July 15th, on forms which, together with all further information, can be obtained at the Vestry Hall.

Appointment.—The Electric Lighting Committee of the Tunbridge Wells Town Council recommend that Mr. H. L. P. Boot, of Dublin, be appointed resident engineer at the Corporation's electricity works.

——— Mr. T. Hesketh, who is at present engaged by the Blackpool Corporation at their electricity works, has been appointed assistant electrician at Madrid by the Electricity Supply Company for Spain.

Removal.—On and after the 24th inst. Messrs. Clayton and Shuttleworth will remove their London offices and showrooms from 78, Lombard-street, E.C., to 95, Queen Victoria-street, E.C., where motors for electric lighting, pumping, sawing, &c., will be on show. These will include portable and fixed steam engines and patent oil and gas engines (in motion).

——— The County of London and Brush Provincial Electric Lighting Company (Limited) have removed from 49, Queen Victoria-street, E.C., to Moorgate-court, Moorgate-place, London, E.C.

Dissolution of Partnership.—Messrs. F. and A. Wright, who have hitherto carried on business under the style of Alexander Wright and Co., as electrical apparatus manufacturers, at 19 and 21, Old Queen-street, and Millbank-street, Westminster, London, S.W., have dissolved partnership. Debts by Mr. F. Wright, who continues.

Personal.—Mr. A. E. Evans, who has for same years past been connected with the International Electric Company, has severed his connection with that firm, and has started in business as accountant and auditor at London-road, Romford, Essex.

Bankruptcies.—In the failure of J. T. Todman, electrician, a composition offer has been submitted by the debtor, which is to be discussed at a meeting shortly to be called.

Liquidation.—On May 9th it was resolved that the Johannesburg Lighting Company (Limited) be wound up voluntarily, and Mr. J. Taffs, 54, St. Mary-axe, London, E.C., was appointed liquidator.

——— A summary of the liquidator's accounts is issued in respect of the winding-up of the London Metallurgical Company (Limited), from which it would appear that a balance of £737. 9s. 1d. is in the liquidator's hands for disbursement.

——— A summary of the liquidator's accounts in Poole and White (Limited) is issued showing a balance of £520. 19s. 11d., after payment of Board of Trade and court fees, incidental outlays, &c.

Madras Electric Tramways Company (Limited).—On the calling of the petition of the Commercial and Land Mortgage Bank for the winding-up of this Company, it was stated that the debt had been paid, and leave to withdraw the petition was sanctioned by Mr. Justice Romer.

Exports of Telegraph Wire and Apparatus.—The value of exports of telegraph wire and apparatus connected therewith from this country during May only reached £26,942, as compared with £90,077 in May last year. The returns for the first five months of the year amounted to £126,688, against £542,095 in the corresponding period of 1894.

Pearson's Automatic Fire Indicator Company (Limited).—This Company has entered into an agreement with E. Mann, electrical engineer (referred to as the vendor) for the transfer to the Company of the vendor's rights in the invention of R. Pearson for a thermometric circuit closer used for a fire alarm, and the right to the patent which has been applied for in connection with the same, pursuant to the Provisional Protection No. 5,650 (1894), and the right to take up and apply for patents for the said invention in any of the British colonies and dependencies and in foreign countries. The consideration for the transfer is fixed at £2,000, payable £1,000 in cash and £1,000 by the allotment of 1,000 £1 fully-paid shares in the Company.

The "Hunningscone" Microphone Transmitter (Deckert Patent, No. 21,565).—We have received the following from the General Electric Company (Limited):—

"As it has come to our knowledge that certain manufacturers of microphone transmitters are adopting the name of our transmitter, known as the 'Hunningscone,' and are advertising their own wares under this title, with the result that some of our customers have been thereby imposed upon, we beg to offer the following explanation:—We are the

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originators of the name 'Hunningscone' as a name for Hunning's transmitter, and that name was suggested by the fact that the internal construction of our transmitter necessitated the use of a number of cones or pyramids, arranged in a peculiar manner, to which is due (in conjunction with other details) the excellent effects obtained. This transmitter is manufactured to the Deckert patent, of which we possess the sole rights, and is the same as now used in large quantities by the General Post Office on their long lines, including the trunk lines recently opened between London, Glasgow and Dublin, and is also universally adopted by the National Telephone Company. Intending purchasers, therefore, would do well to be quite sure that they are obtaining the genuine article, manufactured to the Deckert patent specification otherwise they are not obtaining the original Hunningscone, but something which must necessarily be inferior or the manufacturers would not be pushed to such straits as to purloin a title for it. At the same time it speaks well for our transmitter that trade competitors should as a guarantee of excellence advertise their supplies under titles which have appeared in our catalogue for the last three years."

Argentina.—The *Review of the River Plate* says that electric lighting is making rapid strides throughout the country, and it will not be long before all the principal cities have adopted the light. Esperanza, in the Province of Santa Fé, is now lighted, and Quilmes is soon to be lighted, by electricity. Concordia is talking about adopting it, and several other municipalities are contemplating its adoption. The lighting of the important towns of Rosario and La Plata is given as a proof of complete success.

Association of Municipal and County Engineers.—The annual meeting of this Association takes place at Halifax on the 27th, 28th and 29th inst. The electricity works are to be visited on the 29th.

Beckenham (Kent).—At the last meeting of the Urban District Council a letter was read from the Crystal Palace District Electric Supply Company notifying a reduction of the Company's charges for electric current.

Bedford.—Major Tulloch, R.E., held a Local Government Board inquiry last week into the application of the Town Council for sanction to borrow £27,000 for electric lighting extensions. Opposition to the loan was offered by Mr. W. J. Jessop on the ground that the electric lighting was being carried on at a loss. The Mayor stated that the installation was most successful, and was supported in this statement by many leading members of the Corporation. With regard to Mr. Jessop's opposition, it was contended that the figures given by that gentlemen were altogether erroneous, and the opposition personal and against the interests of the ratepayers. The local gas company was unrepresented at the inquiry.

Board of Trade Revised Regulations.—The Edinburgh Town Council have appointed Mr. Mackenzie and Sir James Russell to lay the Council's views before the Board of Trade as to the regulations and conditions proposed to be made by that body for the public safety in connection with electric light installations.

Bolton.—In the electrical engineer's report presented to the Gas Committee of the Corporation last week it was stated that 67 consumers were taking current equivalent to 5,200 8 c p. incandescents. The whole of the contracts have been let for the extensions recently approved, and it was anticipated that the new plant would be ready for work by September next.

Bray.—The Town Commissioners, at their last meeting, considered a letter from Mr. S. G. Fraser on the subject of constructing an electric tramway from the railway station at Bray to Bray Head, and thence through the Putland property to the summit of the hill. Mr. Fraser points out that the poles for the overhead conductors could be utilised for the lighting of the route by electricity. In Mr. Fraser's opinion, the ascent of Bray Head by an electric tramway presents no serious engineering difficulties. At the same meeting a letter was read from the Earl of Meath, generously offering land in the route of the proposed tramline, and this offer and Mr. Fraser's letter were referred to a committee specially appointed to consider the whole subject.

Cape Town.—At a recent meeting of the Town Council of Cape Town the question of the electric lighting of the city was discussed, and it was stated by the Mayor that the original estimate of £75,000 had not been exceeded. It was decided to considerably increase the number of public lamps by a further 50 additional arcs, and it was also decided to put an arc lamp outside every place of worship in the city. Complaint was made that some of the street lighting was ineffective, but it was pointed out that a few initial difficulties had been met with which had been overcome by the contractors. An attempt to worry the officials responsible for the electric lighting of the city was unsuccessful.

Derby.—The Market Hall has recently been completely fitted for the electric light by Messrs. John Davis and Son, of All Saints' Works, Derby, and Newgate-street, London. The switching on ceremony took place last week. There are six 20-ampere arcs fitted for lighting the interior of the hall, and the approaches are also lighted by arc lamps. The stalls and shops are provided with incandescents, of which about 400 are fitted throughout the buildings. Special care has been given to the switchboard arrangements and safety devices, and by a simple arrangement of the meters the consumption of current can be taken for any of the various sections at a glance. Gas is, we understand, to be entirely superseded by the electric light.

Dundee.—The annual meeting of the Gas Committee of the Town Council was held on Wednesday to receive the accounts for the past year and the estimates for the ensuing year. Treasurer Ritchie stated that the revenue was £80,042. 10s. 4d. The expenditure, including the deficiency on the electric lighting department, reached £80,173. 11s. 2d., a deficiency of £131. 0s. 10d. This was due to the serious fall in the price of their gas residual products. Next year they anticipated to bring out a balance on the right side in connection with the electrical department, the estimated revenue being £4,400, while the estimated expenditure was £4,386. It was resolved that no change be made in the charges for electric current.

Edinburgh.—The Town Council have adopted the recommendation of the Electric Lighting Committee (mentioned in our last issue) to extend the mains to the Regent, Carlton, and Royal Terraces, South Back Canongate, George-square, and the south side of the city, at an estimated cost of about £5,000. Mr. Cranston asked if the committee had received the necessary guarantee, and Mr. Mackenzie said that from the people in the terraces they had more than the necessary guarantee, and in Clerk-street and George-square they had the same. The Committee considered the electric light was a success.

Electric Traction in America.—The Manhattan Elevated Railway Company has, it is stated, decided to substitute electricity for steam as the motive power on its road.

Electric Traction in France.—It is proposed to construct a tramway between Neris and Montencon, and a short railway line from Montaign to Moissac, Tarn-et-Garonne, the motive-power in both cases to be electric.

Fire.—An outbreak of fire occurred on Monday last at the premises of Messrs. New and Mayne, electrical engineers, 9, New Bridge-street, Westminster, S.W.

Fort William.—A meeting of gentlemen interested in the proposal to light this burgh by electricity was held on Tuesday last, Mr. R. Yorke, electrical engineer, of West Regent-street, Glasgow, attended, and gave particulars of the proposed scheme, which is receiving much local support, and a company is being formed to carry out the work. The promoters have been presented with the land through which the water from the River Nevis is to be taken, and negotiations are in progress for the acquisition of further land for erecting a turbine house.

The Gas Institute.—At the meeting at Edinburgh, last week, several Papers were read in which the effect of the introduction of the electric light on gas undertakings was discussed. Mr. W. Newbigging, of Manchester, claimed that in no single instance had the introduction of the electric light been detrimental to gas companies. Mr. F. H. Medhurst dealt with the question of the bye-uses of electricity, and Mr. Frank Wright gave, as an instance of the economy of the electric light, the case of the Army and Navy Stores, the managers of which had substituted the electric light for 8,000 incandescent gaslights. He found from practical experience that gas at 2s. 6d. per 1,000ft., used in a flat-flamed burner, was 25 per cent. dearer than electricity at 4d. per unit.

Guildford.—The Board of Trade have written to the Town Council asking for their observations upon a letter the Board have received from the Guildford Electric Supply Company, the undertakers under the Guildford Electric Lighting Order (1894). The letter stated that, although the Company was not in a position at present to prove compliance with the provisions of section 7 of the Order, progress was being made, and the Board of Trade were asked to grant an extension of six months to carry out the provisions of the section. After a short discussion the clerk was instructed to reply to the effect that the Council had no observations to make on the subject.

Hackney (London, N.E.).—At the last meeting of the Vestry the Electric Light Committee were empowered to obtain, at a cost not exceeding £200, the opinion of an expert and collect other evidence and particulars in relation to a combined electric lighting and dust disposal scheme for this parish. It was suggested that the local authorities of Stoke Newington and South Hornsey should be invited to arrange for the electric lighting of that portion of the High-street which lies in their respective parishes.

Hanley.—A special meeting of the Town Council was held on Tuesday last, at which a deputation from the North Staffordshire Tramways Company attended to lay before the Council the Company's views as to electric traction in the district. It was pointed out that the Company had under consideration the adoption of the overhead system of electric tramways, and the consent of the local authority was desired, as if reasonable conditions could be obtained

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the necessarily considerable amount of capital required would be available. The Company's scheme would involve the entire re-equipment of the line. The Directors, having duly considered the advantages of electric traction, were preparing a comprehensive scheme for extensions from Trent Vale to Longton-road, Stoke, Newcastle to Hanley, Longport to Burslem, Golden Hill and Tunstall to Burslem, and Silverthorne to Burslem. These lines would act as feeders to the main line, and enable the whole system to be worked at a more moderate rate than if the main line only were worked electrically. After full discussion in Committee the Council adopted a resolution approving of the general views of the scheme. The recent application of the Council for powers to borrow £5,000 for electric lighting purposes has received the assent of the Local Government Board.

Lord Kelvin.—The *Pall Mall Magazine* for July contains a handsomely illustrated Paper by Mr. Arthur Warren descriptive of the career of Lord Kelvin, portraits of whom and of Lady Kelvin accompany the text. The illustrations include a view of "Netherhall," Lord Kelvin's country seat, of the testing rooms at White's in Cambridge-street, Glasgow, and of Lord Kelvin's lecture room at Glasgow University. The magazine is beautifully printed and illustrated throughout.

Lambeth (London, S.W.).—The Vestry have again considered the offer of the County of London Company to take over conditionally the Vestry's Provisional Order; and it was finally agreed to refer the matter to the Electric Lighting Committee, two members from each of the standing committees being appointed to act with the Electric Lighting Committee in this matter.

Leeds.—The Yorkshire House-to-House Company have notified their customers of a further reduction in the charge for electric current as from July 1st. The maximum gross charge will be 6d. per unit, while consumers of 1,500 units per quarter will be charged 5¾d. per unit, and consumers of 3,000 units 5½d. per unit. A liberal scale of discounts is also announced, under which the minimum net price is under 4½d. per unit, whilst the greater price payable by any consumer is just under 5¾d. per unit. For heating, cooking and motive power the Company are supplying current at 3d. per unit. The use of electricity for these purposes is steadily extending in Leeds. The number of equivalent 8 c.p. lamps now connected to the mains is about 28,000, compared with 11,500 twelve months ago.

Longton (Staffs.).—At the meeting of the General Purposes Committee of the Town Council last week the Town Clerk reported that a communication had been received from the Board of Trade with reference to the application of the Corporation for sanction to use mechanical power for traction purposes (which had hitherto been refused) on portions of the tramway constructed in the borough in 1881. The Board of Trade now stated that, having regard to the street improvements which had been made and were in contemplation, and to the desirability of extending the tramway system beyond the disused lines, favourable consideration would be given to an application for a Provisional Order authorising such lines afresh and sanctioning the use of steam or other mechanical power thereon. A motion to apply for a Provisional Order was adopted. A letter was read from the Secretary of the North Staffordshire Tramway Company (Limited), stating that the Company had had under consideration the subject of adopting some improved form of traction, and had come to the conclusion that the only method suitable for the district was that of the overhead electric system, and asking for the consent of the Council to the general principle. A deputation was appointed to discuss the matter with the Directors of the Company and report to the Committee.

Middlesboro'.—At last week's meeting of the Town Council, on the proposal to adopt the minutes of the Electric Lighting Committee, a resolution declaring "that it was the opinion of the Sub-Committee specially appointed that it would be in the true interests of the borough to proceed forthwith with the electric lighting scheme at a cost of not less than £25,000" was discussed. This resolution was the outcome of a decision arrived at by the Council about 12 months ago that the Committee should visit several of the principal electric lighting stations throughout the country with the object of obtaining information from various sources. The Committee came to the conclusion that the electric light would be profitable, that it was everywhere preferred to gas, and that it would be advisable that the town's installation should be immediately put in hand. Mr. Alderman Bell, however, advised that the matter should be discussed and dealt with less ambitiously; he approved of the electric light, but thought it would better to commence at a cost of from £10,000 to £15,000, and he moved a resolution to this effect, which, after some discussion, was carried.

Monifieth (Forfar).—The Town Commissioners are considering the question of the lighting of this district. Three schemes, viz.: (1) that of providing an electric lighting installation; (2) the erection of gasworks within the burgh; (3) the obtaining of a gas supply from Broughty Ferry, have been submitted, and a public meeting is to be called for the purpose of obtaining the views of the inhabitants on the question.

Ootacamund (India).—The scheme promoted by the Oriental Electric Light Company, of Bangalore, for lighting Ootacamund by electricity has (says the *Pioneer*) met with great success. The whole of the Government House, including the Military Secretary's and Private Secretary's bungalows, are to be lighted by incandescent lamps, as well as the Government House and Banqueting Hall, the Guindy Park at Madras, and the Government House at Ooty.

Rhyl.—The District Council have informed Messrs. Dickinson and Co., of Birmingham, engineers for the proposed electric tramway at Rhyl, that they will give them every assistance. An interview is to be arranged with the firm, who have invited the Council to send a deputation to the Midlands to inspect the various systems at work there.

Smoke Nuisance.—At the Westminster (London, S.W.) Police Court on Wednesday, Mr. W. R. Renshaw, of the Queen Anne's Mansions Lighting and Heating Works, St. James's Park, was summoned by the Westminster Vestry for permitting the issue of dense black smoke from a chimney so as to cause a nuisance. Defendant pleaded in extenuation that the smoke from this large chimney was no more than the aggregate from smaller chimneys of houses accommodating fewer families than Queen Anne's Mansions. The magistrate (Mr. De Rutzen) said that this amounted practically to a claim that the Queen Anne's Mansions were entitled to a volume of smoke proportionate to the number of tenants, but as these mansions constituted the biggest block of residential buildings in London the result would be the poisoning of the surrounding locality, and therefore the argument would not stand. A fine of £5 was imposed, with five guineas costs.

South America.—Telephone communication has been re-established between Rio de Janeiro and Nictheroy.

Southampton.—The Harbour Board on Tuesday last decided to erect three additional electric cranes, and to erect a supply station on their own property in place of taking current from the local company. Mr. J. G. W. Aldridge, of 9, Victoria-street, Westminster, London, S.W., consulting electrical engineer to the Board, has been instructed to prepare the necessary plans and specifications.

Southport.—In reference to a Note which appeared in our last issue, we find our report was inaccurate as to the reduction in the price of gas. No reduction has been made in consequence of the introduction of the electric light. The Town Council has now approved the adoption of the Brighton method of charging for electric current.

The Southwark Bridge Explosions.—Before Judge Emden, at Lambeth (London), on Tuesday last, a case of considerable importance to the public was tried, arising out of the explosions that occurred in February last on Southwark Bridge. The plaintiff, James Price, was crossing the bridge about noon on the day mentioned when four explosions took place at different points, the pavement being blown into the air, several persons sustaining injuries. This was a test case, and the claims of other persons depended upon its result. Major Cardew, R.E., who held an inquiry into the matter, was called, and said he attributed the explosions to an accumulation of gas in the electric mains. This was, however, controverted on behalf of the gas company, who attributed the fracture to the excessive frost. The Judge considered that negligence had been established—first in that the defendants has not discovered the fracture by the smell of the escaped gas, and also in their not seeing that the pipes were left properly supported after other persons to their knowledge had been excavating and working around them. Judgment was given for the plaintiff, with £12 damages, and costs on the higher scale, but with leave to appeal.

St. Pancras.—The Vestry have postponed the election of a chief electrical engineer for a fortnight. The final selection is to be made from Messrs. S. W. Baynes (Bradford), H. R. J. Burstall (London), and B. Deakin (London).

Swansea.—The report of the Electric Lighting Committee which is to be shortly presented to the Corporation will contain a recommendation that from £50,000 to £60,000 be borrowed to carry out electric lighting and refuse destruction schemes.

Synagogue Lighting.—The new synagogue at Cardiff, which is built to the plans of Messrs. Joseph and Corbett, is to be lighted throughout by electricity.

The "Strike" at Ponders End.—In reply to a question from Sir Charles Dilke, in reference to the strike of a number of the workmen of the Edison and Swan Company at Ponder's End, Sir U. K. Shuttleworth, in the House of Commons last week, stated that the Company were supplying incandescent lamps under an Admiralty contract. He had no knowledge as to the cause of the strike, except such as he had obtained through the newspapers and the Electrical Trades' Union, the officials of which complained that the wages paid by the Company were contrary to the resolution of the

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House of Commons. It was, however, necessary that the Company should be heard in the matter, and the Admiralty had asked for an explanation. It is almost too much to call this a strike. It is merely a passing incident, the seriousness of which has been much exaggerated.

The Telegraph in Central Africa.—The steamer "Isle of Dursey" has left Glasgow Harbour with 250 miles of telegraph material on board, weighing over 400 tons, for use in the extension of the African Trans-Continental Company's line from Blantyre. Southward from Blantyre the line has been practically completed, with the exception of a short stretch through Portuguese territory which intervenes in the district of the Zambesi. This portion will shortly be completed, when telegrams will be transmissible from Britain to Blantyre without interruption. The projected extension to the north, for which the material is taken by the "Isle of Dursey," will proceed from Blantyre by Lake Nyassa to Karonga, and thence to Abercorn, at the southern extremity of Lake Tanganyika, from which the line will pass along the western side of the waterway. The African Lakes Corporation of Glasgow have undertaken to deliver it at Chikwawa, on the Upper Shire, in British Central Africa. The telegraph posts are lightly made of steel, wooden poles being quickly destroyed by the white ants which infest the district.

Telephonic Communication for Fire Brigade Stations.—At the last meeting of the County Council, on the recommendation of the Fire Brigade Committee, it was agreed to connect the Bishopsgate fire-engine station and the fire-escape and horse-cart stations in Eastcheap and Finsbury by telephone.

Tiverton.—Last week the Mayor presided over a meeting convened for the purpose of considering the question of establishing a telephone service in the town. The Chairman said the National Company were prepared to put Tiverton in communication with the outer world if the town could guarantee 20 subscribers at an annual rent of £8 for five years. After a short discussion a committee was formed to make further inquiry and report to a future meeting.

Tramways Institute.—The annual general meeting of the Tramways Institute of Great Britain and Ireland will be held at the Holborn Restaurant, London, W.C., on Thursday next, the 27th inst., at 11 a.m. Included in the business is the reading of the following Papers:—"Traction and Lighting by the International Electric Storage Accumulators," by Mr. A. G. New; "Thwaites and Cawley's System of Electric Haulage," by Mr. G. Cawley, &c.

Warehouse Lighting.—The Midland Railway Company's extensive range of warehouses at Liverpool, now in course of erection, and which are estimated to cost, with the site, a quarter of a million sterling, are to be illuminated by the electric light, the plant consisting of three Davey Paxman two-cylinder engines, each driving a Thomson-Houston dynamo, and two smaller engines driving Edison-Hopkinson machines. A hydraulic plant is also to be installed, and this, with the electric lighting plant, is in charge of Mr. S. L. Smart, the Company's resident engineer. Mr. Chas. Trubshaw, the Company's architect, has prepared the plans and designs, the contractors being Messrs. W. Brown and Son, of Salford, who have, it is stated, executed work for the Midland Company in different parts of the country to the amount of about five millions sterling.

West Ham.—At the last meeting of the Town Council the recommendation of the Highways and Parks Committee that 12 leading electrical firms be invited to submit estimates for an installation of the electric light for the compulsory area, and that the Committee be empowered to draw up the conditions of tendering and report to the Council thereon, was adopted.

Works Lighting.—Considerable improvements have recently been made in the new plate mill at the Butterley Company's Ironworks, Codnor Park, including the addition of the electric light, consisting of seven 2,000 c.p. arcs and some incandescents. A Robey engine forms a portion of the plant.

BOOKS RECEIVED.

"Digest of British and Foreign Patent Laws." By Alfred J. Boult, M.I.M.E. London: Bemrose and Sons (Limited). 5s.

"Electrical Transmission and Distribution of Power," based upon results of undertakings carried out by the Electrical Company (Limited), of London. London: The Electrical Company (Limited).

"Manuale di Magnetismo ed Elettricita." By Guiseppe Poloni. Second Edition. Milano: Ulrico Hoepli.

"Armature Winding of Electric Machines." By H. T. Parshall and H. M. Hobart. (London: Robert W. Blackwell.)

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.

APPLICATIONS FOR PATENTS.

Note.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

May 27, 1895.

10,418. R. Wende. Berlin. Improvements in or connected with time-recording apparatus for consumption of electric current.

10,433. G. E. Dorman. Stafford. Improvements in dynamo-electric generators and motors.

10,445. H. C. F. Störmer. London. Improvements in apparatus for electrolysis of alkali salts with quicksilver as cathode. [Date applied for under Patents, &c., Act, 1883, Sec. 103, November 26, 1894, being date of application in Norway.]*

10,448. L. Falero and H. Lumley. London. Improvements in secondary or storage batteries.

10,480. A. Wright. Brighton. Improvements in methods of supplying electricity to arc lamps.

May 28, 1895.

10,502. E. W. Lancaster. Birmingham. Improvements in movable pendants and brackets for suspending and carrying electric gas or oil fittings and for other purposes.

10,518. C. Fane. London. A self-contained electrical grinding machine.

10,535. C. B. Callow and H. J. Eck. London. An automatic device for use with electric motors.

10,536. C. B. Callow and H. J. Eck. London. An automatic device for starting electric motors.

10,538. G. E. Dorman. Stafford. Improvements in dynamo electric generators and motors.

10,539. G. E. Dorman. Stafford. Improvements in dynamo electric generators and motors.

10,569. E. Massy. London. Improvements in electrical apparatus for lighting gas.

10,587. C. J. Reed. London. Improvements in and relating to electric heaters.

May 29, 1895.

10,604. R. Taylor. Birmingham. Improvements in insulators or insulated connections for telegraph, telephone, and other electrical wires.

10,614. T. Sloper and G. E. Beckett. Devizes. Improvements in or relating to electric telephone systems.

10,647. A. G. New and A. J. Mayne. London. Improvements in the electrical propulsion of boats and vessels.

10,655. G. Binswanger and A. E. Angold. London. Improvements in and connected with arc electric lamps.

10,656. G. Binswanger and A. E. Angold. London. Improvements in and connected with arc electric lamps.

10,660. J. D. Stuart. Cardiff. Improvements in or relating to electric contact makers.

10,679. D. B. Morison. London. Improvements in or connected with furnaces or apparatus in which materials are fused by means of an electric arc.

May 30, 1895.

10,658. G. C. Whipple and H. E. Warren. London. Improvements in electrical thermometers.*

10,687. F. d'A. Goold. Woking. Improvements in the arc-striking and feeding devices and arc lamp frames for arc lamps, more especially applicable to those arc lamps used singly or two or more in series across incandescent or constant-potential mains.

10,746. G. Benham and W. Smith. London. Improvements in or relating to the connecting and disconnecting the sockets of incandescent electric lamps.

May 31, 1895.

10,778. J. Perry. London. Improvements in dynamos and motors.

10,779. F. Hamer. London. A new method of and apparatus for the conversion of heat energy into mechanical energy and into electrical energy.

10,792. W. Elliott. London. An improved dry battery for electrical purposes, and material for packing same.

10,810. R. E. B. Crompton. London. Improvements in electric tramways.

10,816. H. W. Handcock, A. H. Dykes, and R. S. Lloyd. London. Improved method of installation for electrical conductors within buildings, and casings and appliances therefor.

10,817. H. W. Handcock, A. H. Dykes, and R. S. Lloyd. London. Improvements in joint blocks or boxes for electrical conductors, and the combination thereof with the conductor casings.

10,836. C. Payen. London. Improvements in storage batteries.*

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June 1, 1895.

10,875. J. W. Collings and W. Friese-Greene. Weston-super-Mare. Improvements in means of lighting cigars, cigarettes, and pipes by electricity.

10,903. J. B. Stone and S. Barnes. London. Improvements in or relating to automatic safety devices for electric currents.

10,929. E. Hermite, E. J. Paterson, and C. F. Cooper. London. Improvements in apparatus for electrolysing chloride solutions.*

10,930. E. Hermite, E. J. Paterson, and C. F. Cooper. London. Improvements in apparatus for electrolysing chloride solutions.*

10,951. E. Freund. London. Improvements in secondary batteries.

June 4, 1895.

10,977. F. H. Starling. Nottingham. Improvements in holdfasts for lightning conductors.

11,014. J. W. Myers. London. Improvements in electric governors.

11,016. H. Blackman. London. Improvements in electrolytic decompositions, and especially in the electrolytic production of bleaching agents and their uses, and in electrodes and apparatus therefor.*

11,025. Siemens Bros. and Co. (Limited). London. Improvements in apparatus for working railway switches and signals by means of electrical energy. (Messrs. Siemens and Halske, Germany.)

11,032. Theodor Eremin. London. Improvements in secondary batteries or accumulators.

11,035. H. Zeidler. London. Improvements in electrical signal or time-alarm clocks.

June 5, 1895.

11,085. J. D. F. Andrews. London. Improvements in arc lamps.

June 6, 1895.

11,110. W. Fox and F. S. Burroughs. Salford. Improvements in and relating to electric arc lamps.

11,153. A. B. Blackburn and W. L. Spence. London. Improvements in motor generator transformers.

11,180. H. Edmunds. London. Improvements in means for protecting pipes, electric cables and the like laid in the ground.

11,181. H. Edmunds. London. Improvements in switching apparatus for electric circuits.

June 7, 1895.

11,222. D. G. Fitzgerald. London. Improvements in voltaic batteries.

11,227. G. Feraris and R. Arno. London. Improvements in the arrangements for starting alternate-current electromotors.

11,233. J. Peschek. London. Improvements in arc lamps with hand regulation.

11,235. E. Jonathan Dale. London. Improvements in electric fire-alarm apparatus.

June 8, 1895.

11,266. J. D. F. Andrews and E. J. Piper. Westminster. Improvements in electric light ceiling roses.

11,279. E. Lever. Liverpool. Improvements in or connected with locomotives, also applicable to tramcars, electric cars, carriages and other vehicles.

11,283. G. Pettinger. London. Improvements in and relating to electric high and low-tension fuse heads for use in blasting and other purposes.*

11,297. A. Zobel. London. Improvements in or relating to incandescent electric lamps with two or more filaments.

11,293. E. Jordiss. London. An improved method or process for obtaining metals or metallic alloys by electrolysis.

June 10, 1895.

11,355. H. Edmunds. London. Improvements in or connected with electric cables.

June 11, 1895.

11,358. E. J. Piper. London. Improvements in electric switches.

11,375. F. S. Randall and J. Shallcross. Glasgow. A covering for electric wires.*

11,369. S. P. Parmby. London. Arc lamp.*

11,414. W. W. Scott. Wolverhampton. Improvements in and relating to soundless voice-conveyors for telephones.

11,434. C. Adams-Randall. London. Improvements in telephony.

June 12, 1895.

11,449. R. Middlemass. Scarborough. An improved grip to be employed in laying electric cables.

11,478. J. Y. Johnson. London. Improvements in apparatus for the electrolytical separation of precious metals from their ores or other materials containing them. (L. Pelatan, France, and F. Clerici, Italy.)

June 13, 1895.

11,516. E. Hopkinson. Manchester. Improvements in fittings for electric lamps.

11,528. A. J. P. Whitaker and F. G. Treharne. London. Improvements in and relating to insulators for electrical purposes.

11,540. The Morris Tube Ammunition and Safety Range Company (Limited) and A. J. H. Wyatt. London. Improved electric primer.*

11,544. Bullers (Limited) and E. J. Chambers. London. Improvements in the manufacture of the insulator arms of telegraph poles and poles for carrying conductors of electricity generally.

11,547. The Cowper-Coles Galvanising Syndicate (Limited), S. O. Cowper-Coles and W. P. Routh. London. Improvements in and connected with apparatus for coating strips, wire, and like metal articles by electro-deposition.

11,548. J. E. Kingsbury. London. Improvements in telephone systems. (The Western Electric Company, United States.)

11,549. J. E. Kingsbury. London. Improvements in telephone systems. (The Western Electric Company, United States.)

11,555. S. Cambie. London. Improved means for opening and closing doors by electricity.

11,558. E. Mercer and J. J. Class. London. Tee junction pipe clips for electric mains and services.

11,560. J. G. W. Aldridge. London. Improvements in or connected with electric mains or conductors.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

4,021. Brown. Telephone transmitters.
8,539. Andreoli (Raverot) and Another. Telephone exchange system.
10,032. Gautier. Electrolysis.
10,701. Snell. Electrical connections for marine purposes.
10,917. De Ferranti. Electric safety fuses.
11,286. Holden. Electric lamps.
11,483. Liardet. Driving dynamos, &c., by water power.
12,817. Zobel and Buchmüller. Electric incandescent lamps.
12,867. Weighill and Moore. Telephone cabinets, &c.
13,136. Taylor and Dearlove. Submarine telegraph, &c., cables.
13,550. Anderson. Electric tramways.
13,581. Thompson. Electric cables.
13,549. Anderson. Electric tramways.
15,065. Tyer. Making electric contact by passage of a railway train.
29,965a. Thomson (Coffin). Electrically heating metal, &c.

1895.

2,289 Kingsbury (Western Electric Company). Recording telephonic conversations.
2,430. Hardingham (Felten and Guilleaume.) Insulating electric conductors.
2,914. Devonshire (Steinmetz). Electric distribution.
2,915. Devonshire (Steinmetz). Alternating current distributing systems.
3,573. Burchell. Telephonic apparatus.
4,257. Thompson (Mathieson). Electric arc lamps.
5,428. Denison. Electric transmitting thermometer.
6,007. Siemens, Bros. and Co. (Siemens and Halske). Electrically-propelled railway trains.
7,625. Rothenberger and Others. Electric wire insulators.
7,657. McDougall and Others. Secondary batteries.
8,026. Faulkner. Electric railway systems.
8,147. Nees. Driving electric cars.
8,226. Von der Poppenburg. Electric batteries.

COMPANIES' MEETINGS AND REPORTS.

Electric and General Investment Company (Limited).

The following report of the Directors of this Company for the year ended May 31st last will be submitted to the sixth ordinary general meeting of shareholders to be held at Winchester House, Old Broad-street, E.C., on Tuesday, July 2nd, at 3 p.m.:—

The profit and loss account shows a gross profit on the transactions of the year of £8,470. 17s. 1d., and after deducting all standing charges and the interim dividend already paid on the Ordinary shares, there remains a net balance available for distribution of £5,330. 13s. The Directors now recommend the payment, out of the profits for the past year, of a further dividend upon the capital paid up on the Ordinary shares at the rate of 30 per cent. per annum for the past six months, and a dividend on the Founders' shares of £20 per share for the year. This will leave a balance of £330. 13s., which the Directors recommend should be added in equal moieties to the reserve funds of the holders of the Ordinary and Founders' shares.

The trustees for the Founders' Shares Reserve Fund propose to distribute to the holders of such shares a sum of £15. 16s. per share out of the proceeds of investments sold and dividends received, making, with the before-mentioned dividend, a total distribution of £35. 16s. on each Founders' share.

The Directors who retire this year are Lord Cloncurry and Mr. Braithwaite. The latter offers himself for re-election, but Lord Cloncurry permanently retires, on account of his continued residence in Ireland. The auditor, Mr. Rait, seeks re-election.

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NEW COMPANIES, STATUTORY RETURNS, &c

BEAMAN AND DEAS SYNDICATE (LIMITED).—This Company was registered on June 17th with a capital of £30,000, in £50 shares, to acquire from S. J. Beaman and J. Deas, engineers, of Warrington, Lancs., certain patent rights in connection with "improvements in destructor furnaces," and to carry on the business of contractors, boiler makers, wire drawers, engine builders, and manufacturers of and dealers in electric, magnetic, telephonic, and other apparatus. The first Directors are S. J. Beaman, J. Deas, T. Tunstall, J. L. Tunstall and W. Griffiths.

CORK ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—This Company was registered on June 15th in Dublin, with a capital of £1,000, in £1 shares, to carry on the business of an electric light, heat, and power supply company, to carry out contracts for the lighting by electricity of towns, villages, public and private buildings, &c., and to carry on the business of electricians, mechanical and electrical engineers, suppliers of electricity, and manufacturers of and dealers in motors, generators, converters, meters, lamps, batteries, and all apparatus and materials used in connection with the generation, accumulation, supply, distribution, and utilisation of electricity. The subscribers, with one share each, are: M. D. Daly, J.P.; E. Hall, J. Morrough, J. Dwyer, J.P.; J. Peardon, W. McGrath, H. Dale, J.P.; J. Pike, J. G. McCarthy, W. H. Hill, A. C. Reilly, J. H. Scott, E. J. Julian and R. A. Atkins, all of Cork.

CRAMP MANGANESE BRONZE COMPANY OF GREAT BRITAIN (LTD.).—This Company was registered on June 14th with a capital of £50,000, in 25,000 Preference and 25,000 Deferred shares of £1 each, to carry on the business of manufacturers or workers of and dealers in bronze and other metals or metallic alloys, metallurgists, civil, electrical, marine and mechanical engineers.

ELECTRIC ORGAN COMPANY (LIMITED).—This Company was registered on June 15th with a capital of £110,000, in 55,000 £6 per cent. cumulative £1 Preference shares, and a like number of Ordinary shares of similar value, to carry into effect five agreements made between the Hope-Jones Electric Organ Company (Limited), Robert Hope-Jones and others, to apply electric and pneumatic action to organs and other musical instruments, and to carry on the business of builders and manufacturers of organs and musical instruments, electricians, and manufacturers of and dealers in electrical, pneumatic and other apparatus. The subscribers, with one share each, are: T. Threlfall, Robert Hope-Jones, H. Crewdson Howard, A. W. Speed, A. Foxworthy, R. Hope-Jones and H. R. Terry. The first Directors are: J. E. Austin, A. W. M. Bosville, R. Hope-Jones, T. Threlfall and J. M. White.

INDIA-RUBBER, GUTTA-PERCHA AND TELEGRAPH WORKS COMPANY (LIMITED).—The annual return to February 28th was filed on the 11th ult. The nominal capital is £812,000, in £10 shares, of which 50,000 have been subscribed for and allotted, and upon each of these the full amount has been called and paid.

INDO-EUROPEAN TELEGRAPH COMPANY (LIMITED).—The annual return to May 13th has been filed. The Company's capital is £450,000, in 18,000 £25 shares. Of these 17,000 have been taken up, and the full amount has been called and paid.

INTERNATIONAL ELECTRIC STORAGE (LIMITED).—This Company, which has left its registered office, has failed to file its statutory returns, and its name, we learn, is to be struck off the register of joint stock companies unless it complies with the provisions of the Companies Acts.

KENNEDY STORAGE BATTERY COMPANY (LIMITED)—The annual return to December 31, 1894, has been filed. The whole nominal capital of £100,000, in £1 shares, has been taken up, and issued as fully paid. The Directors have not yet been able to obtain the transfer of the Company's patent, but they desire to retain the registration.

LONDON PLATINO-BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The annual return to May 20th has been filed. The nominal capital is £400,000, in £10 shares. Of these 37,548 have been subscribed for and allotted, and the full amount called and paid thereon.

RAILWAY ELECTRIC READING LAMP COMPANY (LIMITED).—The annual return to May 10th has been filed. Only seven shares have been subscribed for out of a nominal capital of £100,000, in £5 shares, and nothing has been called.

CITY NOTES.

AFRICAN DIRECT TELEGRAPH COMPANY (LIMITED).—The coupons on this Company's Four per Cent. Mortgage Debentures, due on July 1st next, will be paid on and after that day at Parr's Banking Company and the Alliance Bank, Bartholomew-lane, London, E.C. Coupons to be left three clear days for examination. The debenture register will be closed from the 24th to the 29th inst. inclusive.

ACME AND IMMISCH ELECTRIC WORKS (LIMITED).—A private meeting of the members of this Company was held at the works, Ferdinand-street, Chalk Farm-road, London, N.W., on Wednesday last, to which the Press were not admitted.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—The coupons on this Company's second issue of Five per Cent. Debentures, due the 30th inst., are payable on and after the 29th inst. at Parr's Banking Company and the Alliance Bank (Limited), Bartholomew-lane, E.C. Coupons to be left three clear days for examination.

CALLS DUE.—An instalment of £2 per share on the first issue of 10,000 Six per Cent. Cumulative Preference shares of the County of London and Brush Provincial Electric Lighting Company (Limited) becomes due on the 29th inst.

CHELSEA ELECTRICITY SUPPLY COMPANY (LIMITED).—A confirmatory meeting to approve certain modifications in the Articles of Association of this Company was held at Draycott-place, Cadogan-gardens, London, S.W., on Wednesday last.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended June 16th were £862, as against £831 in the corresponding week of 1894, being an increase of £31. The total receipts for the half-year amount to £22,299, against £21,755 for the corresponding period of 1894, an increase of £544.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The transfer books of the debenture stock of this Company will be closed the 24th to the 30th inst., inclusive, for the preparation of interest warrants.

CROMPTON AND CO. (LIMITED).—In the Chancery Division, on Monday, Mr. Justice Romer sanctioned a petition for the reduction of the capital of this Company by a sum of £20,000, the reduction to be effected by the cancellation of 4,000 Ordinary fully paid up shares, that amount having been lost or being unrepresented by available assets.

GREAT NORTHERN TELEGRAPH COMPANY.—Coupons fallings due on July 1st on the shares of this Company will be paid by Messrs. C. J. Hambro and Co., 70, Old Broad-street, London, E.C. Coupons have to be left three clear days for examination.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY (LIMITED).—This Company have declared an interim dividend of 6s. per share, free of income tax, on the Ordinary shares of this Company, payable on August 1st next.

INDO-EUROPEAN TELEGRAPH COMPANY (LIMITED).—This Company is prepared to receive, at its offices, 18, Old Broad-street, on and after July 1st, applications for the sixth series of coupons, to be issued to holders of share warrants to bearer in this country. Application must be made on printed forms obtainable at the Company's offices.

LIVERPOOL ELECTRIC SUPPLY COMPANY (LIMITED).—An extraordinary general meeting of this Company is to be held on the 22nd inst. for the purpose of approving the following resolutions:—"1. That an agreement, dated May 28, 1895, entered into between the Company and the Mayor, Aldermen and citizens of the City of Liverpool, for the sale of the undertaking of the Company to the Corporation, be approved, subject to such alterations as Parliament may see fit to make therein. 2. That the Company apply to Parliament in the present session for an Act to make all necessary and useful provisions for effectuating such sale, for the distribution of the price thereof and the assets of the Company, and for the eventual winding-up and dissolution of the Company, and that the Directors be instructed to take all necessary steps for obtaining such Act. 3. To determine the provision to be made in such Act or otherwise for the appropriation and distribution of the reserve and renewal fund of the Company and the payments to be made to the Directors and any officers and servants of the Company in recognition of their services. 4. That the Bill for the Act now submitted to the meeting be approved subject to such additions, alterations and variations as Parliament may think fit to make therein." If these resolutions are legally approved, a confirmatory meeting will be promptly called.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 16th inst. amounted to £1,268. The amount for the corresponding week last year was £882; increase, £386.

MANCHESTER SUBURBAN ELECTRIC SUPPLY (LIMITED).—It is stated that arrangements are now completed in connection with the above Company. The share capital is to be £25,000, in 3,000 Six per Cent. shares and 22,000 Ordinary of £1 each, half of which are offered for subscription. The registered offices are 8, South King-street, Manchester, and Mr. J. K. Lawton is secretary *pro tem.*

PACIFIC AND EUROPEAN TELEGRAPH COMPANY (LIMITED).—The coupons on this Company's Four per Cent. Guarantee Debentures, due the 30th inst., are payable on and after the 29th inst. at Parr's Banking Company and the Alliance Bank (Limited), Bartholomew-lane, E.C. Coupons to be left three clear days for examination.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended June 14th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,389.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the half-month ended June 15th are £2,085, as compared with £2,181 in the corresponding period of 1894. The February receipts, estimated at £4,746, realised £4,808.

WOODHOUSE AND RAWSON UNITED (LIMITED).—The Five and a-Half per Cent. Debenture-holders in this concern met by adjournment, before Mr. C. J. Stewart (Official Receiver and liquidator), at the Carey-street offices of the Board of Trade, to consider the proposal to proceed against the Directors and other officials with a view to recovering certain moneys for which they are thought to be liable. Mr. Stewart said that although the whole of the Ten per Cent. Debenture-holders and a majority of the Six per Cent. Debenture-holders had on the last occasion voted against the institution of proceedings, it had to be borne in mind that substantial dividends would, no doubt, be paid to those two classes of creditors, who consequently disliked the idea of entering into litigation and risking the assets which were to be available for the costs. The present meeting would probably take a different view, as there was no prospect of any dividend whatever being paid to them. The business of the meeting was to consider whether proceedings should be taken against the Directors and other officials of the Company with a view to the recovery of moneys, and whether an arrangement could be made with the other classes of the debenture-holders under which some benefit would accrue to the holders of the Five and a-Half per Cent. Debentures. A resolution in favour of the proposed proceedings was negatived by a substantial majority.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, June 12.		Price Wednesday, June 19.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending June 19. Highest	Lowest
			TELEGRAPHS					£ s. d.		Highest	Lowest
£1,012,880	Stock	10/0	Anglo-American	46	48	46	48	4 3 4	Jan., Apr., July, Oct.	..	..
£2,993,560	Stock	20/0	Do. Preferred	84½	85½	86	87	4 17 8	" "	86¾	85½
£2,993,560	Stock	5/0	Do. Deferred	8½	8¾	8½	8¾	..	..	8 5/16	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	103	106	103	106	3 16 11	January and July ..	103¾	..
130,000	£10	3/0	Brazilian Submarine	13	13½	13	13½	4 16 4	Mar., June, Oct., Dec.	13½	13¼
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 8 11	June and December	112½	..
10,000,000	$100	7%	Commercial Cable Capital Stock	154	158	154	158	4 8 7	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	3½	4½	3½	4½	4 8 11	April and October ..	..	—
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10½	9¾	10½	4 7 7	" "	—	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	105%	108%	105%	108%	4 3 4	..	..	—
60,710	20	2/0	Direct United States Cable, 1877	9½	9¾	9½	9¾	4 0 5	Jan., Apr., July, Oct.	..	—
400,000	10	2/6	Eastern	16¼	16½	16¼	16½	3 18 9	" "	16½	16 5/16
70,000	10	6%	Do. 6 per Cent. Preference	17¼	17¾	17¼	17¾	3 7 7	" "	..	—
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	123	126	123	126	3 3 6	May and November	124½	—
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	109	106	109	4 13 3	February & August	..	..
250,000	10	6/6	Eastern Extension	16⅞	17⅛	16⅞	17⅛	4 7 7	Jan., Apr., July, Oct.	17⅛	16 13/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	124	127	124	127	3 3 0	February & August	..	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	104	108	104	108	4 14 9	January and July ..	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	104	108	104	108	4 14 9	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	107	110	107	110	3 13 9	February & August	109	107½
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	111%	114%	111%	114%	3 10 6	May and November	..	—
180,227	10	2/3	Globe Telegraph and Trust	10	10¼	10	10¼	4 5 4	Jan., Apr., July, Oct.	10 3/16	10
180,042	10	6%	Do. 6 per Cent. Preference	16¾	17	16¾	17	3 10 7	" "	17	16¾
150,000	10	7/2	Great Northern	22	22½	22	22½	3 11 1	Jan., April, and July	22	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	105½	..
17,000	25	37/6	Indo-European	44	47	44	47	5 6 5	May and November	46½	45
37,548	10	2/6	London Platino-Brazilian	5	7	5	7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	106	110	106	110	5 11 1	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	106	109	107	110	3 14 1	..	108½	..
11,839	8	4/0	Reuter's	3½	4½	3½	4½	..	April and October	..	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	124	129	124	129	4 13 0	" "	127¾	..
15,609	10	5/0	West African Telegraph	4½	5½	4½	5½	..	January and July ..	..	—
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	102	105	102	105	4 16 7	March & September	102½	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July ..	1½	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	100	105	100	105	7 12 5	June and December	102	101
88,321	10	6d.	West India and Panama	¾	1	¾	1	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	9¾	10½	9¾	10½	5 6 8	May and November	10 1/16	9⅞
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	6 6 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110	113	110	113	4 10 6	June and December	..	..
64,242	15	6/0	Western and Brazilian	10½	10¾	10½	11	4 1 11	May and November	..	..
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½	6¾	6½	6¾	..	—	..	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4½	4¾	4½	4¾	..	..	—	..
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	103	107	103	107	5 14 10	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	103	107	103	107	5 14 10	" "	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	5 19 8	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	101	103	102	104	5 17 8	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	—	..	..	..
224,850	10/0	1½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	—
171,504	£1	8·215d.	Oriental Telephone and Electric (fully paid)	9/16	1 1/16	9/16	1 1/16	..	Yearly	..	..
484,597	5	2/6	National	5½	5¾	5½	5¾	4 6 11	June and December	5 11/16	5 9/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15½	16½	15½	16½	3 12 9	" "	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½	15½	14½	15½	3 17 5	" "	—	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅝	6⅛	5¼	6	4 3 4	—	5 13/16	5 13/16
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	104	106	105	107	3 5 5	January and July ..	106¼	..
58,000	5	1/0	United River Plate	1½	2½	1½	2½	..	" "	..	—
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	87	92	87	92	5 8 8	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	14	15	14	15	1 13 4	—	14⅞	14⅞
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15¾	16¼	15¾	16¼	3 13 10	..	16 1/16	15⅞
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	133	136	3 13 6	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	—	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900		..		..	..	—	..	..
8,322	£5	..	House-to-House Electric		..		..	..	—	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).		..		..	..	—	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July ..	..	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7¾	7⅞	7¾	7⅞	..	—	..	..
111,000	5	..	London Electric Supply	..		..		..	—	..	—
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	10¾	11¼	10¾	11¼	2 13 4	..	11 1/16	10 15/16
£150,000	Stock	4½%	* Do. 4½% Debs.	117	119	117	119	3 17 1	June and December	..	..
6,452	£10	2/0	Notting Hill Electric	8	8½	8	8½	..	..	8½	8½
19,980	£5	4/6	St. James and Pall Mall	8½	8¾	8½	8¾	..	—	8⅝	—
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9¼	8¾	9¼	3 15 8	—	9¼	..
59,900	5	5%	Westminster Electric Supply (fully paid)	7¾	8¼	7¾	8¼	3 2 6	—	..	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅜	2⅝	2¼	2½	6 0 1	—	2 5/16	—
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2⅜	2⅝	5 1 1	—	..	—
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	112	115	112	115	3 19 4	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2	3	2	2½	..	January and July ..	..	—
12,139	5	—	Edison and Swan United	1¾	2¼	1¾	2¼	..	..	2 3/16	1¾
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		—		..	..	—	..
120,000	2	..	Electric Construction	½	¾	½	¾	..	..	..	—
12,845	2	2/9¾	Do. 7 per Cent. Cumulative Pref.	1½	2	1½	2	..	..	—	..
91,195	2	10/0	Elmore's Patent Copper Depositing	1	1½	1	1½	..	..	1⅜	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	February & August	23⅜	21¾
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 7 5	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..	—	..	..
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)		⅛	—	⅛	..	..	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	43	45	43	45	5 6 8	March and July	45¼	44
£150,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4 11 9	January and July	..	—
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	—
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,870	10	12/0	W. T. Henley's Telegraph Works Ordinary	10	11	10½	11½	5 4 4	..	11½	..
£30,000	10	7%	Do. 7 per Cent. Preference	14	15	14	15	4 13 1	..	14¼	11½
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1¼%	City and South London Railway	43	45	42	44	2 16 10	May and November	43	..
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	..	—
£67,130	Stock	4%	Do. 4% Perpetual Debenture	131	133	132	134	2 19 9	May and November	132½	—
37,500	£10	2%	Liverpool Overhead Railway	9⅞	10	9 15/16	10 1/16	1 19 10	—	..	—
6,295	10	5%	Do. 5% Preference	14¾	15¼	14¾	15¼	3 5 7	—	..	..
125,000	Stock	4%	Do. 4% Debenture	111	113	111	113	3 10 2	January and July	..	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 893. [No. 9. Vol. xxxv.] FRIDAY, JUNE 28, 1895. PRICE SIXPENCE.

NOTES.

THE year 1895 seems destined to be written in letters of fire in the annals of electric lighting in London. Early in February, as our readers will remember, there was a serious fire at the Kensington Court station of the Kensington and Knightsbridge Electric Lighting Company, and on Monday evening last the Metropolitan Electric Supply Company's station in Sardinia-street was practically destroyed by fire. The flames burst out with great suddenness in the upper floors about a quarter past 6 o'clock in the evening and the fire spread with the utmost rapidity, notwithstanding the streams of water from the hydrants fitted to the premises. The interruption of the supply of the district served by the station was, however, only of short duration, thanks to the energy and good will of the staff. By 8:30 most of the theatres and other important buildings in the neighbourhood of the Strand were lighted as usual from the Metropolitan Company's remaining stations and by to-day it is anticipated that current will be available to everyone as usual. No lives were lost and no secondary accident, beyond the bursting of a steam-pipe, was caused by the conflagration. The catastrophe could scarcely have happened at a more awkward time, and the Company must be congratulated on so quickly getting a supply to its more important customers. It is to be hoped that these two disasters will bear fruit in more elaborate structural and mechanical precautions against fire. The cause of the fire is still unknown.

AFTER nearly four years of incubation the Central London Railway scheme has been brought to the notice of the investing public, who would appear to have formed a higher opinion of the prospects of this line than they did of those of the Great Northern and City Railway in February last. A contract has been entered into with the Electric Traction Company (Limited) for the acquisition of land and the construction and equipment of the railway for the sum of £3,244,000, of which £2,544,000 is to be in cash and £700,000 in Four per Cent. Debenture Stock. The line is to be opened for traffic by December 31, 1898.

WITH the experience which has been gained from the construction and working of the City and South London Railway, the Central London Railway should present no unsolved problems either to the civil, the mechanical, or the electrical engineer, and in view of the much larger traffic and smoother load-curve, the line should also prove a more decided financial success than the pioneer concern. Indeed, the only unknown quantity in this undertaking is the Electric Traction Company (Limited), which at present consists of the usual seven signatories, none of whom are known to fame. It is to be hoped that the intervention of this concern does not portend anything in the shape of financial finesse. The construction and equipment of the line is, it would appear, to cost something like £500,000 a mile; the figure for the City and South London Railway is less than £300,000. It is not very obvious why there should be this enormous difference. An increase of 15 per cent. in the diameter of the tubes cannot surely be responsible for an increase of some 75 per cent. in the cost of construction and equipment.

A SOMEWHAT sensational statement was put forward a few days ago by a daily contemporary to the effect that when all the five Post Office telephone circuits between Leeds and London are in simultaneous operation the induction is so serious that the remedial measures which will have to be taken will greatly delay the opening of the lines to the public. It is quite true, we believe, that there is some cross-talk when all the circuits are being used, but it can scarcely be characterised as serious, and the proposed remedy, as we stated in our issue of June 14th, is merely to cross the mutually interfering circuits at long intervals, crossing having so far proved quite effectual.

EVEN if it possessed no practical advantages over the mechanical analyser, or were distinctly inferior to it as an engineering instrument, the graphical method of developing periodic complex functions in a Fourier's series, which is discussed by Prof. PERRY in an article this week, would at any rate have the advantage of being of higher educational value. Prof. PERRY, if we understand him rightly, thinks that this graphical method of CLIFFORD's might actually be ranked among practical engineering instruments and processes. It would, at any rate, speak well of the mathematical tastes and abilities of the profession were it to become so; and we are quite ready to admit that the modern engineer is far more scientific than the engineer of yesterday. But, with the glorious intricacies of Prof. PERRY's diagram befor us, we hesitate to believe that this elaboration of curves is likely to find any very general use in the engineer's office.

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We do not overlook the fact that, in a time competition with a harmonic analyser, the graphical method came in a very good second; but this achievement presupposes an expert at work on either side, and the average man is, we venture to think, more likely to become expert with an analyser than with Fourier's series and all its works. Educationally, however, Prof. PERRY's graphical treatment of an idea originally due to Prof. CLIFFORD is exceedingly valuable; though even grinding away at a mechanical analyser is an employment not altogether without educational value to some minds.

THE notes which we print elsewhere on some experiments upon the attraction between a solenoid and a cone-shaped iron core are of interest as indicating one way of producing a mechanical movement of some considerable power that shall have a motion proportional, over a limited range, to the current passing through the apparatus. Doubtless there is scope, in many mechanical applications, for electromagnetic mechanism of this order. Not much has been done in this line since the researches of BRUGER, which, however, were directed to a different end. We would throw out the suggestion to those interested in mechanisms of this kind that something might be done toward the attainment of a closer proportionality by the application of a graphic construction to connect the shape of the core with the width of gap in the magnetic circuit and the saturation of the core, so as to make the travel for a given controlling force (such as gravity) proportional to the ampere-turns of exciting current. Mr. McMAHON's experiments seem to show that no part of the travelling core ought to be cylindrical.

IN our "Correspondence" columns this week will be found a long letter from Messrs. HOUSTON and KENNELLY anent some editorial criticisms with regard to the nomenclature and symbols adopted by them in their valuable "Contribution to the Theory of Demagnetisation," which appeared in our issue of May 31st. As to "block" letters *versus* "black" letters for magnetic quantities, we can only repeat what we have said before—namely, that the table of symbols referred to by Messrs. HOUSTON and KENNELLY was practically the work of a single individual, and was merely *recommended* by the Congress. To possess any international validity and force such a sweeping reform should be the outcome of the careful consideration of experts, and not the work of a single hand blessed by the hurried recommendation of an overworked Congress. Until some such properly considered, properly authorised edict is promulgated, everyone who adopts any of the variegated symbols contained in the recommended table does so because he individually prefers them, not because he must do so under pain of being classed as a scientific free lance.

As regards our correspondents' remarks about the use of the word "gauss," we still hold the view that the "misconception" is with those who regard magnetising force (**H**), and magnetic flux (**B**) as "essentially the same physical quantity." It is, of course, true that in what is known as the electromagnetic system of units the dimensions of **B** and **H** are identical. But this is only because the dimensions of μ, the permeability, are ignored, just as, in the corresponding electrostatic system, the dimensions of K, the specific inductive capacity, are omitted. It is quite arbitrary to neglect the dimensions of μ and K, and look upon them as mere numbers. In the electromagnetic theory **B** and **H** have to be regarded as distinct physical quantities with different dimensions, for it is impossible any longer to neglect the physical nature of μ and K. Our correspondents' remarks about the measurement of these quantities only show that magnetic flux (**B**) can be measured, for they estimate **H** from the flux of induction it produces. This process is quite legitimate, but the quantity primarily measured is **B** and not **H**. If our only way of measuring voltage was by the current it produced in conductors, we should use such a method, as indeed we do in most cases; but that would not alter the fact than an electromagnetic voltmeter acts primarily from current, not from volts; nor would it make it legitimate to regard a volt and an ampere as the same kind of quantity.

Cable Interruptions.—There are no cable interruptions to report this week.

City and South London Railway.—As a train on the City and South Lond on Electric Railway from Stockwell was entering the Oval station shortly before 10 o'clock on Saturday morning last, the last coach left the metals and caught fire. The line was blocked for some time. No one was injured.

Argon.—At a recent meeting of the Académie des Sciences M. Berthelot announced that he had succeeded in making argon combine with bisulphide of carbon under the action of the electric discharge. M. Berthelot subsequently recovered the argon that had combined with the bisulphide of carbon.

Electric Lighting of the Side Streets of the City.—At the last meeting of the City Commissioners of Sewers the suggestions of the electrical inspector, Mr. Voysey, referred to in our issue of June 14th, were adopted, and the Streets Committee were requested to consider the desirability of experimenting also with incandescent gas lamps.

Strand Electric Lighting Order.—On Wednesday last Lord Camperdown's Committee on the Strand Electric Lighting Order heard further evidence as to the relative merits of the methods employed by the Charing Cross and the Metropolitan Companies, the latter being supported by Lord Kelvin and Mr. Ferranti. The Committee passed the Order.

A Water Power Bridge.—According to an American technical journal a plan is on foot in Buffalo to erect a bridge across the Niagara River, and beneath it to place a number of undershot water wheels, which would be used to drive dynamos which would furnish light and power to the city. It may be remembered that Old London Bridge had water wheels arranged in this manner.

Personal.—The staff of the Indo-European Telegraph Company have presented Mr. W. Andrews, the Managing Director of the Company, with a handsome silver casket, in celebration of his completion of 25 years' control of the management. In making this announcement, *The Times* compliments Mr. Andrews and the Indo-European Company on the distinguished services rendered by them to Indian communications, and especially upon the accuracy and punctuality with which the leading journal's Indian correspondence over the Company's system has been accomplished.

Road Traction.—On page 249 of our last issue we alluded to a Bill, which Mr. Shaw Lefevre had brought in, to amend the law with respect to the use of locomotives on highways. As we then stated, the Bill contains only one clause, and its object is to facilitate electric and similar road traction by exempting carriages so propelled from the regulations of the

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Locomotives Act. A copy of this Bill has now been published, and it may be interesting to state that the weight of the vehicles which are to be exempted from the application of the Locomotives Acts of 1861 and 1878 must be less than two tons.

Accident on the Chicago Elevated Railway.—"It is to be regretted," says the *Western Electrician* of Chicago, "that a fatal accident, due to the electric current, has already occurred on the electrically operated metropolitan elevated road in Chicago. On Monday, June 10th, a workman employed on the structure started to climb to the top. In doing so he grasped one of the conducting rails, and as his body was in contact with the metal structure he received the heavy operating current through his body at the pressure of 500 volts. He was unable to release himself, but fellow workmen finally pulled him away and removed him to a place of safety, where he died in ten minutes."

Aluminium-Copper Telegraph Wires.—Tests have recently been made of some aluminium-copper wires intended for use in connection with the Monteil Trans-African Expedition. The percentage of the alloy composing these wires is 40 per cent. aluminium and 60 per cent. copper. The resistance of a kilometre of these wires having 1mm. cross-section is found to be 31·1 ohms for soft and 33·29 ohms for hard-drawn wire, the resistance of an ordinary copper wire of the same dimensions being 16·45 ohms. The tensile strength of wires of this alloy, 2·3mm. in diameter, was found to be, on an average, 28 kilogrammes per square millimetre (17·78 tons per square inch).

Electric Lighting at Berlin.—In the annual report of the Berlin Town Council on the administration of the municipal gasworks some interesting figures are given in regard to electric lighting in Berlin. There are in all 185 street arc lamps, 71 of which are alight all night, the remainder only burning up to midnight. For private purposes there are 9,932 arc lamps, 200,474 glow lamps, and 667 motors and apparatus. Of these, 4,259 arc and 79,212 glow lamps are supplied by isolated plants, of which 251 are driven by steam and 97 by gas engines. Current for the remainder is supplied by the Berlin Electricity Works. The increase of the lamp connections over those connected at the end of the previous year (1893) was 16·23 per cent.

Royal Society Government Grant.—Of the sum of £4,000 annually voted by Parliament to the Royal Society, an appropriation has been made which includes several grants for electrical and allied researches. Among these we notice the following:—£25 to Messrs. J. Holm and J. R. Erskine-Murray, for experimental investigations on contact electricity of conductors; £50 to Prof. G. M. Minchin, for the measurement of the electromotive forces developed in certain photo-electric cells by the light of the moon, planets and stars; £150 to Prof. O. J. Lodge, for assistance in experiments intended to elucidate the connection between ether and ordinary matter; £162. 10s. to Mr. R. Threlfall, for preparation of pure selenium and exact determination of its electrical properties.

Electro-magnets and Hot-Wire Devices.—Referring to a recent discussion on the relative advantages of electro-magnets and hot-wire devices which took place in the columns of the *Electrical Engineer* of New York, Mr. W. M. Stine observes that "it should be borne in mind that a heated wire acts in a sense like a spring which may be expanded and contracted by the heating power of an electrical current. On the other hand, an electro-magnet acts in many cases as an ether stress spring, and, being practically massless, must always be greatly superior to a material spring. The faults of the electro-magnet are hysteresis, residual magnetism, &c.; of the hot wire, sluggishness, drift, variation of constants, &c. The hot wire acts by virtue of the C^2R loss in it, and primarily absorbs power; the electro-magnet acts in proportion to its ampere-turns, and only incidentally absorbs power. Though the hot wire is in general an inferior device when compared with an electro-magnet, there are cases in which it can be used to advantage."

Damage by Lightning.—At Crewe, on Wednesday afternoon, lightning struck a chimney in the railway works, and the chimney fell. Chimney-stacks in Alton and Lockett-streets were also smashed. Considerable damage was done in the district.—At Normanton two miners returning from their employment were killed by a flash of lightning.—At Hammersknott Park, the site of the Royal Agricultural Society's Show, five people seeking shelter under an ash tree situated a short distance from the members' pavilion, were struck by lightning, and two were killed.—During a heavy thunderstorm which passed over Wisbech and district on Wednesday, last week, one of the lighthouses at Sutton Bridge was struck by lightning and almost completely wrecked. There is a hole nearly 6ft. wide in the top of the lighthouse, and the walls of the building are cracked in all directions.—An American barque, loaded with petroleum, and on a voyage from Philadelphia for Havana, when off the Bahamas, on the night of May 21st, was struck by lightning. One of the oil tanks exploded and set fire to the ship. The captain and some of the crew perished; only six survived.

The Efficiency of Heaters.—The German Hygienic Association, says the *Gas World*, offers a prize of £225 for a research essay on the heat given out by heaters. The programme is "The heat given out in heating installations by heaters in their various forms and modes of use is to be ascertained. The investigations are to be described in detail in respect to the arrangement of the heaters, the nature of the heating agents, and the observations made; and they are to be illustrated by drawings. The heating values obtained are to be stated in units of heat given off per hour per unit of surface. In the case of heat given out to air, the investigations must be conducted with currents of air at speeds as different as possible. The heaters are to be described in detail as regards form and measurement, and the relation of their heating efficiency to their weight is also be ascertained." Essays to be written in German, with a motto and sealed envelope, and sent to Prof. Konrad Hartmann, Charlottenburg, Fasanenstrasse 18, before July 1, 1896. The essay will remain the property of the successful competitor, but he must publish it within six months, and give the prize offerers 300 copies gratuitously. The prize may be divided or withheld.

The Brighton-Rottingdean Seashore Electric Railway.—At the last meeting of the Brighton Town Council a letter, dated May 24th, from Mr. Magnus Volk was brought before the notice of the Council by a Committee. The letter stated that the Brighton and Rottingdean Seashore Electric Tramroad Company found that the power required to drive the car through the water could only be ascertained by actual experiment, and were advised that the best means of ascertaining this would be to drive the car in the first instance by means of a small surface-condensing steam engine of the marine type, which the Company undertook would neither emit steam nor smoke. The contractors were prepared to give an undertaking to remove the steam engine within six months at the very outside, and would be quite willing that permission should be given only on condition that neither smoke nor steam were emitted. The Borough Engineer and Surveyor handed in a lengthy report on the subject, stating amongst other things that to his mind it was very questionable whether the use of steam engines, even temporarily, was authorised by the Company's Act of Parliament. After a lengthy debate the Brighton Town Council decided by 28 votes to 3 to confirm the Committee's recommendation and to refuse the permission asked for.

An Electric Lighting Act for India.—In a recent issue the *Times of India* gives a *précis* of the statement of objects and reasons appended to the Bill to facilitate and regulate the supply of electricity for lighting and other purposes in Calcutta. The Government has at present no power to grant a licence or provisional order for the supply of electricity. The Indian Telegraph Act, 1885, under which licences have been granted to telephone companies, deals only with appliances for making communications by means of electricity. Act No. XIII. of 1887 is an Act to provide for the protection of person and property from the risks incident to the supply and use of electricity; but it does not provide for the grant of licences. Nor does it provide for many other matters which are essential for the protection of contractors from undue interference or restraint, and the public from excessive charges and undue

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preference. These matters cannot be satisfactorily arranged without legislation. The object of the present Bill is to enable the Government of Bengal to grant licences for the supply of electric lighting within any part of Calcutta. The Bill closely follows the Electric Act of 1882 (44 and 45 Vic., Cap. 56); but as it is intended to empower the Local Government to grant licences only, every reference to "provisional orders" and "special Acts" has been omitted. The Local Government is substituted for the Board of Trade throughout. The definition of Calcutta is taken from the Calcutta Municipal Act of 1884; but power is given in the Bill for extending its provisions to the Howrah Municipality. The necessary powers for breaking up streets, &c., for the purpose of supplying electricity within the area specified in the licence have been adopted for the most part from the Gas Works Clauses Act of 1871.

Kew Observatory.—An account of the past year's work of the Kew Committee of the Royal Society is given in a recent number of the *Proceedings* of the Royal Society. The grounds of the observatory have been augmented by about five acres; and, at the expense of the Chairman, Mr. F. Galton, a substantial paling has been erected round the premises in the Old Deer Park, Richmond. The ordinary departments of the observatory have been carried on in the usual manner, and with little or no interruption. Advantage was taken of the great frost in January to dismount and overhaul the electrograph; and this same instrument had, in August, an enforced holiday of nearly three weeks, owing to the accidental breakage of a suspension thread. Prior to starting on the Jackson-Harmsworth North Polar Expedition, Mr. Armitage received at the observatory a short course of instruction in the use of magnetic instruments, and some instruments from Kew were taken upon that expedition. In the department of thermometer testing, arrangement is, as announced at the last meeting of the Physical Society, about to be made for platinum thermometers to be tested and calibrated. There is a considerable increase in the number of instruments tested, the total being 20,936, as against 20,197 for the previous year. Of this total, however, no less than 15,593 were clinical thermometers; while the number of standard thermometers tested was 74, as against 88 for the previous year. In each case the calendar year is referred to. A useful department of work is the transmission of reliable photographic paper to various physical and other observatories throughout the world. It is interesting to notice that an institution of the scientific character of the Kew Observatory is self-supporting, by virtue of the revenue arising from fees for tests, &c., to the extent of £1,943, out of a total revenue of £4,173.

Thomson Carbon Brush for Low Potential Machines.—While carbon brushes have proved eminently successful for high potential machines, says the *Electrical Engineer* of New York in a recent issue, they have not been shown to be so satisfactory for the ordinary low potentials of 110 volts and under. This, of course, is largely due to the heat generated in the carbons by the heavy currents and the additional pressure required to get a good contact. One of the methods of overcoming this difficulty, employed in the past, has been to mix with the carbon a more or less conducting material. Recently, however, Prof. Elihu Thomson has devised another method. Instead of employing a solid block, use is made of a number of small rods of carbon plated with a thin film of copper. These rods are assembled in the form required and of the required size so as to give the desired thickness, length and width of the brush, and the copper plated carbon pieces are united by soldering, that is, by "sweating in" solder between them in a sufficient number of places to hold them together. The carbon surface applied to the commutator is broken away into facets, and the current which is taken from the commutator through the carbon faces is at once delivered to the metal which unites the various carbon pieces and is conducted through the body of the brush by the metal chiefly. The metal is so thin that the moment it touches the commutator at any point, the extra conductivity causes it to shunt enough current to disintegrate it at once, so that at all times the carbon surfaces take the wear and the metal is eaten away a short distance as rapidly as the carbon is presented. This method of construction also permits of the conductivity of the brush being varied to suit the current to be taken up, and the potential of the dynamo will determine the amount of the metal which is to be used relatively to the carbon; that is, by plating the pieces more heavily the conductivity can be raised between limits, and by putting the merest film of metal on the carbon pieces it can be lowered.

Obituary.—We regret to record the death, on the 23rd inst., at Copenhagen, of Col. O. V. Hoskiaer, who was born in that city on June 25, 1829. After having passed the Danish Military High School and the lower military grades, he served in the Dano-German War in 1864, at the defence of the fortress of Fredericia. After the war he served as a captain—afterwards colonel—of the Royal Engineers, and was, in 1867, appointed chief of the Telegraph Corps, remaining in the army until 1890, when he retired. For several years Col. Hoskiaer was *aide-de-camp* to the King of Denmark, and on different occasions he acted in a similar position to various royal visitors at the Danish Court. With his extensive technical knowledge, his energy, and his linguistic attainments, he naturally took an active and leading part in several industrial undertakings in his country, and was a prominent member of several technical and learned associations, among these being the Technical Society of Copenhagen, of which he was President. With the Great Northern Telegraph Company he was connected almost from its formation. During the manufacture and laying of the Company's cables in China and Japan he was their controlling engineer, and acted in a similar capacity on several subsequent occasions, afterwards joining the Board of Directors of the Company. His kindness, affability, and never-failing courtesy won for him many friends, not only in his own country, but also abroad, and especially here in England, where he was a frequent visitor. Col. Hoskiaer is the author of several works in Danish, and in this country his "Guide for the Electric Testing of Telegraph Cables," which has passed through three editions, is well known, and has a wide circulation.

The Spectrum of Carbon from the Electric Furnace.—In a recent communication to the Académie des Sciences, M. Deslandres stated that M. Moissan recently pointed out that the carbons which he uses for his electric furnace are purified by the passage through them of the large currents employed. As it is very difficult to purify carbon by the chemical way, M. Deslandres emphasizes the importance and interest of this property of the electric furnace, especially to spectroscopists who often use pure carbon in qualitative analysis. It was on this account that M. Deslandres paid special attention to the statement of M. Moissan, and carried out an investigation to verify its correctness. M. Moissan placed at M. Deslandres' disposal two carbon electrodes, a positive and a negative, 20cm. long and 5cm. thick, which he had made use of in some electric furnace experiments. M. Deslandres took from each electrode small pieces of carbon at distances of 15, 10, 5 and 1cm. from the arc. He found that the pieces which were taken from the electrode at some distance from the arc showed the ordinary impurities of carbon, namely, alkaline metals, together with copper, iron and silicium. When, however, he came to examine the pieces which had been taken close up to the arc, the bands denoting impurity finally disappeared, with the exception of the calcium bands, which, although very much reduced, always remained visible, a fact which M. Deslandres attributes to the lime wall of the furnace, which is probably partly volatilised when large currents are used. M. Deslandres attributes this purification of carbon to a purely physical cause, the impurities being much more volatile than carbon, and being therefore vapourised before it. The purest carbon was obtained from the mushrooms which form on the negative, and with one of these mushrooms M. Deslandres obtained a spectrum which contains fewer impurity bands than any of the spectra hitherto published. It would be interesting to know whether other substances than carbon could be freed of their more volatile impurities by this process; *e.g.*, whether platinum or gold might be refined in small quantities by this means more readily than by any other.

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PERIODIC FUNCTIONS DEVELOPED IN FOURIER SERIES.—THE GRAPHICAL METHOD.

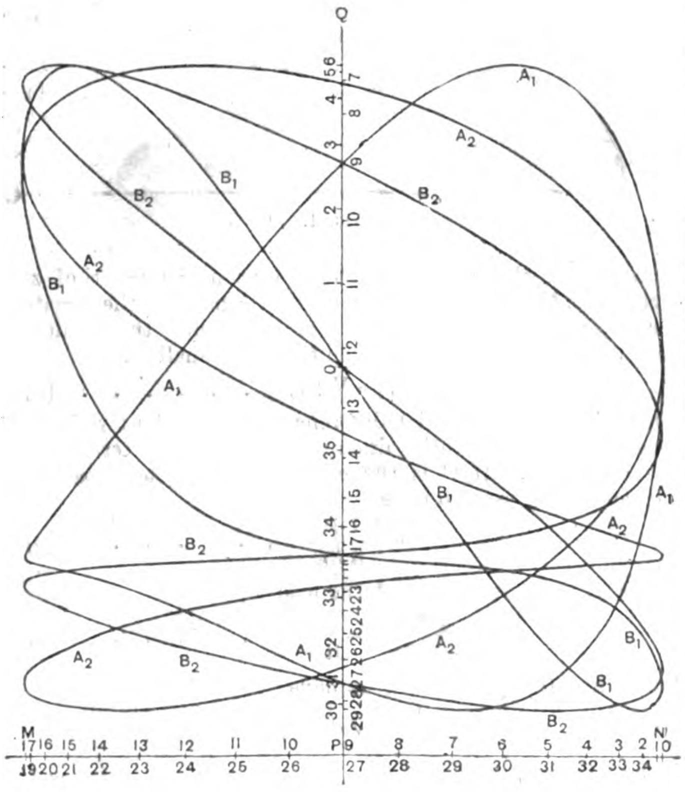
BY PROF. JOHN PERRY, F.R.S.

More than a year ago I described, at a meeting of the Physical Society, how my students at Finsbury were accustomed to utilise Prof. Clifford's idea as to the Fourier development. Since then I have several times been obliged to describe in detail the actual process employed. It is so simple and so quick and so accurate that I think it ought to become a regular exercise in engineering classes. The amount of accuracy is dependent simply upon the scale on which the drawing is made.

To illustrate the method, I give an example worked out by Mr. J. P. Fox last year. The periodic time was divided into 36 equal parts, and at each of these instants the value of the function was given. These instants are numbered 0, 1, 2, 3, &c. . . . 35. Calling the function $f(t)$ we have

$$f(t) = A_0 + A_1 \sin kt + B_1 \cos kt + A_2 \sin 2kt + B_2 \cos 2kt + \&c. \quad (1)$$

where k stands for $2\pi/T$, T being the periodic time. Mr. Fox did not find it necessary to draw the actual curve for $f(t)$.



To find A_0 it was only necessary to add up all the 36 given ordinates and divide by 36. It would have been a little more accurate to have found A_0, the average ordinate, by Simpson's rule or by actually plotting and finding the average height by the planimeter method. I see that Mr. Fox has not stated the value of A_0. Most English planimeters are graduated for square inches, so I will take it that the given ordinates are represented by so many inches. It is quite easy to multiply them by any number, and the answers found may be divided by this number.

To find A_1. The distance M N is the diameter of a circle (not shown on the figure) whose circumference is 36in. This circumference is divided into 36 equal parts. The points of division are marked 0, 1, 2, 3 . . . 35. Perpendiculars are drawn from each point to the diameter 0, 18. The feet of these perpendiculars are indicated by the corresponding figures, and this is how the straight line M N is marked out. Perpendiculars (I shall call them verticals) are raised from these points.

At any convenient place a straight line P Q is drawn at right angles to M N. In the figure it happens to be drawn from the middle of M N. The points 0, 1, 2, &c., marked on P Q are at distances from P which represent the given values of our function at the times 0, 1, 2, &c.

Project horizontally from 0 in P Q, and vertically from 0 in M N, and find the point of intersection. This is a point in the curve A_1. Project horizontally and vertically from the points 2, then 3, and so on, and in this way find 36 points in the curve A_1. Draw this curve in pencil. Carry the point of a planimeter from the 0 point, 1 point, 2 point, &c., to 0 again. Divide the area so found by 18, and the answer is the required value of A_1. It is to be generally understood that, although some areas are really negative and some positive, if the planimeter point be always carried round in the direction of increasing numbers the observer has no thinking to do—he has not to consider whether a particular loop is positive or negative.

To find B_1. As we have 36 intervals of time, and 9 is the quarter of 36 :—

Project horizontally from the points in the line P Q..	0	1	2	3	4	&c.
To meet verticals from the points in the line M N	9	10	11	12	13	&c.

Observe that in the line M N the point 0 may be called 36, the point 1 may be called 37, and so on.

The area of the curve B_1, which is found by joining the points of intersection, divided by 18, gives the value of B_1.

To find A_2 :—

Project horizontally from the points in P Q	0	1	2	3	4	&c.
To meet verticals from the points in the line M N	0	2	4	6	8	&c.

We thus find points in the curve A_2. The area of this curve divided by 36 gives the value of A_2.

To find B_2 :—

Project horizontally from the points in P Q	0	1	2	3	4	&c.
To meet verticals from the points in M N..	9	11	13	15	17	&c.

We thus find points in the curve B_2. The area of this curve divided by 36 gives the value of B_2.

Mr. Fox was told that these were the only terms, but if there had been more terms wanted—

To find A_3 :—

Project horizontally from the points in P Q	0	1	2	3	4	&c.
To meet verticals from the points in M N.	0	3	6	9	12	&c.

Divide the area of the resulting curve by 54 to find A_3.

To find B_3:—

Project horizontally from the points in P Q..	0	1	2	3	4	&c.
To meet verticals from the points in M N...	9	12	15	18	21	&c.

Divide the area of the resulting curve by 54 to find B_3.

Observe that if the circumference of the circle of which M N is a diameter is l inches, the successive divisors of the above areas are :—for A_1 and B_1, $\frac{1}{2} l$; for A_2 and B_2, l ; for A_n and B_n, $\frac{n}{2} l$.

The points in M N used to find A_n are numbered 0, n, $2n$, $3n$, &c. ; and for B_n they are $\frac{c}{4}$, $\frac{c}{4} + n$, $\frac{c}{4} + 2n$, $\frac{c}{4} + 3n$, &c. where c is the number of given ordinates. In our example c was 36.

When the coefficients up to A_6 and B_6 are wanted it is advisable to let c be at least 60.

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If instead of the form (1) we wish to have the expansion in the form $f(t) = A_0 + a_1 \sin (k t + e_1) + a_2 \sin (k t + e_2) + \&c.$, it is only necessary to remember that $a_1 = \sqrt{A_1^2 + B_1^2}$ and $\tan \epsilon_1 = \frac{B_1}{A_1}$.

The above example was worked out by Mr. Fox in a time competition between him and another student who was practised in using a mechanical analyser.

Mr. Fox found $f(t) = A_0 + 4{\cdot}690 \sin \frac{2\pi}{T} t + 1{\cdot}744 \cos \frac{2\pi}{T} t + 1{\cdot}940 \sin \frac{4\pi}{T} t - 0{\cdot}328 \cos \frac{4\pi}{T} t$ in one hour and a-half from the time when he opened the envelope containing the 36 numerical values of the function. In another quarter of an hour he obtained the equivalent form,

$$f(t) = A_0 + 5{\cdot}003 \sin \left(\frac{2\pi}{T} t + 20^\circ{\cdot}38\right) + 1{\cdot}97 \sin \left(\frac{4\pi}{T} t - 9^\circ{\cdot}9\right).$$

The numbers given to the two competitors were calculated from

$$f(t) = A_0 + 5 \sin \left(\frac{2\pi}{T} t + 20^\circ\right) + 2 \sin \left(\frac{4\pi}{T} t - 10^\circ\right),$$

but I forget what was the particular value of A_0 used. The curves were inked in afterwards. It may be of use to the student if I give the areas found for the four curves. A_1 was 84·42 sq. in., B_1 was 31·41, A_2 was 69·88, and B_2 was $-11{\cdot}80$.

WAVE FORM SYNTHESIS.

BY JAMES MARK BARR, STANLEY BEETON, C. PERCY TAYLOR.

(*Concluded from page 260*).

SYNTHESIS OF WAVES.

It is obvious that the *experimental* method of attacking the subject with wave forms of predetermined shapes has every advantage. There are really two fields for work in alternate-current wave form synthesis: the one which takes up the subject classically and deals with the details of the theory of "injector waves," and the other which has to do with the immediate practical effects of a few typical shapes produced by trial methods and applied experimentally aside from any theoretical principles of wave synthesis. The first field is very broad, and requires for its development much time and detailed experiment. It would be necessary to work with a great number of wave forms, varying between wide limits of shape and differing consecutively among themselves by small variations of contour. We propose to confine ourselves in the present Papers to the second field of wave form synthesis, and aside from the experimental results with several particular wave shapes (which are to follow), we shall not go further than merely suggesting certain lines of classical study and experiment. However, certain rudimentary points in the theory of synthetic waves have inevitably presented themselves, and several essential principles of operation in the production of desired wave shapes have been roughly developed.

The results given below have been obtained in the laboratories of the Central Technical College and as stated, our preliminary results were got by the use of a Gramme dynamo and a two-part injector commutator. This first commutator was made of two parts, so that we could inject the resistance, inductance or capacity once in every half-wave, the armature giving one period per revolution.

Fig. 1 is a simple diagram of the arrangement.

The brushes b_1 b_2, which are set with any angle θ between them, bear upon the injector commutator J keyed to the dynamo shaft. When the slot between the two parts coincides with the line A B, then the electromotive force wave of the armature crosses the zero line. The angle ϕ between A B and the brush b_1 determines the *epoch* (as measured from the position of zero electromotive force) at which the resistance, inductance or capacity—connected across terminals T_1, T_2—is thrown into the armature circuit. The angle θ determines the duration of the effect. This we call the *interval*. A sufficient number of variations were produced by resistance and capacity, and we found it disadvantageous to use inductance on account of sparking at the injector.

It is possible to predict the potential difference wave resulting from the use of the "injector" with a known resistance or capacity to be taken at terminals of a given load, but the mathematical expressions for such predetermination are rather cumbersome. For *resistance* injection with non-inductive loads we have a graph consisting of two parts. Assuming the machine to give a sine wave expressed by $V = V_0 \sin p t$, the resultant graph coincides with this while the resistance is short-circuited. When resistance is in circuit we have $V = \frac{R}{R+r} V_0 \sin p t$ as the expression for the graph during the interval, where R is resistance of load and r is the injected resistance.

For capacity injected with non-inductive load the case is more complicated. Again, assuming the dynamo to give $V_1 = V_0 \sin pt$, the resultant graph again coincides with the curve given by the latter expression while the condenser is short-circuited.

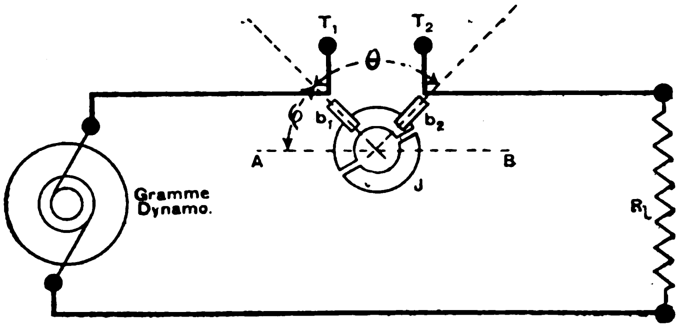

FIG. 1.

Let t_1 be the *epoch* as measured from the point of zero dynamo E.M.F. at which the condenser comes into the armature circuit, and let t be any point of time while the condenser remains in circuit. Then at the time t we shall have

$$V_1 = V + v, \quad \ldots\ldots \quad (a)$$

where V is the potential difference between the terminals of load and v the potential difference between the terminals of the condenser. If C is the current, and K the capacity of the condenser, we also have

$$v = \frac{1}{K}\int_{t_1}^{t} C\,dt, \quad \ldots\ldots \quad (b)$$

and if R is the resistance of the load

$$C = \frac{V}{R}. \quad \ldots\ldots \quad (c)$$

Combining (a), (b), and (c), we have

$$V + \frac{1}{RK}\int_{t_1}^{t} V\,dt = V_0 \sin p t.$$

Differentiating,

$$\frac{dV}{dt} + \frac{V}{RK} = p V_0 \cos p t.$$

The solution of this differential equation is

$$V = V_0 \frac{p R K}{1 + p^2 R^2 K^2} (\cos p t - p R K \sin p t) + A e^{-\frac{t}{RK}}.$$

The value of the arbitrary constant A is determined by putting $V = V_0 \sin p t_1$ when $t = t_1$. This gives

$$A = V_0 e^{\frac{t_1}{RK}} \left[\sin p t_1 \left(1 + \frac{p^2 R^2 K^2}{1 + p^2 R^2 K^2}\right) - \frac{p R K \cos p t_1}{1 + p^2 R^2 K^2}\right].$$

Thus we have as our final solution

$$V = \frac{V_0}{1 + p^2 R^2 K^2} \Big\{ p R K (\cos p t - p R K \sin p t) + e^{\frac{t_1 - t}{RK}} [(1 + 2 p^2 R^2 K^2) \sin p t_1 - p R K \cos p t_1] \Big\},$$

this being the equation to the curve while the condenser remains in circuit. We have worked out approximate graphic

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methods for predicting wave shapes; but we have not the space to give them in the present article.

For practical testing with these waves it is necessary to have a higher frequency than could be obtained from the two-pole Gramme, and we therefore made use of a Ferranti dynamo, at a frequency of 100 ∿.

As this machine gave eight periods per revolution, it was necessary to make an injector commutator (hereafter called the injector) of 16 parts, in order that we might have, as with the Gramme, one "injector effect" on each half-wave.

But by using more than one pair of brushes (b_1, b_2 in Fig. 1) one is able to have any number of "injector effects" on each half wave. Our final working arrangement is shown in Fig. 2. When the brushes b_1, b_2 are short-circuited as represented, the dynamo circuit includes a simple non-inductive load R_l, and a dynamometer D, the inductance of which is negligible. Across the terminals T_1, T_2 we place a resistance, R_j, or capacity,

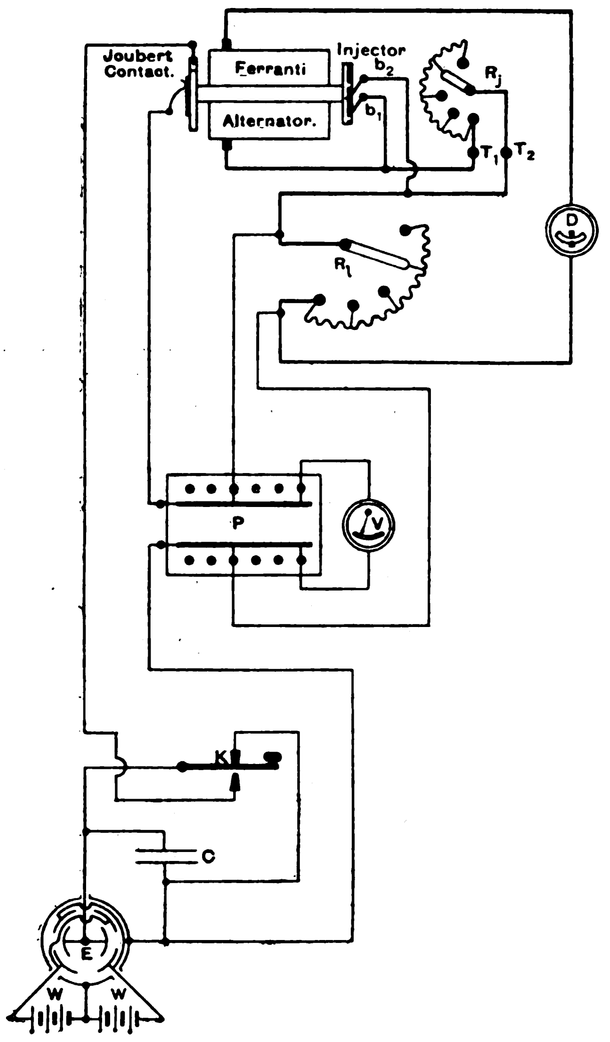

Fig. 2.

and this is thrown into the armature circuit during the interval when the brushes b_1 and b_2 bear upon separate segments of the "injector." The root-mean-square, of the amperes are read at D, and the the R.M.S. volts at the terminals of load are read at V, the voltmeter being connected through mercury contacts mounted on a paraffin block P as represented.

Two voltmeters were used at V (a Cardew and an Ayrton and Mather electrostatic instrument) in order to have check readings.

The readings of the instantaneous volts at terminals of load, from which we plotted our wave forms, were taken at E with an Ayrton and Mather quarter cylinder electrometer connected up as shown, and arranged to be intermittently connected across load by the usual form of Joubert rotating contact on the shaft of the alternator.

It may be of interest to call attention to the method adopted in connecting up the electrometer. If the development of both needle and quadrants is rectangular, we have :—

$$\text{Deflection} = k\,(a-b)\left(N - \frac{a+b}{2}\right), \quad . \quad . \quad . \quad (1)$$

where

N = potential of needle above case,
a = „ one pair of quarter cylinders,
b = „ the other „ „ „

and k is a constant depending upon the size of the needle and quadrants, their distance apart, and the control (torsional). In

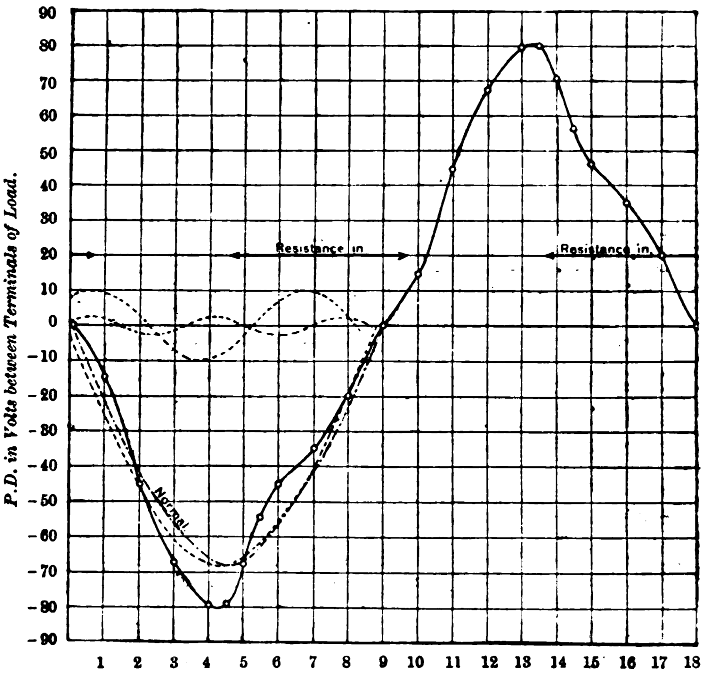

Fig. 3.—R.M.S. volts, 50. Resistance injected, 5 ohms. Load resistance (non-inductive), 6·86 ohms. Ferranti dynamo, 100 ∿ per second. Harmonics dotted.

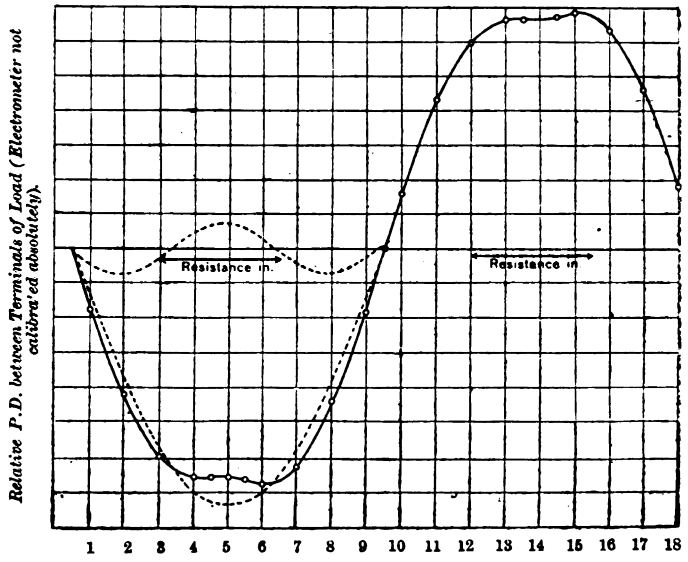

Fig. 4.—R.M.S. volts, 32. Resistance injected. 2 ohms. Load resistance, (non-inductive), 3·17 ohms. Gramme dynamo, 20 ∿ per second. Harmonics dotted. Normal coincident with fundamental harmonic.

the usual heterostatic method the needle is given a separate charge, *i.e.*, N is fixed, and the potential difference to be measured is that between a and b.

In these experiments a method due to Mr. Mather is used. We make $a = -b$ by connecting up the electrometer as described below, and so get rid of the $\frac{a+b}{2}$ in equation (1). We then have

$$\text{Deflection} = k\,(a-b)\,N, \quad . \quad . \quad . \quad . \quad (2)$$

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so that the instrument has a straight line law. This is a great advantage for the readings of potential difference wave forms, because the low readings are got to the same degree of accuracy as the higher ones.

The connections used to obtain the above result are shown Fig. 2. The two pairs of quarter cylinders were charged by

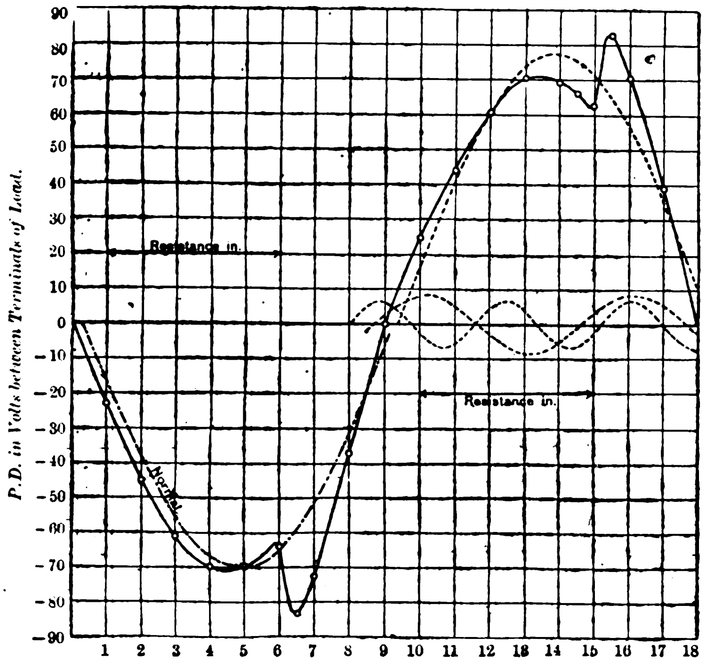

Fig. 5.—Resistance injected, 5 ohms. Load resistance (non-inductive), 6·86 ohms. Ferranti Dynamo, 100 ∿ per second. Harmonics dotted.

means of water cells, and the middle point of the set was joined to the case in order to get $a = -b$. Another advantage of this method is that equation (2) gives greater sensibility than (1) with the same auxiliary charge, because N is necessarily greater than $\left(N - \frac{a+b}{2}\right)$.

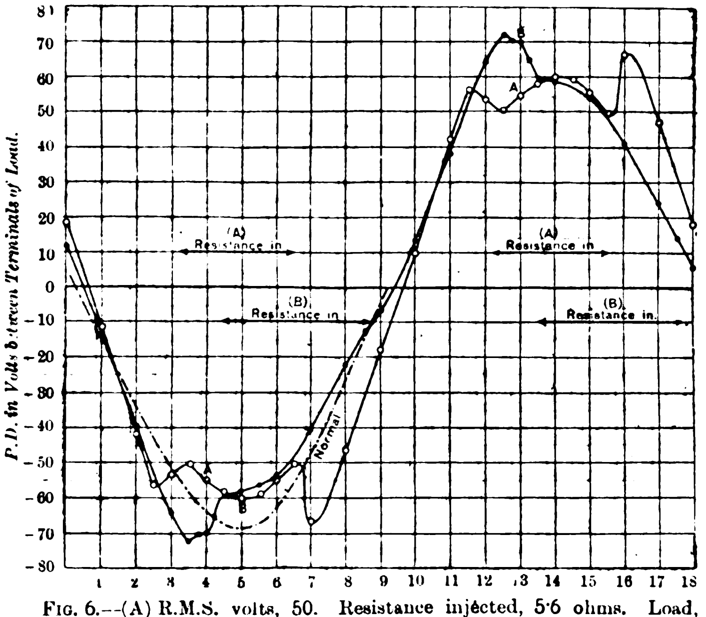

Fig. 6.—(A) R.M.S. volts, 50. Resistance injected, 5·6 ohms. Load, 8·43 ohms in parallel with primary of transformer taking about 1 ampere magnetising current. (B) R.M.S. volts, 50. Injected resistance, 5·60 ohms. Load, 11·43 ohms in parallel with transformer as above. Ferranti dynamo, 100 ∿ per second.

The wave forms of potential difference obtained with the arrangement shown in Fig. 2, are given below, together with the first two shapes (Figs. 4 and 7) got with the Gramme machine.

The dotted curves on these and the other figures are the more important harmonic components into which we have resolved the experimental curves by means of the analyser mentioned in the first part of this article. The normal potential difference wave of the machine is also shown and marked as such in each figure.

As mentioned above one really deals in this method, for resistance injected, with two graphs—the normal wave form of the dynamo as running without injector, and the normal graph on the load as it would be were the resistance at the injector con-

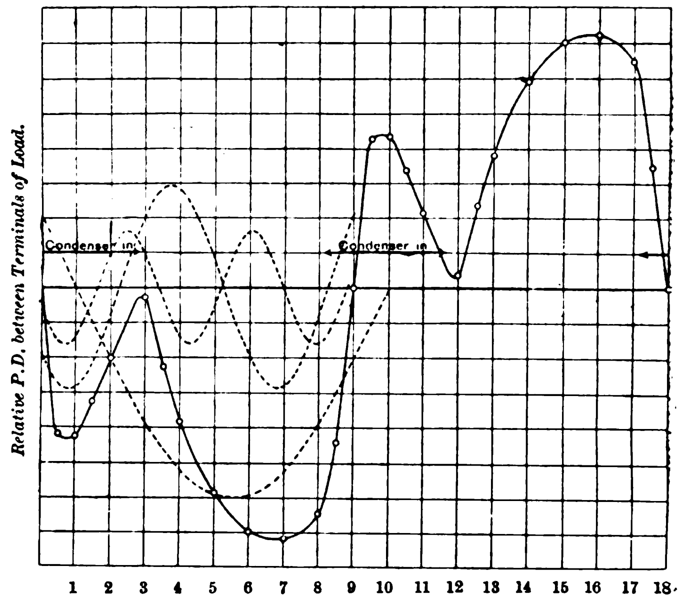

Fig. 7.—R.M.S. volts, 30. Injected capacity, 220 microfarads. Load resistance (non-inductive), 3·17 ohms. Gramme dynamo, 20 ∿ per second.

tinuously in the circuit. We have found that, as would be expected, the wave form resulting from the use of the injector has as its limiting contours the two virtual graphs just referred to. Thus the resultant potential difference or current waves, when there is no inductance in the circuit, change instantly from one of the virtual graphs to the other, according to the epochs and intervals of the injector. When inductance is present we have to remember the law of current rush, and

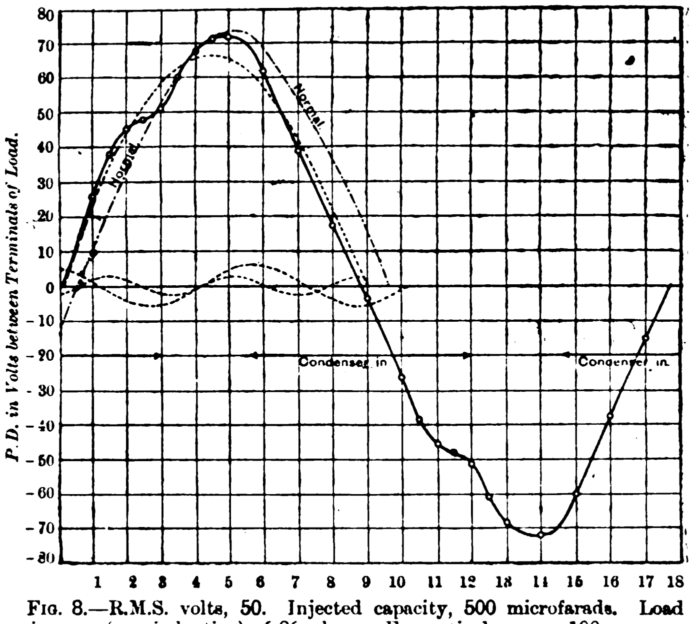

Fig. 8.—R.M.S. volts, 50. Injected capacity, 500 microfarads. Load resistance (non-inductive), 6·86 ohms. Ferranti dynamo, 100 ∿ per second. Harmonics dotted.

we observe in such cases that there is an assymptotic rush from one graph to the other. Figs. 5 and 6 well illustrate these points. In Fig. 5, from contacts 6 to 10 and 15 to 1, the graph is a portion of a sine curve which would have a maximum ordinate of over 100 volts, and during the interval (contacts

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Nos. 1 to 6 and 10 to 15) the graph is part of a sine wave having a maximum ordinate of 71 volts. The root-mean-square value of this wave is rather higher than 50 volts, but in all of our actual tests with irregular forms we keep all waves at the uniform value of 50 R.M.S. volts.

In Fig. 6 (A) we show a wave produced by injection of resistance in the middle of the half-period, as indicated in the figure. In this case we had considerable inductance in the circuit (the primary of a 1·5-kilowatt Mordey transformer), and the effect is shown in the irregularity of the peaks. In Fig. 6 (B) we show a wave of the same order as Fig. 5, and this wave also was taken at the transformer terminals. It is interesting to note that this wave, which approximates to the characteristic shape of the Westinghouse (Stanley) alternate-current arc dynamo, likewise exhibits at the peaks the curious dip or point of inflection to be observed with the Stanley machine. Fearing that these dips were due to false readings, we repeated our observations many times at the peak values, but we found that the inflection was always present.

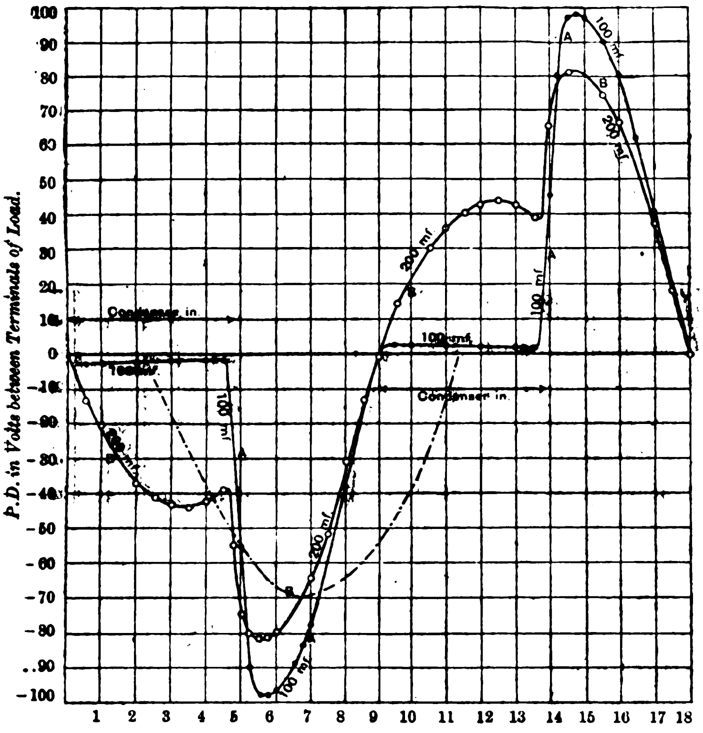

FIG. 9.—Waves of equal R.M.S. volts, showing variation of effect with change of capacity injected for same interval and at same epoch. (A) 100 microfarads injected. (B) 200 microfarads injected. R.M.S. volts, 50. Load resistance (non-inductive), 6·86 ohms. Ferranti dynamo, 100 ∿ per second.

Fig. 4 shows another wave, with the injection at the middle of the half period. Due to uncertain contact and sparking, the resistance came on and went out gradually; and, besides this, the Gramme armature had appreciable self-induction. Hence the rush from one virtual graph to the other is not as marked as in Fig. 6 (A). Fig. 3 shows the effect of injecting resistance during an interval which extends on both sides of the zero point of the potential difference. This gives a wave high in the middle of the half-period. With such waves the rush from one virtual graph to the other is not so easily discerned as in the case of injection at the middle of half-period. Another point to be observed in connection with resistance injection is that if we remove resistance from the circuit at a point near the zero of the wave, there is not much change to be observed in the resultant graph in the neighbourhood of this point. Resistance injection is very useful for obtaining peaked waves, but unless we make several successive injections in each half-period it is difficult to obtain flat-topped waves. Thus far, we have dealt chiefly with peaked forms, as flat-topped waves are most easily produced by using a revolving contact maker which periodically reverses a constant potential difference. This arrangement gives us a rectangular wave, and we shall publish the results of tests with this shape in a later article. However, as will be shown below, it is possible to produce flat-topped waves from a sine shape by the use of condensers.

The effect of injected capacity on the graph is due to the gradual rising of the potential difference between the terminals of the condenser as the charge increases, thus causing a lowering of the curve of potential difference between the ends of the load; but after the curve crosses the zero line, the potential difference between the terminals of the condenser is added to that between the terminals of the dynamo This addition gradually lessens in effect as the charge goes down. This is clearly illustrated in Fig. 8, but it is to be noted in this case that the condenser was short-circuited before the charge was much reduced. In Fig. 9 we show the alteration of effects for different injected capacities for the same epoch and interval. It is seen that if we have an infinitely large capacity its injection has no effect, and the machine wave remains normal. As the other limit, if we have a zero capacity the graph follows the zero line during the interval. In the 100 microfarad curve (Fig. 9) the capacity is so small that the potential difference at the condenser terminals remains practically equal to that of the dynamo during the whole interval, whence the resultant potential difference is

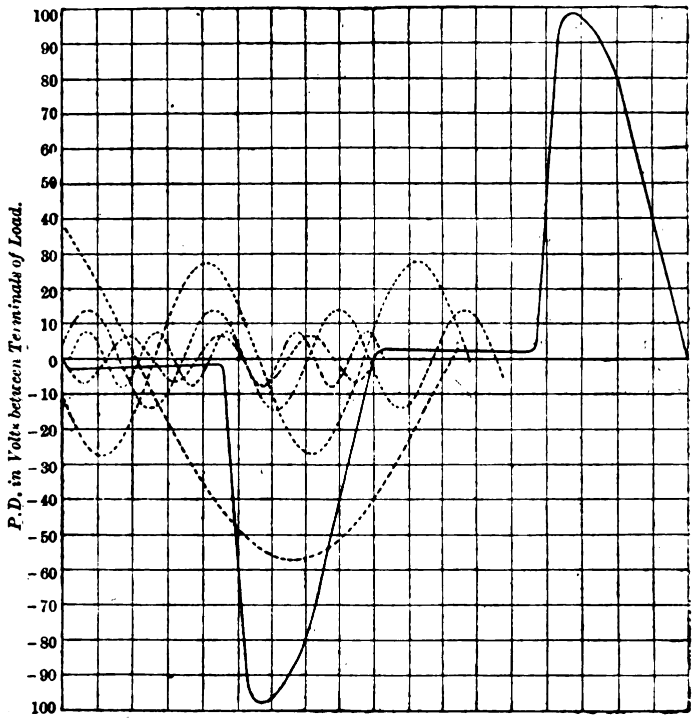

FIG. 10.—Showing harmonic analysis of curve A, Fig. 9.

almost nought. With the 200 microfarads injected we should have had the same result if the load resistance had been reduced in the same proportion as the capacity was increased. But this resistance was kept the same, and hence the condenser charge, and the potential difference at its terminals, did not increase so rapidly as the dynamo potential difference. Thus the graph is higher during the interval in this case.

For capacity injection with an inductive load the effect is different, owing to the fact that the current is no longer in phase with the potential difference at the terminals of load. Fig. 12 shows graphs of potential difference and current taken on a 3-kilowatt Mordey transformer (open secondary), with 100 microfarads injected. In this case, since the current does not follow the potential difference wave, but keeps a nearly constant value during a good part of the interval, the charge continues to increase at a rapid rate, whence the condenser potential difference becomes greater than the dynamo potential difference, and therefore the resultant graph crosses the zero line. By making the epoch earlier and the injected capacity greater, thus getting a less rapid lowering of the graph, we obtain a flat-topped wave.

For a number of the curves shown we have given the virtual Fourier harmonics present in the graphs, as they serve to indi-

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cate the deviations from the fundamental sine wave, and also as they are useful in the consideration of resonant effects and motor problems.

We have read with interest of Dr. Fleming's ingenious method for obtaining the root-mean-square values of plotted wave forms; but we think that as long as an Amsler

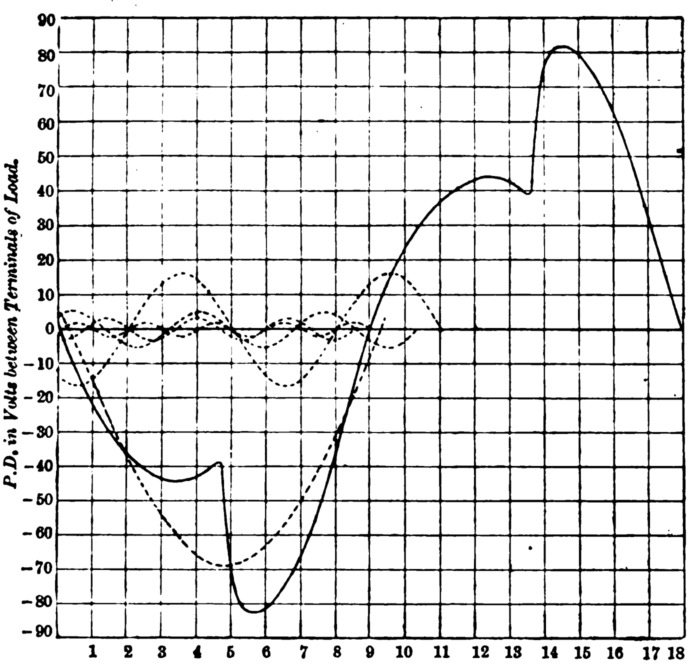


FIG. 11.—Showing harmonic analysis of curve B, Fig. 9.

area planimeter is required in connection with the polar plotting, one might as well use an Amsler first-moment planimeter with the usual rectangular co-ordinate wave form. We have found it most advantageous to retain the distinct advantages of rectangular plotting and to use the latter instru-

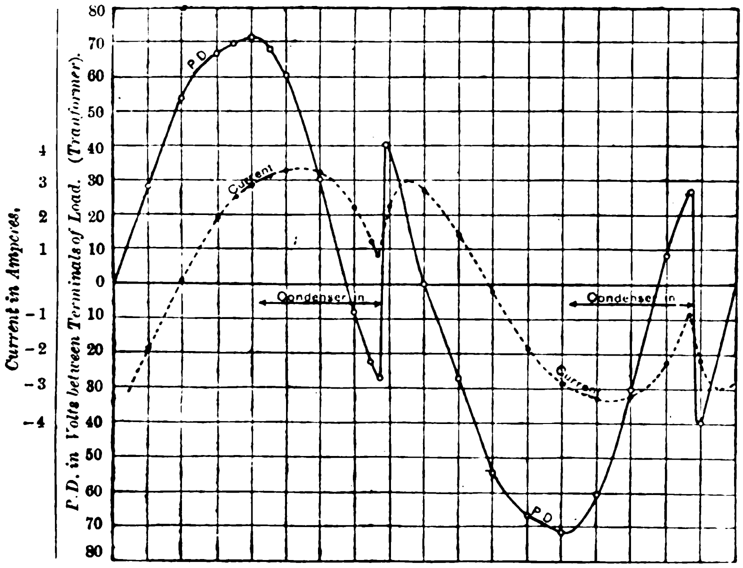


FIG. 12.—R.M.S. volts, 46. Amperes, 2·5. Injected capacity, 100 microfarads. Load, primary of transformer. Ferranti dynamo, 100 ∾ per second.

ment. This instrument, with one tracing over the ordinary curve, gives the value of the integral $\frac{1}{2}\int_0^T y^2\,dt$, the first moment of the ordinates, and $\sqrt{\frac{1}{T}\int_0^T y^2\,dt}$ is the root-mean-square value.

The experimental work has been carried out at the Central Technical College, as mentioned, where, due to the courtesy and kind interest of Prof. Ayrton and Mr. Mather, we have had excellent facilities. We have been especially fortunate in having at our disposal an aggregate condenser capacity of nearly 1,200 microfarads.

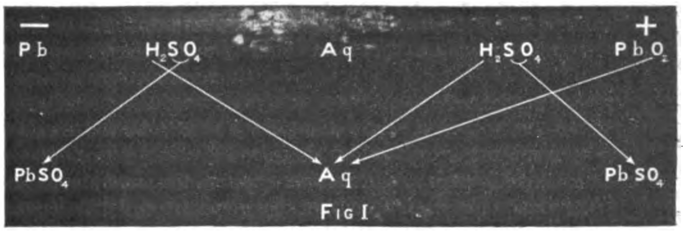
At present we are making some tests on transformers with various wave shapes, and we hope shortly to publish our results.

THE ELECTRO-CHEMICAL REACTIONS IN SECONDARY CELLS.

BY W. R. COOPER, M.A.

In a Paper which appeared towards the close of the past year in Wiedemann's *Annalen*,* the well-known double-sulphating theory of secondary cells received fresh support from Herr F. Streintz, whose views have since aroused adverse criticism from the pen of M. G. Darrieus in a recent number of *L'Electricien*.† We propose to briefly consider the two articles referred to.

Assuming that the energy of the cell is due only to the salts formed at the expense of the sulphuric acid, Herr Streintz represents the electrolytic changes on discharge in the following way :—



In this representation of the reactions no account is taken of the formation of plumbic acid, H_2PbO_3, of hydrogen absorbed by the negative plate, or of the liberation of gases in the free state.

In order to calculate the E.M.F. of the cell from thermochemical data, the electrolytic changes are considered to take place in three successive stages. First, water is decomposed by the liberated SO_4 of the sulphuric acid, the latter being reformed. There is thus an absorption of heat equivalent to that represented by the numerical part of the equation—

$$H_2O = H_2 + O - 68{,}400 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Oxidation of the negative plate, and reduction of the positive, both to the form of monoxide, result from the liberated oxygen and hydrogen, and there is a consequent evolution of heat according to the equations—

$$\left.\begin{array}{l}\overset{-}{Pb} + O = PbO + 50{,}300 \\ \overset{+}{PbO_2} + H_2 = PbO + H_2O + \alpha\end{array}\right\} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The quantity α is unknown.

Since the metallic oxides cannot exist in the presence of free acid, there is finally an evolution of heat due to the formation of lead sulphate on both plates, according to the equations—

$$\left.\begin{array}{l}\overset{-}{PbO} + H_2SO_4Aq = PbSO_4 + Aq + 23{,}400 \\ \overset{+}{PbO} + H_2SO_4Aq = PbSO_4 + Aq + 23{,}400\end{array}\right\} \quad . \quad . \quad . \quad (3)$$

The thermo-chemical data employed are those given by Ostwald, expressed in calories.

The total electro-chemical change is, therefore, represented by the equation—

$$\overset{-}{Pb} + 2H_2SO_4Aq + \overset{+}{PbO_2} = 2PbSO_4 + Aq + (\alpha + 28{,}700),$$

and the E.M.F. is represented by an evolution of heat amounting to $(\alpha + 28{,}700)$ units.

The quantity α was indirectly determined by a method which need not here be fully considered. It depends upon the measurement of the heat evolved on the conversion of lead peroxide into lead sulphate by the action of sulphurous acid in the presence of hydrochloric acid. This was carried out in a manner due to Nernst. The result arrived at is vitiated to

* Wiedemann's *Annalen*, October, 1894. † *L'Electricien*, May 18, 1895.

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some extent by the fact that a part of the lead sulphate formed is converted into acid salts. By means of equations connecting the quantity so obtained with a, and involving known thermo-chemical data, the value of a is deduced to be +58,300 heat units.

Thus the total heat evolved in the electro-chemical changes considered is represented by 87,000 units. Assuming the number of coulombs per gramme of hydrogen to be equal to 96,540, and the joule to be equivalent to 0·239 heat units, then, lead being divalent, 46,150 calories correspond to one volt, and the E.M.F. is given by $\frac{87,000}{46,150} = 1{\cdot}885$ volts.

The E.M.F. of a cell containing very dilute H_2SO_4 (sp. gr. 1·055) was found experimentally to be 1·900 volts, and the temperature coefficient of a similar cell was found to be +0·000140. It would thus appear that the E.M.F. of this cell, due to chemical energy alone, amounts to 1·860 volts, a result which is very close to that already found by calculation. Owing to the many errors that may be introduced in the determination of thermochemical data, Herr Streintz remarks in conclusion that the coincidence of these results may be partly due to a fortunate combination of circumstances, but that the investigation should nevertheless serve to show that the reactions may be represented in a simple manner.

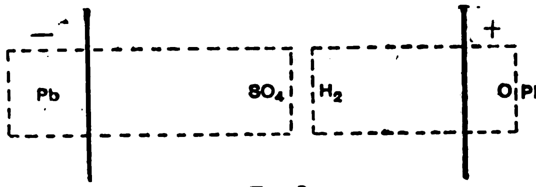

FIG. 2.

M. Darrieus in *L'Electricien* opposes the above theory, and denies the statement *that the metallic oxides cannot exist in the presence of free acid.* The results of experiments are given showing that lead monoxide, remaining for two days in sulphuric acid of various degrees of concentration, was only partly converted into sulphate. Whence it would appear that the double-sulphating theory, as put forward by Messrs. Gladstone and Hibbert and others, is untenable. It has also been observed that the amount of sulphate upon the positive plate is a variable quantity, a result which is easily explained by this limited action of the acid.

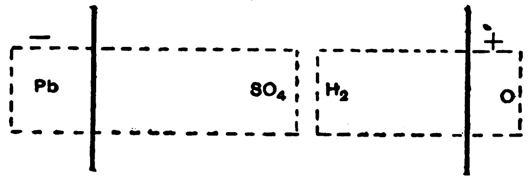

FIG. 3.

That such a theory has arisen is due solely to the desire to apply Thomson's law to the cell at any price, and it is wholly contrary to all laws of electrolysis. In conclusion, M. Darrieus observes that this is altogether unnecessary if only the characteristic properties of the active material on the negative plate be considered.

To us it does not appear that the experimental determination of the amount of lead sulphate formed by the action of sulphuric acid on lead monoxide fulfils the required conditions for a crucial experiment. Unless the litharge were in a fine state of subdivision, it is improbable that the whole would be converted into lead sulphate, because this insoluble compound would form an exterior protective coating upon the particles, thus preventing further action of the acid. But in the electrolytic actions considered we have first the reduction of the lead peroxide by the hydrogen, and it is reasonable to suppose that where such reduction can take place free acid is present, and would also form the sulphate. Owing, however, to the continual formation of water by both reactions, and consequent weakening of the acid, the sulphate formed would be expected to be variable in amount.

There are, however, other reasons for strongly doubting the validity of the double-sulphating theory. The semi-graphical equation which is given by Herr Streintz at the beginning of his Paper can only be regarded as misleading. The first molecule of sulphuric acid may be considered to act in the usual way, as indicated by the diagram (Fig. 2). But how is the action of the second molecule of acid to be represented? The ions H_2 and SO_4 are both required at the same plate.

There is a tendency at the present time to discard the distinction between primary and secondary reactions. This is chiefly due to a confused idea of what constitutes either of these classes. No electrical energy can be given to the circuit by a chemical change without the liberation or separation of an ion. In considering the action of the second molecule of sulphuric acid, we may look upon the PbO as equivalent to two poles of a cell, one of Pb, the other of O. The sulphuric acid is broken up, the SO_4 passing to the Pb to form sulphate, the H_2 passing to the O to form water, according to the diagram (Fig. 3). If the Pb is brought sufficiently near to the O, we have a molecule of PbO. In that circuit there may be electrical energy due to the reaction, but it is a closed circuit contributing nothing to the energy of the cell.

The solution of the difficulty appears rather to lie in considering the true nature of the negative plate. M. Darrieus * has found that if spongy, or reduced, lead be substituted for zinc in a Daniell cell, the E.M.F. is 0·68 volt, whereas the calculated value is only 0·3 volt. He therefore infers, since the action of a Daniell cell is simple, and satisfies Thomson's law, that the negative plate of a secondary cell consists of lead having a different molecular condition, or of an allotropic modification such that its reducing powers are greater than the ordinary lead for which heats of combination have been found. A correction amounting to 0·34 volt should, therefore, be added to the calculated values in such cases. For example, the E.M.F. of a secondary cell, calculated on the assumption that only one molecule of sulphuric acid is concerned, assumes the value 1·6 (as given by M. Darrieus), which is increased by the above correction to 1·94 volts.

It is not improbable that further research in this direction may place the matter on a more satisfactory footing than has hitherto been possible.

NOTES ON SOME EXPERIMENTS WITH ELECTROMAGNETIC MECHANISM.

BY P. V. McMAHON.

In publishing the following notes on some experiments made with electromagnetic apparatus, I do not lay claim to bringing forward anything of great importance or novelty, although some of the apparatus made and experimented with are, so far as I am aware, new. My aim in these researches was to arrive at an electromagnetic apparatus corresponding to an ammeter or voltmeter, but instead of moving a pointer over a scale, a mechanism was required capable of moving over a wide range with considerable force, while responding instantaneously to any variation in the electromotive force or current, as the case might be; further, the distance moved had to be directly proportional to the increase or decrease of ampere-turns. In fact, the apparatus was required to have a wide range, maximum strength and maximum sensitiveness—a combination which is almost impossible, as any person who has experimented in this direction can easily see. I regret to say the experiments have not been altogether satisfactory, but a fair amount of success has been achieved, and in bringing the results forward I hope they may be of some assistance to those working in the same direction. If when the experiments were started the same amount of data had been at hand, in all probability more satisfactory results would have been obtained in less time. The experiments will be given in the order in which they were made, the first being the simple solenoid and core.

The solenoid was 7in. long and $4\frac{1}{3}$in. diameter over flanges, contained 613 turns of No. 12 B.W.G. acc. copper wire, and had a resistance of ·39 ohms.

* *L'Electricien*, 2nd series, Vol. VIII., p. 237.

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The core in the first experiment was $13\frac{1}{2}$in. long, $\frac{29}{32}$in. diameter, cone-shaped at the point for a distance of 4in. down. In the second set of experiments with this core, which I shall call No. 1, an iron jacket or band enclosed the coil. This jacket was $1\frac{3}{4}$in. wide by $\frac{5}{8}$in. thick, had a hole top and bottom $1\frac{5}{16}$ diameter to allow plenty of clearance for the core, and could easily be slipped into and out of position on the coil.

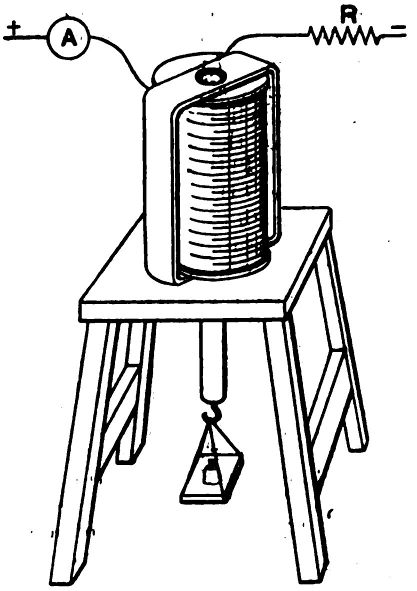
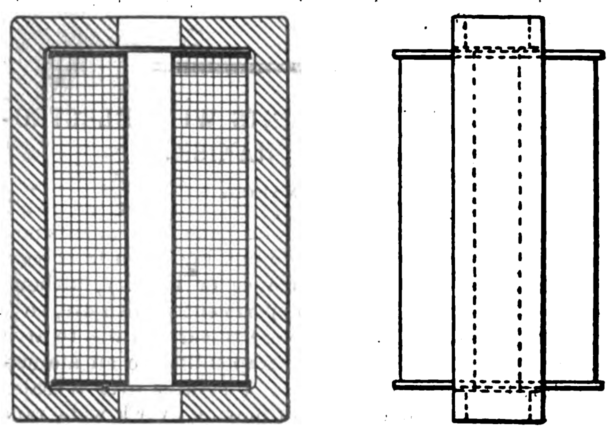


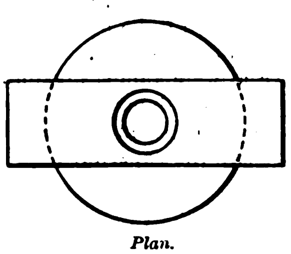
Fig. 1.

The core and jacket were of best Lowmoor iron, as, in fact, was all iron used in these experiments.

A quarter-size scale drawing is given of solenoid and jacket (Fig. 2) and No. 1 core (Fig. 3). Fig. 1 shows the general arrangement of experiment.

Section through Iron-clad Coil. *Elevation.*





Plan.

Fig. 2.—¼ Full Size.

The curve A gives ampere-turns and travel of core, with scale pan attached weighing 36oz. With 2,630 ampere-turns the point of the core was just flush with the top of the coil. In this position there was balance, and fewer ampere-turns would not support the core. Increasing the current gradually, we obtain points for curve A (Fig. 4), which is nearly a straight line for a range of 2in., and then bends off somewhat like the B-H curve for magnetisation of iron. A variation of 9,870 ampere turns gives a travel of 3·18in., lifting a weight of 36oz., scale pan included (of this weight the core was 31oz.). The core responded to the variation of current almost instantaneously.

Increasing the weight to 47oz. and varying the current as before, we obtain the curve B, with 3,750 ampere turns, and point of core flush with top of coil; balance was obtained as in A. Increasing ampere turns to 12,500, a travel of 2·95in. was obtained, or 2·95in. for a variation of 8,750 ampere turns, and an increase in weight of 23·4 per cent. Compare this curve (B) with B_1, in which the solenoid was ironclad, having same weight to lift; the travel is reduced, and the core point was 1·2in. outside top of coil. With 2,630 ampere turns a less number could not be obtained, as the ammeter readings were not reliable below 5 amperes, and the magnetisation was not increased beyond 9,000 ampere turns, as the core kept sticking to the sides of the solenoid for higher readings. Here for a variation of 6,370 ampere turns the core travelled 1·9in., as against 2·6in. for same variation of ampere turns. In this curve B_1, travel is more nearly proportional to the ampere turns; but the travel is less, and the arrangement is not

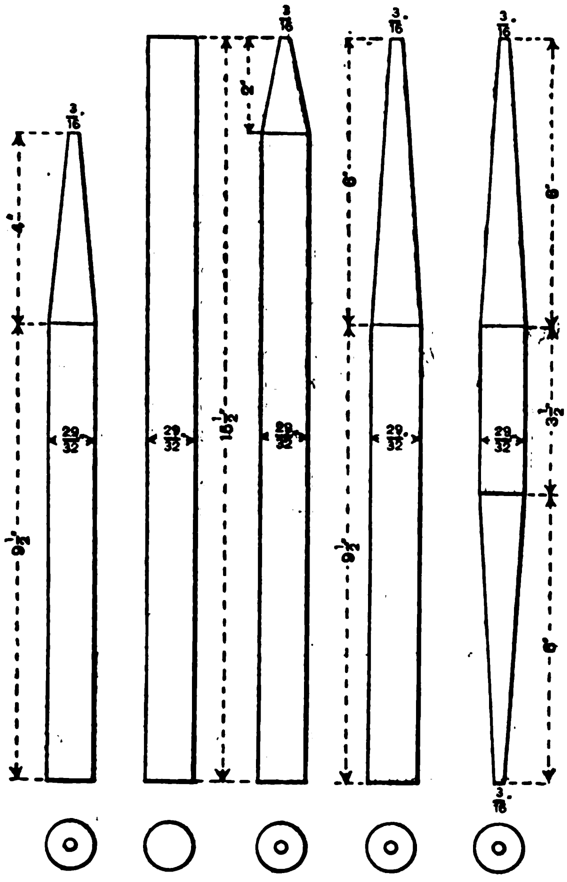


Fig. 3.

nearly as sensitive as in B curve. With the iron jacket, it seems as if the decrease of air gap between the cone-shaped point of the core and iron of jacket caused the core to move more than the action of the core and solenoid proper. In that case the length of the core would not affect the arrangement as long as there was sufficient iron to keep the lower air-gap constant, as shown in Fig. 4A.

Next the weight was increased to 84oz., and the result is shown in curve C with solenoid and core, and in C_1 with iron jacket over solenoid. In C for a variation of 5,500 ampere turns the core travelled 2·25in., and, as can be seen, the relation between the rate of travel and increase of current is fairly pro portional, the curve being nearly a straight line. In this, as in B, the arrangement was sensitive. The iron jacket was now placed around the solenoid and the curve C_1 obtained for the same variation of ampere turns, viz., 5,500, and same weight the travel being 2·4in.; the earlier part of the curve is straighter than in C, but then it becomes more curved towards the end of its

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travel. The introduction of the iron jacket made the arrangement more sluggish as before, and this sluggishness became more apparent as the exciting power was increased. It can be noticed from the curves that in C_1 the core was 0·2in. outside coil before balance between weight and exciting power was obtained; without jacket this balance was obtained as the point of core was flush with top of coil.

The last experiment with this core (No. 1) the weight was increased to 180oz. Here the travel is much shorter, and it

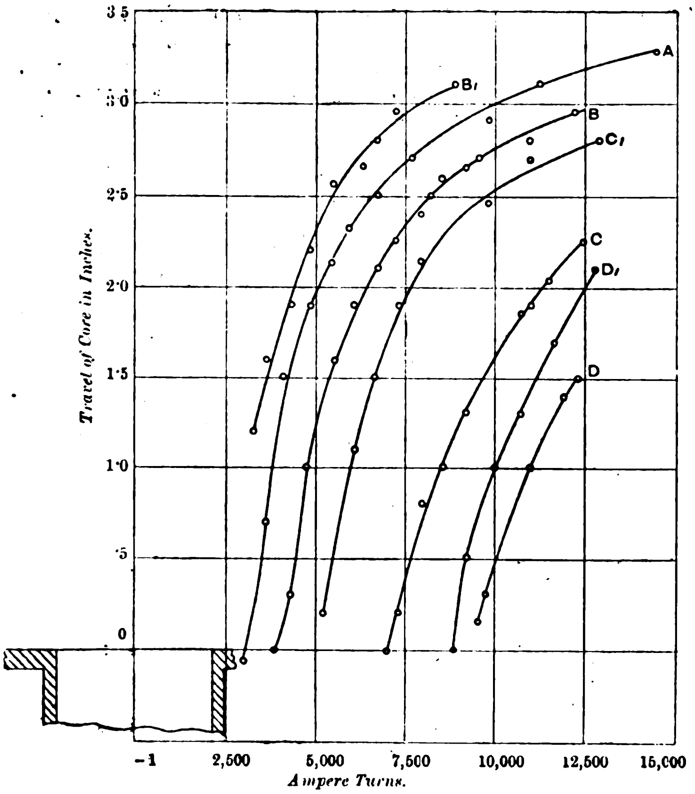

Fig. 4.

required a great deal more ampere-turns to support the weight. In D the travel was only 1·35in., and variation 3,000 ampere turns, the point of the core was ·15in. beyond the solenoid before balance was obtained. With the iron jacket and same weight and between same ampere turns variation the travel was 1·4in., or almost the same as without the jacket; but for a wider range of variation the travel was more. Another point worthy of notice is that the D_1 curve becomes straighter after the point of core is 0·5in. outside coil, and does not bend as in

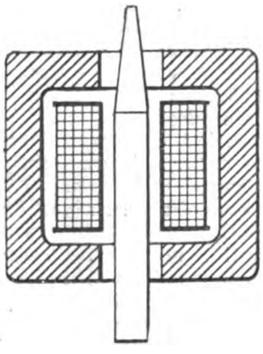

Fig. 4A.

B_1 or C_1. The use of the iron jacket again made the arrangement sluggish.

Tabulating result of the seven experiments with No. 1 core, and comparing results as to maximum travel, maximum sensitiveness and minimum variation of exciting power. A travel of 1·75in., one-fourth the length of the coil is taken as a standard, and for this travel all curves except B_1 and D are fairly straight, *i.e.*, the travel is very near proportional to the increase

Table I.—*Core 13½ long, tapered ¼in. at the top.*

—	Maximum travel.	Maximum ampere turns variation.	S i variation for 1¾in. travel.	Weight. Total.
A	3·15in.	9,870	1,750	36oz.
B	2·95in.	8,750	2,250	47oz.
B_1	1·9in.	6,370	4,750	47oz.
C	2·75in.	5,500	3,500	84oz.
C_1	2·55in.	7,250	2,500	84oz.
D	1·35in.	3,000	—	130oz.
D_1	2·0in.	3,700	3,500	130oz.

or decrease of exciting power between these limits. The curve A is the best: we have the smallest variation of ampere turns, and the arrangement is very sensitive, but in that case only a small weight was attached to the core, and consequently the power is small. In all cases the addition of the iron jacket made the arrangement sluggish, and therefore B_1, C_1 and D_1 can be struck out for want of sensitiveness. Turning our attention to A, B and C, we see that as the load is increased the required variation of exciting power increases in direct proportion, or the ratio of variation to load is practically a constant.

(To be continued.)

THE PERMANENT PROTECTION OF UNDERGROUND PIPES FROM ELECTROLYTIC CORROSION.*

BY HAROLD P. BROWN.

Some electric railway engineers insist that the only thing necessary to protect the pipes is to provide perfect bond wires between the rails, and plenty of feeder wires running from the dynamos to the rails. These are both of vital importance, as at present nearly half the energy generated by the railway dynamos at full load is wasted in merely overcoming the resistance of the conductors leading to and from the motor cars. But, assuming that the bond wires are perfect and the feeder wires ample, it is, of course, true that the current flowing on the pipes would be reduced, but they would still carry a considerable proportion and still suffer corrosion at the points where the current left them.

Referring to Fig. 1, we will suppose that R represents four continuous rails, each having a cross-section of 9 sq. in., or 36in. total. It will be found in nearly any city which meets modern requirements for gas and water service, that, considering the cross-section of metal of the pipes P in the network, under and parallel to the rails in the same and the two adjoining streets, it will amount to about 30 sq. in. The pipes are surrounded by the same moist earth that touches the rails, and they will, therefore, carry from *r r* to *t* 45 per cent. of the current, less the loss caused by the resistance of the earth at *r r* and *t*, and by the resistance of the pipe joints. To reduce this percentage one half would require rail feeder wires of 36 sq. in. cross-section, if iron, or 4 sq. in., if copper wires. Even with this enormous expense the rate of injury to the pipes would be reduced but one half.

Three-Wire System.—Another method of protecting the pipes which has been tried in a few small cities is an adaptation of Mr. Edison's three-wire system. This system is a great success when used for its intended purpose, the distribution of electrical energy for light and for power from stationary motors. Mr. Edison states that the use of this system for railways with bare overhead trolley wires will not protect the pipes for the reasons given below, and that it is extremely dangerous. In this system two sets of dynamos are used, as shown in Fig. 2. There are two trolley wires, T and T′, over each street. The negative pole *e* of the dynamo A is connected to T, while its positive pole *d* is connected to the wire *f* leading to the rails R, and also to *e′*, the negative pole of dynamo B, whose positive leads to T′. The current is supposed to leave dynamo B at *d′*, and pass through trolley wire T′ to one half the number of cars on the road. It divides at *r* between the rail R and the pipe P; returns to rail at *t*, passes through the other half of the cars on the road and returns over trolley wire T to dynamo A. If more of the cars C are running than cars D, the dynamo B would take the heavier load and the pipes would suffer at *t* and *t′*. If dynamo A had the heavier load, the pipes would suffer *t* and *r*. If both loads were balanced the pipes would suffer at *t*, which would be a constantly shifting point. The result would

* From the *Street Railway Review.*

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be that the entire system of pipes would be corroded in the vicinity of any line of rails; that the total amount of corrosion would be somewhat reduced, but that it would be impossible to tell from electrical measurements on the surface of the street the condition of the pipes. The advocates of this system claim that when the number of cars is perfectly balanced between trolley wires T and T′ the pipes will not be damaged. This is not true, even though such balancing were possible, which it is not. Experience proves that even in an electric lighting station, it is extremely difficult to perfectly balance the lamps between the two dynamos. With trolley wire T over the up track and T′ over the down track, T′ would be overloaded when the heavy travel was down town in the morning, and *vice versâ*. It is, therefore, suggested that the two wires be divided between the two tracks, but there are serious practical difficulties in the way of this. The only advantage of this system would be the saving of copper wire to the railroad company. Its most serious disadvantage is the greatly increased fire risk, owing to the presence over each street of two bare trolley wires with 1,100 volts pressure between them. The ordinary trolley

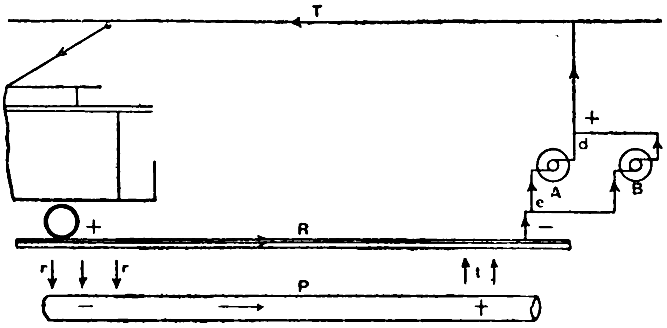

FIG. 1.

system is bad enough and difficult enough to maintain mechanically in position with 550 volts pressure between it and the ground; the double-trolley system is far worse in both respects, as it has two trolley wires which are supported by insulated hangers from the same set of span wires, and which have 550 volts between them. But the three-wire system, with its 1,100 volts between the two wires, is so much more dangerous and difficult to maintain, that the fire risk and serious inconvenience to firemen will cause city authorities and insurance boards to oppose it as soon as its character is understood. Its proper field may perhaps be on suburban roads, and even there the trolley wires, which are alongside of each other, should be of the same potential, the wires being joined to T in one section and to T′ in the next section. The Brooklyn strike was an object lesson of the difficulty in maintaining even a single-trolley wire against line cutters. But with this system a striker, unseen on a house top, could easily throw a weighted wire across both trolley wires, melting them instantly and dropping their ends in the street.

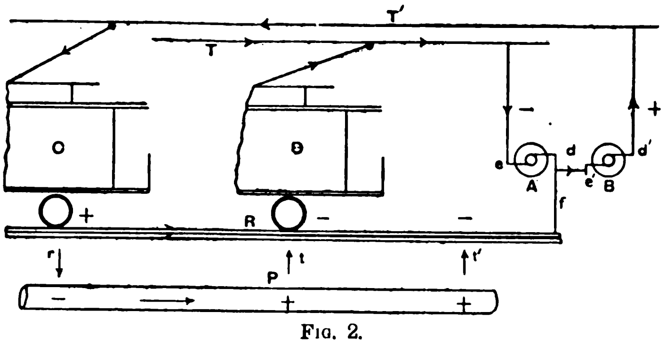

FIG. 2.

Insulated Rail Feeder Wires.—Some few engineers have insisted that running insulated feeder wires to the rails would protect the pipes. This, for the reasons given in the first paragraph, could not be of any help unless the rails also were insulated from the earth.

Pipe Feeder Wires.—Another scheme of pipe protection, frequently advocated in the past year, has two points in its favour, one of which, however, if true, is a serious reflection upon the condition of the road using it, and a rather grim joke upon the engineer advising it. It consists in connecting the negative terminal of the dynamos with a feed wire leading to the points upon the pipes which are positive to the rails. The theory advanced is that this connection will "make the pipes more negative than the rails." This ideal result is utterly impossible unless when broken or rusted bond wires are present in all four rails not far from the station. Referring again to Fig. 1, it is proposed to run a pipe feeder wire from the negative pole *e* of the dynamos to the pipes at *t*, where they are positive to the rails. This wire is supposed to "pump the current out of the pipes" and make them negative to the rail! Assuming, as before, that there are four continuous rails, or their copper equivalent, leading from *t* to the power house, and that, as is generally the case, one-third of the current is returning on the pipes from *r r* to *t*, a pipe feeder wire from the latter point to the station would require a cross-section of 18 sq. in., if iron, or 2 sq. in. if copper to make the pipes at *t* of the same potential as the rails at that point. But to make the pipes sufficiently negative to the rails, to be safe, this cross-section would need to be at least doubled. If, as was reported from one city whose pipes were "protected" in this way, the pipes were really negative to the rails when a connection of this kind was made with a wire of practical size, it is evident that the rail returns from that point were in so bad a condition that nearly 20 per cent. of the total energy was lost in going 1,500ft. from the power house. Protecting the pipes at such a tremendous cost might be worth while if it really did protect them, but it cannot do so for any definite period. The rail bonds are sure to be patched when they get very bad, and within a very short time the contact at *t* between the pipes and their feeder wire will become so poor that the old condition will reappear. Few electricians appreciate the difficulty of making and maintaining a good electrical contact between two different metals, even in a dry room. And still fewer have any idea of the tremendous difficulty in maintaining such a contact underground. For the past four years experiments have been under way at the Edison Laboratory to obtain between underground steel conductors a perfect electrical contact that would not be injured by water, acid, alkali, or mechanical movement. Every practical combination of metals, every method of joining, of excluding moisture, of providing for expansion and contraction, has been tested with heavy currents and then buried for the test of time. The conductors have been machined and scraped to an exact fit, bolted together under heavy pressure, plated with copper, tin or zinc, provided with sheet lead, tinfoil or other soft metal, or various non-oxidisable alloys placed under compression between the surfaces, covered heavily with paint or other water-repelling insulation; or a combination of several of these But time and heavy currents have caused the failure of every device with but a single exception, of which more later. When two different metals are joined in an electric circuit there are three sources of loss that must be encountered; first, the resistance of the metal itself; second, the contact or surface resistance, which can be somewhat reduced by increasing the pressure; and third, the thermo-electric loss. Electricians always calculate upon the first; sometimes give scant attention the second, but entirely ignore the third. Yet with heavy currents the total loss is often three times the amount due to the first alone. The causes and cure of these latter losses are outside the scope of this Paper; but the maintenance of an underground contact between a copper wire and a steel rail, or an iron or a lead pipe, is a problem that requires notice here. However ample the area of the contact between such surfaces; however great the pressure holding them together, and however careful the methods of excluding moisture, there are several agents of destruction constantly at work that are bound to succeed. Even when two iron plates are joined together in the best mechanical way and placed underground, their surfaces are sure to rust; oil or grease of course cannot be used between them. Even a thin film of iron oxide, on either surface, is of high electrical resistance, injures the conductivity of the joint, and permits the entrance of more and more moisture, thus causing further damage. But when a plate of iron and a plate of copper are bolted together and buried, the difficulties of maintaining an electrical contact are greatly increased. The two metals in contact with the moisture of the earth form a galvanic couple whose action corrodes the iron. The different ratios of expansion, due to increase of temperature from weather or current flow, breaks down both the contact and the protecting paint or other covering, letting in water. Therefore, any ordinary mechanical connection between an iron pipe and a copper wire is doomed to early destruction. In one city a pipe clamp is used in which lead is placed between the pipe and the clamp, and the whole insulated with cotton tape and black paint. It requires slight engineering skill to predict the life of painted cotton as a means of excluding water. And as for the lead, which is evidently used to secure a compression contact and save careful fitting of surfaces of pipe and clamp, it invites a still earlier destruction, since lead suffers more severely from electrolytic decomposition than iron or copper. And to further increase the resistance of the joint, the clamp is of iron, and is welded to the copper wire. Thus a pipe, which is already positive to the rails and suffering corrosion, is to be relieved by an insufficient feeder wire, and the current is invited to pass from iron to lead, from lead to iron, and from iron to copper, suffering a heavy loss at every contact, and making three joints where one is too many. With a copper

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rod $\frac{5}{8}$ths of an inch in diameter and 30in. long, having a contact area of 10 times its cross-section against an iron plate, the surfaces being bright, accurately fitted and held together by very heavy pressure, the electrical loss was $\frac{8}{30}$ths of a volt with 1,200 amperes. In other words, with the best made mechanical joint between iron and copper, the loss was 0·426 E.H.P. Adding the other joints of equal area, iron to lead, and lead to iron, the loss was increased 20 per cent. It is evident that the engineer suggesting this joint has never tested it in heavy service with the proper instruments.

A Successful Method of Pipe Protection.—There are three problems to solve in protecting pipes from electrolytic corrosion:

First. To keep the pipes at least one volt negative to the rails at all points and at all times.

Second. To diminish as much as possible the flow of current on the pipes.

Third. To secure some permanent, inoxidisable contact of low resistance between the pipes and the necessary feeder wires.

In Fig. 3 A represents the main battery of dynamos whose positive poles d are joined to the trolley wire T, and whose negative poles e are connected to the rails R in the ordinary manner. These dynamos are adjusted to maintain the usual 550 volts pressure between d and e. The dynamo B represents at first about one-quarter of the total capacity of the station; but the proportion can be reduced when this plan has been put into service. Its positive pole d', is connected to trolley wire T; but its negative pole e' is connected by suitable feeder wires m to the points t on the pipes which were previously positive to the rails. The pressure of dynamo B is then so adjusted that it gives 5 to 12 volts more than dynamo A; as their positive poles are joined, this difference of pressure asserts itself by maintaining the pipes negative to the rails by 12 volts, less the previous positive charge and the loss incurred in passing the current through the feeder wire m. For instance, at Newark, N.J., the gas and water pipes were 7 volts positive to the rails at a point about 600ft. from one power house, and the service pipes and lead joints were seriously injured. The

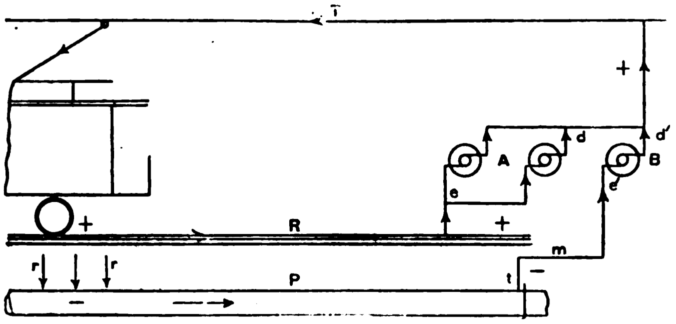

FIG. 3.

average current output of the dynamos was about 1,200 amperes, of which 400 returned by way of the pipes. The dynamos A were run at 550 volts, and by running the dynamos B at 562 volts, the point t on the pipes, which had been seven volts positive to the rails, was maintained at three volts negative, and all further corrosion checked. The closing of the circuit through m and dynamo B caused a drop averaging 60 H.P. in the station load. This was due to removing the resistance of the earth, which was encountered by the current in the pipes P in passing from t to the trolley wire T.

This method, as thus far described, entirely checks electrolysis of the pipes unless it be around some poor joint on same. Such a joint, however, can be easily detected by a low reading voltmeter on the surface of the street, and this action checked by continuing the wire m, diminished in size, to a point beyond the poor joint. It is true that as far as described the tendency of this method is to slightly increase the current flow on the pipes, but this is only the first step in the method. The current reaches the pipes at $r\ r$ near the ends of the railway lines, and here electrical measurements have shown in some cases at Newark that the rails were 15 volts positive to the pipes. This difference, of course, causes a large flow to the pipes, and is produced by poor bonds between the rails and insufficient rail feeders, or by the fact that the network of pipes may lead directly to the power house, while the lines of rails may take a roundabout course. But with proper bonding the difference of pressure between the pipes and rails at $r\ r$ may be brought down from 15 volts to 1 volt by carrying out from the higher pressure dynamo B a continuation of the wire m to the rails at $r\ r$. By this means, and by the proper feeder regulators in the wires m, the rails at r and the pipes at t, whose previous positive potential caused the current flow through the earth, can be made negative, and the current flow on the pipes cut down to a minimum. It was feared by some electricians that in order to keep dynamo B at a definite increase of pressure over the dynamo A, constant shifting of its rheostat would be necessary as the station load varied; or, that the dynamos would not regulate properly. No trouble has been encountered from either source with dynamos of two of the leading manufacturers.

This brings us to the third problem; a permanent, inoxidisable, elastic contact of low resistance between iron pipes and the feeder wires m, or between the meeting ends of steel rails, which contact shall possess an affinity for each metal. Here the writer has been permitted to share in, and to benefit from, the experiments leading in this direction, suggested by Mr. Edison, and carried on for the past four years. A few square inches on the top of the pipe is filed clean of paint or scale, and rubbed with a silvery metal compound, which at once turns any iron rust into pure metallic iron and amalgamates the surface. Metallurgists have long considered impossible a stable iron amalgam, but it nevertheless exists, and is so permanent that neither water nor any acid or alkali which it will encounter under the streets can decompose it or rust the iron surface beneath it. A U-shaped bolt is then slipped under the pipe, and a cast-iron yoke placed over it. The end of feeder wire m has been brazed to a copper saddle, $\frac{1}{8}$th of an inch thick, fitted between top of pipe and bottom of yoke. The centre of the saddle on each side of the wire is cut away to form a receptacle into which, after the copper has been amalgamated, is placed a plastic alloy of electrical origin. The nuts are then tightened up and locked. This alloy gradually hardens and expands, placing the joint under a tremendous pressure, and forming a perfect electrical contact of extremely low resistance, which will not corrode. Moreover, when a joint between iron and copper is thus prepared, all of the contact resistance disappears, and the thermo-electric loss is much reduced. But when this alloy is used between iron or steel surfaces both contact resistance and thermo-electric loss are eliminated. It will give a comparative idea of the efficiency of these contacts to state that, with a copper rod $\frac{5}{8}$ths of an inch in diameter and 30in. long, having an area of ten times its cross-section, in contact with a steel plate, with surfaces accurately fitted together and joined with great pressure, the loss in transmitting amperes was $\frac{24}{120}$ volts. The same with amalgamated surfaces, and with the plastic alloy between steel and copper was $\frac{13}{120}$ volts. With the plastic alloy between amalgamated surfaces of steel and steel it was but $\frac{4}{120}$ volts. Galvanometer tests of joints for heavy currents are, of course, worthless, as they do not show working conditions.

A large number of these joints were put underground about four years ago in order to make a thorough test. Measurements recently made with heavy currents show absolutely no deterioration. Many of them have been taken up, and no trace of oxidation was found, the surfaces being perfectly bright. Thus has the third problem in the way of permanent pipe protection been solved, and its prompt application will save money to water, gas, and subway companies, and to the electric railways.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, June 28th.

PHYSICAL SOCIETY.

5 p.m. Meeting at Burlington House. Papers to be read: (1) "An Electromagnetic Effect," by F. W. Bowden; (2) "On Synchronous Motors," by W. G. Rhodes; (3) "The Electrical Properties of Selenium," by Shelford Bidwell, F.R.S.

MONDAY, July 1st.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

WEDNESDAY, July 3rd.

INSTITUTION OF ELECTRICAL ENGINEERS.

9 p.m. Annual Conversazione in the Galleries of the Royal Institute of Painters in Water Colours, 191, Piccadilly.

Electric Welding in Ships.—In the adjourned discussion on electric welding, at a recent meeting of the North-East Coast Institution of Engineers and Shipbuilders, Mr. H. Macoll said it was a matter of regret that, although such a fitting as a boiler furnace might be welded from end to end with approval by one of the Government Departments which was supposed to concern itself with the safety and efficiency of marine engines in vessels carrying passengers at sea, yet on no account must the smallest portion of the steel working parts of a marine engine be welded if the structure was to obtain a passenger certificate.

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The Electrician.

The Oldest Electrical Journal, 1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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SPECIAL NOTICE.

With this week's number of "THE ELECTRICIAN" is issued (gratis) Supplement Sheet Tables showing Total Capital Outlay and Receipts and Expenditure for the year 1894 of the Statutory Electric Supply Undertakings of the Metropolis.

Complaints of non-receipt should be promptly addressed to the Publisher.

THE LONDON ELECTRIC SUPPLY BUSINESS IN 1894.

Statistics, like mathematics, are an extremely dangerous weapon to place in the hands of an enthusiast, be his mission to utterly destroy the Amalekites—that is to say, the alternate-current men—or merely to exalt the virtues of a particularly fanciful form of current wave. The misuses to which statistics might be turned are, indeed, so many that it is fortunate they prove such very dry caviare to the general. Across the Atlantic, it is true, no self-respecting individual is without his string of so-called "useful data"; with us, anyone who gives way without restraint to his fondness for figures is suspect. In moderation, however, and well arranged and well digested, statistics may in many cases be made actually interesting even to the sciolist, and in almost any case they are of sufficient utility to the expert to justify their existence. The tables dealing with the electric supply business of London, which we publish this week, have, we trust, at any rate the merit of usefulness, although as to general interest it may be they scarcely compare with many collections of figures that might be mentioned.

In preparing these tables year after year one fact is persistently borne in upon us, namely, the unreliability of statistics, unless most carefully sifted, as a basis for exact argument. Here we have something less than a dozen concerns, all of which are engaged in the same business, in the same town, and all of which are bound by law to prepare their accounts on the same lines; yet in almost every instance there are differences not sufficient perhaps, if ignored, to in-

Tables : Year 1894 of the Statutory

COMP.	Capital Expended.	Mains.	Capital Expended.	Meters.	Capital Expended.	Miscellaneous.	Capital Expended.
	%	£	%	£	%	£	%
1. Charing-cross and Strand Electricity			97·2	2,641	1·25	3,286	1·55
2. Chelsea Electricity Supply Company	44·2	33,363	27·9	4,236	3·53	14,398[5]	12·0
3. City of London Electric Lighting Co	29·3	309,236	31·4	14,606	1·47	158,497[7]	16·0
4. House-to-House Electric Light Supp	42·2	24,096	28·7	4,433	5·23	9,517[9]	11·3
5. Kensington and Knightsbridge Elec	32·0	69,670	37·1	7,102	3·62	24,423[11]	13·0
6. *London Electric Supply Corporation*	*28·5*	*166,825*	*19·5*	*8,680*	*1·0*	*305,380*[13]	*35·8*
7. Metropolitan Electric Supply Compa	39·4	156,038	24·8	14,295	2·27	59,612	9·47
8. Notting Hill Electric Lighting Comp	19·3	38,732	49·4	1,523	1·94	4,562	5·83
9. St. James and Pall Mall Electric Lig	26·4	57,426	25·3	9,719[21]	4·23	15,979	7·03
10. St. Pancras Vestry	33·1	39,842	36·2	3,713	3·37	8,055[23]	7·32
11. Westminster Electric Supply Corpor	26·7	173,856	42·2	20,339	4·94	14,073[25]	3·42
12. Crystal Palace District Electric Supp	—	—	—	—	—	—	—

[1] The Depreciation Fund of this Co This, according to the accounts, is the total expenditure up to December 31, 1894, *less depreciation*,
[2] Of this sum nearly £123,000 v this amounts in all to £15,346, the actual total capital outlay since the commencement of the
liability company was formed ; the balany has been £242,413.
[3] The Depreciation Fund of this Co To make this ratio fairly comparable with those of the other undertakings we have taken
[4] Includes property subject to £80 James' Company capital outlay at what actually has been spent, viz., £242,413, and not at £227,067,
[5] This item includes the sum of £is the capital expenditure *less* the total amount allowed for depreciation since the undertaking began
plant.
[6] The balance to the credit of the v This is the total expenditure on buildings up to December 31, 1894, *less depreciation*, amounting in all
[7] In order to make the various i547.
corresponding items in the accounts of This is the total expenditure up to December 31, 1894, *less depreciation*, which for plant, machinery,
laying, all charges debited to these two eesumably including mains, meters, and so on), amounts to £13,798.
column ; the expenditure on machinery This sum includes cost of switches and labour.
outlay on the street lamp leads. The fo A sum of £3,739 has been paid off loans.
expenditure :—Street lamps, £25,559 ; This includes £7,267 spent in connection with the public lamps.
£69,504 ; Southwark order and mains, £The Depreciation and Sinking Funds of this Company stand at £12,594.
[8] The Depreciation account stands a This sum includes £10,133 paid to the City of Westminster Electrical Syndicate.

Companies.	Coal.	Per cent. of generating expenses.	Cost of coal per Board of Trade unit sold.	Oil and waste, &c.	Per cent. of generating expenses.	Cost of Oil, Waste, &c., per Board of Trade unit sold.	alaries and wages.	Per cent. of generating expenses.	Salaries and wages per Board of Trade unit sold.	Repairs and Maintenance.	Per cent. of generating expenses.	Cost of repairs and maintenance per Board of Trade unit sold.
	£	%	d.	£	%	d.	£	%	d.	£	%	d.
1. Charing Cross and Strand Electrici	4,806	50·7	1·03	611	6·44	0·13	1,960	20·6	0·42	2,098[2]	22·1	0·45
2. Chelsea Electricity Supply Compan	2,080	52·2	1·06	353	8·86	0·18	983[3]	24·9	0·50	566	14·2	0·29
3. City of London Electric Lighting (	14,429	62·3	1·37	2,309	9·97	0·21	6,420	27·6	0·61	1,980[7]	8·98	0·18
4. House-to-House Electric Light Sup	2,827	52·3	1·69	665	12·3	0·39	1,584	29·3	0·94	629	11·6	0·37
5. Kensington and Knightsbridge Ele	2,929	39·5	0·71	581	7·97	0·14	1,975	26·5	0·48	1,940	26·2	0·47
6. *London Electric Supply Corporation*	*7,235*	*55·2*	*1·88*	*1,075*	*8·2*	*0·28*	*3,091*	*23·6*	*0·80*	*1,695*	*13·0*	*0·44*
7. Metropolitan Electric Supply Com	23,219	54·8	2·11	3,787	8·93	0·34	8,630	20·3	0·78	6,728	15·8	0·61
8. Notting Hill Electric Lighting Co	459	34·5	0·84	112	8·48	0·20	354	26·6	0·65	400	30·1	0·73
9. St. James and Pall Mall Electric I	4,926	41·8	0·69	846	7·19	0·12	4,516	38·4	0·69	1,465	12·4	0·22
10. St. Pancras Vestry	2,977	48·2	0·99	459	7·44	0·15	1,676	27·1	0·55	1,064	17·2	0·35
11. Westminster Electric Supply Corpo	5,842	39·1	0·63	1,228	8·24	0·13	6,345	42·6	0·70	1,478	9·92	0·11
12. Crystal Palace District Electric Su	—	—	—	—	—	—	—	—	—	—	—	—

[1] Includes £1,600 set aside for depr end from the sum given in the revenue account under the heading of "sale of current." As the
[2] The lighting of the Company's sta ny has a sliding scale down to 5½d. the result of this arithmetical operation is not particularly
[3] Wages of men alone included ; sala ble to it.
[4] This figure, like all the others re This sum includes £3,695 set aside for depreciation.
for which about 1,000,000 units were so This sum only includes repairs and maintenance of mains, the salaries paid in connection with
the units given is absolutely correct, wor ution work being mixed up with those paid in connection with generating expenses.
[5] The receipts, expenditure, &c., all This figure, like all the others relating to St. Pancras, include the public lighting ; 186,604 units were
a total receipt of £12,971 is recorded and the public lamps at 5d. per unit.
[6] This does not include repairs and This includes £552 for carbons, attendance, and repairs for public lamps.
funds. This sum includes £5,000 set aside for depreciation.

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validate an argument, but quite enough to make good a charge of inaccuracy, whilst in some instances the differences are by no means trifling. Deductions from statistics have always to be made with discretion; how great that discretion must be in most cases is evident from the openings for mistaken conclusions afforded even by figures so much above the average in clearness and accuracy as those which go to fill the annual returns made to the Board of Trade by statutory electric light undertakings. So far as foot-notes can apply the necessary qualifications to bare figures we have endeavoured to qualify them. Another point in connection with the compilation of these tables is the unaccountable reluctance of one of our largest metropolitan electric supply companies to make public the number of units it is their good fortune to sell every twelvemonth. Technically, we believe, the company in question is quite within its rights in refusing to comply in this respect with the requirements of the Board of Trade model form of accounts. By Section 9 of the Act of 1882 it is undoubtedly laid down that: "The undertakers shall on or before March 25th in every year fill up an annual statement of *accounts* of the undertaking made up to December 31st then next preceding, and such statement shall be in such form and shall contain such particulars and shall be published in such manner as may from time to time be prescribed in that behalf by the Board of Trade." But it is to be observed that this section applies wholly and solely to accounts, and accounts are nothing more than "a registry of *pecuniary* transactions." Hence a company which desires to stand upon its rights may very reasonably object to make public the number of kilowatt-hours it has generated, sold and wasted, as being quite as much outside the radius of the word "accounts" as a statement of the tons of coal or gallons of water used. So long as the Board of Trade confines itself to asking how much money is received by a company in return for the x units received by its customers, so long must its request be complied with in virtue of Section 9. But the moment a company is asked to solve for x, it may politely but firmly decline to do so. Nevertheless, it is not very apparent what harm can accrue from the publication of a figure, which every other similar concern has made public without injury to itself and with considerable advantage to the electric supply industry generally. In a business of a purely mercantile character, in which there is keen competition, the argument against the publication of detailed accounts has some force; in the electric supply business as carried on in the metropolis it has none. On the contrary, the publicity to which every item of capital outlay, every improvement in output, every economy in management, has been exposed from the beginning is largely responsible for that very sound state of the electric supply industry in London of which English electrical engineers are justly proud. Directors and central station engineers are able to discover at a glance, by comparing corresponding items, the weak spot of their particular system. Before an evil can be remedied it must be discovered. Moreover, a spirit of emulation is introduced by the publication of comparative statistics which can have nothing but the best results, since, in view of the disastrous effect of chronic breakdowns, undue economy is not likely to be practised.

Notwithstanding the array of figures in the tables, reference to a few of the more important totals may be permitted here. In the first place, the total capital outlay of the London companies, which amounted in round figures to 8½ millions sterling at the end of 1893, had increased to £8,900,000, *i.e.*, by 11 per cent., at the end of 1894. The total output for the past year was greater than that for 1893 by nearly 39 per cent., the Board of Trade units sold in 1894 aggregating over 13½ millions. This latter figure undoubtedly understates the truth, since the London Electric Supply Corporation has filed no accounts for 1894, and its 1893 figures have, therefore, been repeated, and the output of the Metropolitan Electric Supply Company has been computed on a basis decidedly unfavourable to it, though the only one available to us. Coming to the revenue account, the total income for 1894 amounted, in round figures, to £370,000, an increase of 30 per cent. on the corresponding figure for 1893. The total expenditure amounted to £235,000, an increase of only 22 per cent. on the 1893 total. The average ratio of expenditure to receipts now stands at about 63 per cent. The average "total cost" of a Board of Trade unit has been reduced from about 4¾d. to a fraction over 4d. All these averages would, of course, be considerably improved if the fatal 1893 figures of the unfortunate London Electric Supply Corporation were eliminated. However, notwithstanding their inclusion, it is evident that the business of electric supply is making healthy progress in London.

GAS ENGINE ELECTRIC SUPPLY STATIONS.—I.*

In the early part of the present year a representative of *The Electrician* made a tour of the gas engine electric supply stations of Great Britain and Ireland, for the purpose of making a comparative study of this, relatively speaking, modern form of electric supply works. It is now intended to embody the information thus gathered together in the form of a short series of descriptive and, to some extent perhaps, critical articles. Notwithstanding that we found the state of affairs very far from wearing a rosy hue in more than one station, the general and prominent impression which we received went only to strengthen and deepen our faith in the ultimate success of this type of station. Gas power in electric supply stations has not only proved itself to be an established commercial success, but it has also given good grounds for believing that it can be made increasingly successful. If at the present time gas stations are made to pay—and it will be shown that they are—there are indications of further margins of possible economy which only time and increased experience are required to turn into actual economy. Indeed, the prospect of the gas engine as a motor for the dynamo in supply stations appears to be a very good one, whether viewed from the theoretical, the technical or the commercial standpoint.

Turning now for a moment to take a general glance at the less rosy side of the matter, there may seem to be ground for some discouragement—if not for a reversal of the verdict, for the time being—in some of the vicissitudes of gas-engine stations. Of those which we visited, one was on the eve of quitting its *locale* and removing to a place at a greater distance from human private residence, because it had been voted an intolerable nuisance on account of the malodorous gases which were emitted from it. And another was about to place the entire body of its gas generating and engine plant "on the scrap heap," so to speak, and to substitute steam plant, for reasons which, if not quite so explicit, were at any rate apparently not less convincing to those who had control of the matter. And yet a third station which the writer visited had scarcely got past its embryonic stage, or, to take another simile, had not yet travelled far enough on its path of duty to rub off its scarcely-dried paint, or to blow away the odour of its plentiful varnish. Yet all these matters are mere contingencies, and by no means ought to affect a general conclusion. It is not essential to a gas-engine station that residents in its vicinity shall lose their appetites and suffer unpleasant qualms, nor are those conditions always present which, in one case, have obliged the owners to replace their gas engines by ones driven by steam. Nor is anything

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more than time required to turn an embryonic and brand-new station into one ripe with experience, and even the smell of varnish goes off in time. We may say that almost all the evil or negative quantities cancel out, leaving little else than the positive or favourable ones to affect the final result. In fact, it is not the least of the advantages of a comparative study of these stations that we are able to perceive that the defects of each are absent from the others, and to infer that the items of success in each will not be long in aggregating themselves into more than one actual station in the future.

In estimating the suitability of gas power for an electric lighting station, there are two main considerations which it is necessary to make: (1) as to the superiority of gas-engine power over ordinary gas lighting, and (2) as to the superiority of gas power over any other form of motive power for driving dynamos. In any formal treatise it would be requisite that both these points should be fully discussed; but in the present series it is intended to proceed somewhat differently. It will be sufficient if we are able to state just what gas power is found to cost in those actual stations where it is used. The reader will, no doubt, be able to make for himself any comparison he may desire between this cost and that of any other proposed system of lighting.

Gas engines have been used for driving dynamos almost as long as dynamos have been in existence. Most of the early isolated installations of electric-light plant were driven by gas power; and, in fact, much of the experimental and initial experience in electric lighting was obtained with plant of this description. But there is considerable difference between the conditions of working of plant such as this, even in modern times, and those conditions which obtain in a gas-engine installation designed to meet the requirements of public supply. This is true of any kind of engine or motor; it is true of steam plant; but it is more essentially true of the gas engine. What success will be achieved with this engine, and how it will behave, when it is used for lighting a private house with an ample storage plant to cover its multitude of sins, are no guide to the manner in which it will behave, or how successful it will turn out to be, when it has to take its share with several others in the duties of a supply station. To begin with, the same design of engine will not meet the requirements in the two cases; and further, there is hardly one single condition common to them both. That this is so will become more evident when we enter into detailed descriptions of the several stations. If this fact is borne in mind, the reader will the better be able to appreciate the difficulties in which the pioneers of gas-engine stations have at times found themselves, and to understand why it is that, although abundant experience of the gas engine *per se* had been pressed into service, this type of station has had to go through a distinct process of evolution —an evolution which, by-the-bye, is by no means yet completed.

The history of gas engine stations for public electric supply and for electric lighting on a large scale is one of great interest, but we cannot find space in this introduction to notice more than a few incidents. According to Mr. Emerson Dowson, to whose valuable contributions to the literature of gas power we shall make frequent reference, the first important electric supply station worked by gas power was opened at Dessau, in the Duchy of Anhalt, in Germany, in September, 1886. This station was established by the German Imperial Continental Gas Association, in the belief that it would not only promote the use of their gas during the day-time, but also cheapen the production of light. So successful was the initial experiment that the Gas Association has extended the system to other towns in Germany in which it has gasworks. An account of this station appeared in the *Journal of Gas Lighting*, of January 5 and 12, 1892, as a translation from the German of M. W. von Oechelhäuser; and further details are supplied in Mr. Dowson's Paper on "Gas Power for Electric Lighting."* "When the station was opened in 1886," writes Mr. Dowson, "the largest gas engine made gave only 60 (effective) H.P. with two cylinders. They then had two 60 H.P., one 30 H.P., and one 8 H.P. engines, and all the dynamos were driven by belting and countershafts. In 1891 a considerable change was made, as the result of five years' experience, and as larger gas engines were then being constructed, they retained one engine of 60 H.P., with its belting and countershaft, and substituted for the other engines one of 120 H.P. (effective), coupled direct to its dynamo." The success of the latter mode of driving—which is wholly unknown in English gas-power stations—led the Association to decide to adopt it in all their other engines, both at Dessau and in other places. The speed of the 120 H.P. coupled engine and dynamo just referred to is 150 to 160 revolutions per minute, a coal gas consumption of 39 cubic ft. per kilowatt-hour at dynamo terminals being, it is said, obtained at full load. By comparison with this result, it may be remarked that the belted engines at the Dessau station consumed, in the case of the 60 H.P. set, as much as 42 cubic ft. of the same quality of gas per kilowatt-hour; and the loss of power between the engine and the dynamo terminals was 20 per cent., while the loss was only about 10 per cent. in the direct-coupled set. This does not, of course, include the losses in the engine itself.

* *Proc.* Inst. C. E., Vol. CXII.

The following is a summary of the advantages which were found to accrue from the use of gas in the Dessau electric supply station; this summary having been published in May, 1892, after five years' experience, by the German Imperial Continental Gas Association:—

1. Small space required for plant and station.
2. Small consumption of water.
3. No coal or fuel to carry (by hand).
4. No smoke.
5. No risk of explosion.
6. Cheaper than steam engines in respect of (*a*) ground required; (*b*) relative convenience of gas motors as compared with steam in a town, whence greater choice of place within a town and shorter distance to lay cables; (*c*) gas motors above 100 H.P. being cheaper than steam plant.
7. Less loss of electric power, because station is more favourably situated.
8. Less attendance and wages.
9. Exact control over fuel.
10. More regular working and greater security of power to meet unforeseen demands.
11. Cost of fuel can be reckoned at cost of gas supplied—if gas company runs the station.

Although some of the foregoing conclusions are not quite in agreement with English practice at the present time, the summary is interesting as showing the results of prolonged experience on the part of actual gas manufacturers supplying electric power. Doubtless this is a phase of gas-engine station development which, in this country, will before long occupy the serious attention of town gas manufacturers. To be quite exact, we should say that it already has occupied their serious attention; for one of the most interesting of the various schemes for gas stations was advanced by Mr. Denny Lane, the manager of the Cork Gas Company's works, in October, 1891 (see *The Electrician*, Vol. XXVII., p. 629). In another sense, gas manufacturers may be said to be running electric supply stations when, as at Burton, they use steam plant which is fired with the refuse from the gas works; but that is not the sense here intended.

Mr. Denny Lane's proposal may be summarised as follows. The pivot of his scheme is the fact that a given amount of energy can more economically be transmitted a short distance by gas conveyed through pipes than by means of electric feeders. Mr. Lane proposed to replace the "central" electric supply station by ordinary gasworks; and to substitute gas mains for the electric feeders. At the feeding points—the further ends of the gas mains—there were to be gas-engine sub-stations, where gas engines would drive low-pressure dynamos, and where the energy of the gas would be transformed into electric energy. This electric energy would be fed on to the low-pressure network of electric supply mains, just as if it had been brought to the point by a feeder. Coming to Mr. Lane's figures, we find that he calculated that 1 H.P. of gas propelling power will transmit enough gas for 3,000 H.P. over a distance which will cause a loss of gas pressure of 4in. of water. Putting this in another way, it is equivalent to 300 H.P., or 900 cubic ft. of gas per hour, transmitted a distance of one mile in a 6in. main. The cost of such a gas

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main Mr. Lane estimated at £352 per mile, plus £132 per mile for laying, or a total cost of £486 per mile. The annual interest on this sum he reckoned at 1s. 8d. per horse-power transmitted, and taking gas at 2s. 6d. per 1,000 cubic ft., the 800 H.P. is transmitted a distance of one mile at a cost of 0·1 penny per hour. These figures are applicable only to coal gas or gas of equivalent richness, and they become considerably modified when it is proposed to use diluted water gas, such as that made by the Dowson process.

As yet, British gas companies have not ventured to adopt Mr. Lane's scheme, but an application of the scheme in a modified form occurs at Belfast, where the Corporation electric supply station is run by gas power, the gas being metered into the station from the mains of the Belfast Corporation Gas Works. At Leicester, too, the Midland Railway Company has a gas-engine station for generating electric power for the railway station and yard lights, and although the gas is principally made by Dowson producers on the spot, it is also, to some extent, derived from the town gas mains.

Before concluding these preliminary remarks, we may consider two further matters of importance: (1) The general character of the gaseous fuels used, and (2) the principal arguments of a general nature which have been advanced in favour of and against the use of gas plant in electric supply stations.

Up to the present time only three kinds of gaseous fuels have been employed in the stations with which we are directly concerned, namely, town coal gas, town enriched water gas, and Dowson gas. The name Dowson gas is here applied to all gaseous fuel made by a process resembling that used by Mr. Dowson, whether actually made in Mr. Dowson's apparatus or in modified forms of it.

Table I. shows the composition of a number of samples of town coal gas, and clearly indicates the considerable range over which the composition varies. The average specific volume of coal gas, at atmospheric pressure and ordinary temperatures, is about 30 cubic ft. per pound of gas. One pound weight will develop about 22,000 British thermal units by its complete combustion. The thermal value of one cubic foot is, therefore, about 733 B.T.U. This may be expressed somewhat differently by saying that coal gas consumption at the rate of 1 cubic ft. per hour is equivalent to 0·285 H.P., or 1 H.P. can theoretically be developed by the combustion of 3·51 cubic ft. of gas per hour. These figures will be useful for comparison with the actual results obtained in practice.

Table I.—*Analyses of Coal Gas in various towns, in percentage of total volume.**

Name of Town or Gas Company.	Heavy hydro-c'rb'ns	Marsh gas, CH_4.	Hydrogen	C'rbon mon-oxide.	C'rbon di-oxide.	Oxygen.	Nitrogen.
London Gas Light and Coke Company… ..	4·41	37·64	47·99	3·75	—	0·26	5·95
South Metropolitan (London) …………	2·92	36·55	53·14	4·11	0·09	—	3·19
Edinburgh …………	12·23	42·93	33·24	6·61	0·35	1·00	3·64
Glasgow………………	10·00	40·26	39·18	7·14	0·29	0·06	3·07
Kilmarnock (Professor Kennedy's Tests)…	5·55	42·80	43·60	4·30	1·05		2·70
Norwich .. …………	3·26	36·11	53·79	3·40	0·27	0·14	3·03
Society of Arts Trials of Gas Engines……	3·77	37·34	50·44	3·96	0·51	—	3·98

Both Dowson gas and town enriched water gas are commercial modifications of a mixture of gases, known as water gas. Pure water gas is a mixture of hydrogen and carbon monoxide in definite proportions, and is generated by the action of steam on incandescent carbon. The chemical action which ensues may be represented by the following equation:—

$$C + H_2O = CO + H_2.$$

Equal volumes of the two gaseous fuels are generated, and the proportions by weight are 93·33 per cent. of carbon monoxide and 6·66 per cent. of hydrogen. The former gas is highly poisonous; hence, from its large percentage in the mixture, it becomes necessary to take great precaution that commercial gases generated on this principle do not escape from the generating plant, the pipes, and the engine. In the commercial water gases, such as Dowson gas, the percentages of carbon monoxide and hydrogen are not so high as in the pure gas; but the proportion of the former is always sufficient to render the mixture poisonous. Town gas is in some places composed of water gas which has been rendered capable of giving a luminous flame by the admixture of oil vapour. Various enriching substances are employed, but principally benzol or light mineral oil distillates. The town gas of Belfast is an enriched water gas of this kind. Dowson gas consists of water gas which has been diluted by certain inert gases during the process of manufacture. It is practically non-luminous, burning with a faint blue or purple flame. It will be more convenient to describe the details of its manufacture when considering the stations where it is used. The composition of this gas varies widely, according to the conditions under which it is manufactured; but Table II. may be considered to represent a good sample. This analysis was made by Dr. C. Monaco, of Turin, and the sample was taken from the gas holder and not directly from the gas generator.

Table II.—*Average Composition of Samples of Dowson Gas taken from a Gas Generating Plant at Canale, Piedmont. Temp., 32°F. Pressure, 14·22lb. per square inch.*—(*Dr. Monaco.*)

—	Percentage volume.	Percentage weight.	Weight in pounds per 1,000 cubic ft. of Dowson gas.
Carbon dioxide, CO_2	8·40	14·73	10·057
Oxygen, O …………	0·90	1·15	0·784
Hydrogen, H…………	16·47	1·32	0·897
Carbon monoxide, CO.	27·50	30·67	20·946
Nitrogen, N …………	46·73	52·13	35·595
Total……………	100·00	100·00	68·281

According to this analysis, average Dowson gas possesses the following properties. The theoretical volume of air required for its complete combustion is equal to the volume of the gas itself; the heat evolved by the combustion of 1lb. of the gas is equal to 2,600 B.T.U.; and the heat evolved by the combustion of 1,000 cubic ft. is equal to about 177,500 B.T.U.

The principal arguments which may be advanced in favour of the use of gas power in electric supply stations are as follows:—Thermodynamically, the gas engine has both a higher range of *possible* efficiency and a higher degree of *realised* efficiency, than any other form of heat engine. The actual thermodynamical efficiency of the modern gas engine is as high as from 15 to 20 per cent.; and a possible efficiency of 80 per cent. is claimed by some writers. Practically, the gas engine offers several advantages, many of which have already been specified; and to the previous list may be added: (1) less cost of fuel, when suitable gaseous fuel is chosen; (2) less waste of fuel in running engines on light loads, because there may be little or no stand-by losses in gas plant; (3) greater promptness in starting and shutting-down the station.

The principal arguments which have been advanced by the various opponents of this type of engine are the following: (1) that the engine is not capable of sufficiently sensitive governing; (2) that it is dirty in working, and takes a great deal of labour in keeping in cleanly order; (3) that the fact of its being an explosion engine renders it unsuited to steady driving; (4) that it cannot be made in sufficiently large units of power for other than very small stations; (5) that it cannot be made economical on small fractions of full load; and (6) that a gas-engine station in a populous district is a noisy and noisome nuisance, anyway. The sequel will show to what extent these objections are invalid.

Paris Congress of Applied Chemistry.—The Organising Committee of the International Congress of Applied Chemistry, to be held in Paris next year, met, says *Nature*, a few days ago to make preliminary arrangements. The Congress will be divided into 10 sections, and electro-chemistry is one of the number.

* Compiled from "Gas, Oil, and Air Engines," by Bryan Donkin, and "Gas and Petroleum Engines,' by Prof. W. Robinson.

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NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(*Continued from page 265.*)

46. Shipboard Galvanometers.—The marine reflecting galvanometer devised by Lord Kelvin years ago still retains its place on board ship as the most reliable for bridge balances and null methods generally. On account of the rolling of the ship the ordinary suspension of the mirror (hung from a fixed point at the top and free below), as in a shore galvanometer, is out of the question; the suspension silk must be fixed top and bottom, so that the axes of the mirror and coils coincide in all deviations of the galvanometer from the vertical. The mirror

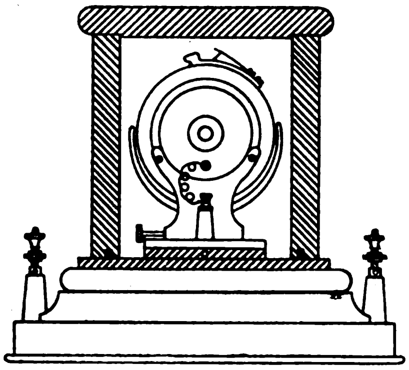

Fig. 129.—Marine Galvanometer.

(with the needles cemented at the back) is suspended on a fine silk fibre mounted in the brass frame shown in Fig. 130. The lower end of the fibre is fixed, and the top end passes out through a central hole in the frame, and is attached to the spring S, which puts a slight tension on the fibre. When the mirror is suspended, the frame is held by the finger and thumb at the projection H, and slipped into place between the two coils as in Fig. 129. The mirror is then central and in the axis of the coils. The instrument is enclosed in a heavy soft iron case (shaded in section lines in the figure) which is a shield against magnetic disturbances set up by the movement of the ship's iron framework when the vessel rolls. A small glass window is

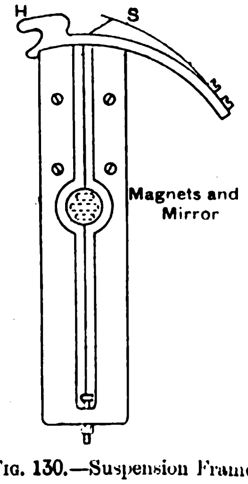

Fig. 130.—Suspension Frame.

provided for the rays of light to pass to and from the mirror. There is a stationary controlling magnet under the lower half of the coils, which keeps the magnets and mirror in the same plane as the coils, independently of the ship's position with respect to the earth's magnetism, and also a convenient screw adjustment (by a pinion and rack rods) of two small controlling magnets, by means of which the spot of light can be brought to zero.

As mentioned above, the instrument is at its best in bridge balances and other tests involving a simple balance to zero. It also does fairly well for false zero work, but it requires practice to read a deflection instantly, as the spot oscillates for some time before coming to rest. This is chiefly due to the very small damping. The magnets at the mirror back are very small, and the resistance of the coils high, so that there is very little induced current due to the motion of the magnets to produce damping. Further, the instrument is quite unsuited for the measurement of momentary currents, such as electrostatic discharges, owing solely to the absence of inertia in the suspended magnets; but such measurements are seldom required on board.

Generally speaking, the conditions of cable testing call for galvanometer suspensions of three distinct types, as follows:

1. The sensitive and light type of suspension, with air damping (for zero balances and deflection readings). Suspension fibre at top only.
2. The heavy or inertia type, with no damping (for momentary currents such as cable or condenser discharges; in this the swing is slow). Suspension fibre at top only.
3. The dead-beat type, with light suspension and plenty of damping (for fault testing.) In this the swing is quick, and it comes to rest immediately. Suspension fibre or wire at top and bottom, generally.

The Thomson reflecting galvanometer, as used on shore, fulfils for all practical purposes the first two conditions, notwithstanding the damping and want of weight for reading discharges. The angular movement is so small for a large deflection of the

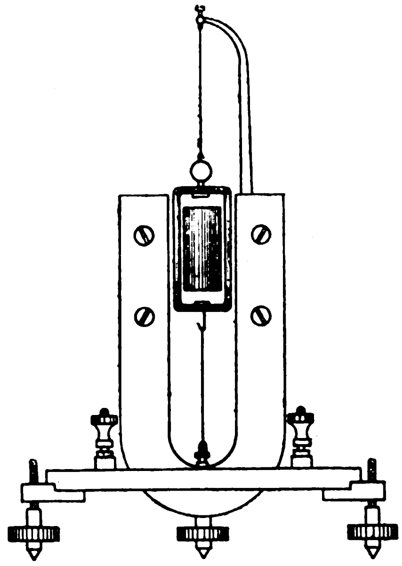

Fig. 131. —Deprez-d'Arsonval Galvanometer.

spot of light that the difference is inappreciably small. In the marine galvanometer, however, the case is different. The lightness of the suspension and fixing of the same top and bottom gives a type of suspension at once very good for the first condition and useless for the second.

It is not absolutely necessary to have a dead-beat galvanometer for fault testing, and the marine galvanometer in practised hands behaves well enough, but it is a great convenience to have a dead-beat one.

Two types of dead-beat galvanometers have been noticed in this work—one damped by air, and another by water. A very good type of dead-beat suspension is in the Deprez-d'Arsonval galvanometer, commonly known as the d'Arsonval. This instrument has a rectangular coil of fine copper wire suspended top and bottom (by thin silver or platinum threads) between the poles of a powerful compound horse-shoe steel magnet (Fig. 131). The tension on the suspension is adjusted at the lower end by the screw, as in Fig. 132, and the suspension wires themselves connect the ends of the coil electrically with the terminals of the instrument. There is also a hollow cylindrical soft-iron core inside the coil, and therefore the coil is in a strong magnetic field. The instrument is on the same principle as the Thomson Syphon Recorder. The current imparts to the coil magnetic poles on the front and back faces, which immediately

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turn towards the opposite poles of the permanent controlling magnet, and therefore the coil turns one way or the other according to the direction of the current put through it. A mirror is fixed to the top of the coil at its centre, by which the deflections are observed in the usual way by a reflected ray of light. The resistance of the coil is generally made small, about 200 to 500 ohms, so that when circuited across the ratio arms of the bridge the damping effect is considerable. The damping in this instrument is entirely by electromagnetic induction, and is most marked when used on a low external resistance and low resistances in the bridge arms. The coil, by virtue of its electro-magnetism and its movement, induces currents in the soft-iron core and magnets; these currents, as is well known by Lenz's law, being in a direction to oppose the motion of the coil, and thus checking or damping its travel. A further damping effect is obtained by winding the coil on a bobbin of thin metal sheet. The instrument is consequently very dead beat, coming instantly to rest after deflection, and is very useful in false zero work.

Some experiments with a suspended coil mirror galvanometer were carried out by Mr. E. Raymond Barker in the year 1887 (*The Electrician*, October 17, 1890) at the Madeira station of the Brazilian Submarine Telegraph Company, with the view of ascertaining its adaptability for signalling purposes under certain conditions. The bifilar suspension with weights, as in the Thomson Syphon Recorder, was used, and it was found that

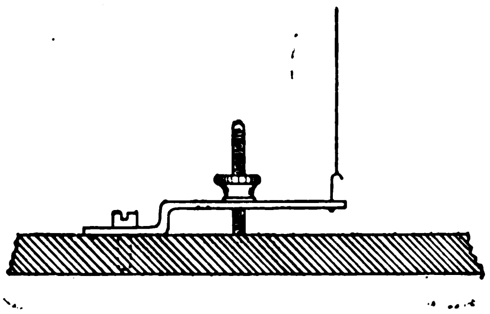

FIG. 132.—Details of Suspension.

the strong directive force of this suspension prevented interference by currents of a vibratory nature, while it was even more sensitive than the ordinary mirror instrument to signals. The signals also were equally good through cables differing in length as much as from 1 to 2,000 nautical miles.

47. Capacity Tests.—It has long been observed that after submersion the capacity of a cable, when tested by the ordinary methods, appears higher than that obtained by measurements during manufacture, and a considerable amount of attention has been devoted to this question to find a correction generally applicable. The factory tests are made on short drum lengths of core in tank each of about two knots, and the sum of the capacities of the several lengths of core composing the finished cable is taken to represent its true capacity. The comparison of the capacity of a piece of cable core with that of a condenser of known capacity is the first step, and, accepting the capacity of the condenser as the true standard, it is evident that the capacity of the cable can most truly be measured by comparison with that of the condenser when the piece of cable under measurement differs least in its electrical properties from those of the condenser, and this condition we have in the short length of core. In the first place, there is no retardation of charge or discharge, these being instantaneous as in the condenser, and in the next place, the insulation resistance more closely approximates to that of the condenser. The error due to difference in the rate of absorption of charge, owing to the different nature of the dielectrics, can be corrected by Dr. Muirhead's method.

Besides measuring the capacity of the drum lengths, the capacities of the completed sections of sheathed cable are tested in the factory before shipment. These sections differ according to the type of cable, and may vary from 200 to 250 knots of deep-sea cable down to 50 or 100 knots of intermediate, or 1 to 10 knots of shore-end. The apparent capacity of these sections is found to be greater than the sum of the capacities of the core lengths composing them, and the final measurement of the whole cable when laid often shews a different capacity per knot depending on the retardation as affected by length of cable and insulation resistance as affected by bottom temperatures. Again, the apparent capacity of a submerged cable increases as its insulation resistance falls, so that it is most important to be able to apply a correction in localising a sealed rupture of the conductor when the insulation is reduced by one or more low places. The time of charge also affects the apparent capacity: the longer the time of charge the greater the apparent capacity. This, however, is within pretty well defined limits, the minimum time taken for a cable of given length to receive a charge at uniform potential throughout being known to a sufficiently close degree.

In the well-known work entitled "Electricity and Magnetism" of the late Prof. Fleeming Jenkin (page 331 of fifth edition), a formula is given by which the time taken in any given cable for the full charge or any given fraction thereof to reach the distant end may be calculated. The following constant is first worked out for any cable under consideration:—

$$F R L^2 \times \frac{233 \cdot 2}{10^{10}},$$

where F is the capacity per knot in microfarads,
R is the conductor resistance per knot in ohms,
L is the length of cable in knots.

The time in seconds in which any percentage of the charge will reach the distant end is then found by multiplying the above constant by a certain number corresponding to each percentage. Thus, multiplying the constant by 6 we have the time in which half the charge will reach the other end; multiplying the constant by 20 gives the time for 98 per cent., or multiplying by 25 gives the time for $99\frac{1}{3}$ per cent. of the charge to reach the distant end of the cable. To reach 100 per cent. of course takes a theoretically indefinite time, but it will be evident that 98 or 99 per cent. of the charge may be considered as the whole charge. For instance, taking the French Atlantic cable, in which the dimensions are length 2,584 knots, capacity 0·43 microfarad per knot, and resistance 2·93 ohms per knot, the above constant works out to 0·196, and this multiplied by 20 gives nearly 4 seconds as the time taken for 98 per cent. of the charge to reach the distant end. Similarly, multiplying by 6 gives nearly $1\frac{1}{5}$ seconds as the time in which the charge will attain half its full potential at the other end.

The most reliable tests for capacity are those devised by Sir W. Thomson (Lord Kelvin), namely, the "mixed-charge" method and the "bridge" method. To the latter a correction for rate of absorption has been devised by Dr. Alexander Muirhead. The bridge method is sometimes alluded to as that in which the cable and condenser are "in cascade." Kempe describes it under the title of Gott's test, by which it is usually known. Mr. Gott independently devised the method, but it was first published by Sir William Thomson in the *Journal* of the Society of Telegraph Engineers, Vol. I, pp. 397 and 398. The tests differ in the position of the earth connections, and in the manner of observing balance, but in other respects they are identical—that is, the condenser and cable under comparison are charged with equal quantities in each method, and at different potentials measurable on the slides or bridge; and the formulæ are the same.

(To be continued.)

A Method of Determining Furnace Temperature.—In a recent communication to the Académie des Sciences, M. Berthelot suggests a method of determining the temperature of a furnace, which is based on the fact that the refractive index of a gas varies with its density. Two tubes filled with the same gas are taken, and a spectrum refracted through each, the two spectra being observed together. If then one is raised to a high temperature, and its contents allowed to expand, so as to maintain the pressure inside constant, it will be necessary to reduce the pressure in the second tube in order to re-establish coincidence between the two spectra. Preliminary experiments in the laboratory have shown the method to be capable of giving very accurate results.

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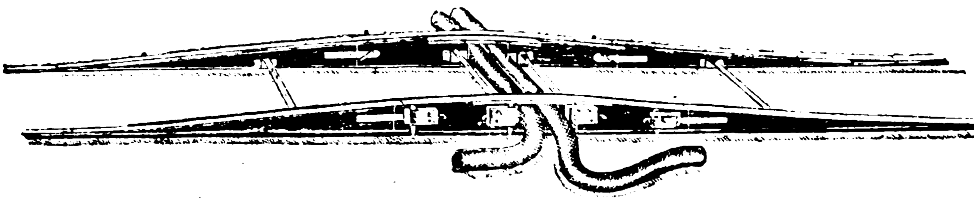
A PORTABLE HOSE BRIDGE.

In a recent issue the *Street Railway Gazette* describes a fire hose crossing designed to prevent the delays that are caused in the United States by fire hose stretched across the street railway tracks.



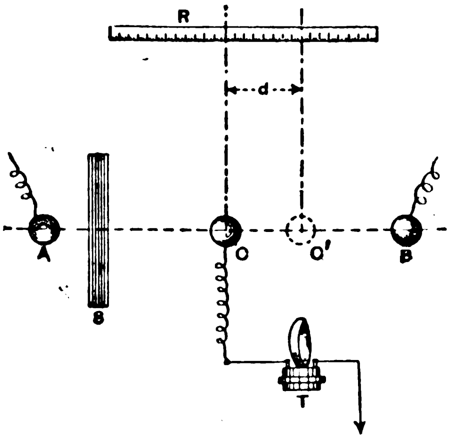
The hose bridge, which is shown in the accompanying illustration, is 16ft. in length, each side being composed of three sections which can be quickly and rigidly connected by a clasp. Braces keep the sides firmly in place, while ratchet spikes, held firmly by springs, hold the parts to the ground and rail. The parts are all made of the best and heaviest materials, and are intended to carry the heaviest motor cars and trailers. The bridges will fit any kind of rail, and are made for any gauge. The bridges can, it is asserted, be placed in position by one man within three minutes. Two lines of the largest fire hose made can be used through the bridge. These bridges are in use in Detroit and other American cities.

A NEW METHOD OF MEASURING SPECIFIC INDUCTIVE CAPACITY.*

BY ALBERT NODON.

The method I am about to describe is the result of some researches which I undertook in May, 1887, in the physical research laboratory, in collaboration with M. Pellat, professor at the Faculty of Science of Paris. These researches related to the laws governing the deflection of the inductive flux in its passage through dielectrics.

If we take two metallic spheres of small capacity and place them in connection with a source of high pressure electricity rapidly varying, such as an induction coil, and if we place between these two electrified spheres a third, also of small capacity, connected to a telephone, one pole of which is to earth, it will be found that there is a well-defined point between the inducing spheres at which the ear ceases to hear any noise in the telephone. The exploring sphere is then in a region where equal and opposite potentials are produced, and their effect is therefore neutralised. Things being in this state of electrical equilibrium, if a parallelipiped be introduced between one of the inducing spheres and the exploring



sphere it will be found that the state of equilibrium is immediately upset. On the ear being applied to the telephone the characteristic rumbling is immediately heard. To restore silence it is only necessary to move the exploring sphere in one direction or the other. The amount of the displacement which is necessary enables one accurately to determine by comparison the specific inductive capacity of the substance which has been interposed.

In the accompanying figure A and B are two copper spheres about 10 millimetres in diameter connected with an induction coil; C is the movable exploring sphere, the motion of which is measured by means of the graduated scale R; T is a telephone, one of the poles of which is connected to the exploring sphere and the other pole of which is to earth. S is a parallelipiped consisting of a dielectric of known thickness, the specific inductive capacity of which it is required to know. It is absolutely essential that the apparatus should remain absolutely the same during an experiment; the conducting wire should also be arranged in a fixed manner and the telephone should be placed several metres away from the apparatus on a fixed stand.

The experiment is conducted as follows:—The equilibrium position of the sphere is first determined. A standard dielectric is then placed between the two spheres A and C, its specific inductive capacity and thickness being known. Paraffin is chosen as the standard dielectric, as it is one of the substances which best fulfil the conditions of the experiment. The interposition of this parallelipiped of paraffin upsets the electrical equilibrium of the inductive system formed by the three spheres A, C, B. The telephone immediately rumbles, and silence is not restored until the sphere C is moved to the position of C'; the distance between the two points C and C' is proportional to the inductive capacity of the paraffin parallelipiped, and will serve as a basis for subsequent measurements. If, now, the parallelipiped S is replaced by another parallelipiped of some other substance, such as sulphur, a new length d' will be obtained before there is silence in the telephone. If we denote the specific inductive capacity of the paraffin by I, the first measurement by d, and the second measurement by d', then the equation to the specific inductive capacity of the second substance, silver, will be $I' = I \times \frac{d}{d'}$.

To measure by this means the specific inductive capacity of dielectric liquids, it is only necessary to place the substance in troughs having parallel faces, and consisting themselves of dielectric material, the specific inductive capacity of which has been determined beforehand. The difference between the values of the specific inductive capacity of the trough when full and when empty will give the required result. In the same way the specific inductive capacity of gases may be determined.

The method which I have just described enables one to obtain in an equal, simple and accurate manner the specific inductive capacity of solids, liquids and gases, and I think it should be of some use in electrical laboratories, in which the determination of specific inductive capacities according to existing methods is long and difficult.

* From *L'Electricien*.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *June 14, 1895.*

Electricity on the New York Elevated Roads.—Periodically for several years the newspapers have announced that the Manhattan Elevated Railway had decided to displace steam by electricity for motive power, and each announcement has been followed by an unqualified denial by that Company. To-day, however, the newspapers contain an interview with the chief engineer of the New York elevated system, in which he states that the contract for an electrical equipment, involving an expenditure of from $6,000,000 to $8,000,000, has been given to the Westinghouse Company. The newspaper account further says that the driving motors will be of 200 H.P. and the trains lighted and heated by electricity. But a short time ago the chief engineer, in denying a rumour of a contract for

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an electrical equipment, referred to the great expense of a change from steam to electricity, which, he said, would involve an expense of $3,000,000; in view of this, the figures quoted above seem rather wide of the mark.

The General Meeting of the American Institute of Electrical Engineers.—The Niagara meeting of the American Institute of Electrical Engineers promises to be one of unusual interest from an engineering standpoint, not only on account of the character of some of the Papers to be read, but from the fact that during the meeting the Niagara plant will be put in commercial operation. Among the Papers is one by the newly elected president, Dr. Louis Duncan, on the electrical system adopted by the Baltimore and Ohio Railroad to transfer its trains through the City of Baltimore. The lines of this Company pass under the city through tunnels, and hereafter cars are to be transferred by electric locomotives, one of which has been completed. Mr. Chas. P. Steinmetz will answer some of the criticisms to which the monocyclic system and its definition has been recently subjected. Mr. W. L. Emmett, an engineer of the General Electric Company, will describe the electrical features of the works of the Pittsburgh Aluminium Reduction Company, and Mr. L. B. Stillwell, of the Westinghouse Company, will read a Paper on the Niagara power plant. Among other Papers will be one describing the 10,000 volt transmission plant at Pomona, Cal., which has now been in successful operation for several years, and one by Prof. Elihu Thomson on the compounding of dynamos by armature reaction.

New Electrical Journals.—During the past week two new electrical papers have been announced, and, strangely enough, they have the same name—*The Electrical Journal.* One of these will be printed at San Francisco, Cal., and edited by Mr. Geo. P. Low, formerly a daily journalist and more recently an underwriters' inspector. The other has been projected by Mr. J. P. Barrett, City Electrician of Chicago, and will be edited by Mr. J. Allan Hornsby. The former will be issued monthly and the other semi-monthly. It appears that both will be published in the interest of students and others little advanced in electrical knowledge.

CORRESPONDENCE.

MAGNETIC SYMBOLS AND TERMS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: We notice in the editorial columns of your issue of May 31st some criticisms on our Paper entitled "A Contribution to the Theory of Demagnetisation," published in the same issue, to which we beg to take exception.

We object to the inference to be derived from your statement:—

"Every individual is, of course, entitled to have his own opinion as to the relative merits of 'block' and 'black' letters; but the use of 'block' letters having become well established in this country, where modern Magnetism took its growth, we may be pardoned for refusing to countenance any further this anarchic tendency of every new writer on magnetic subjects to employ whatever symbols and terms seem good in his own eyes."

So far as relates to the symbols we employ, we desire to point out that we have not selected these, but that they were recommended by the Committee on "Notation and Nomenclature," appointed by the International Electrical Congress of Chicago, and printed by the Congress in its *Proceedings* as the recommendation of that Committee. This notation has since come into extensive use in the United States and in France.

Concerning the use of the word "gauss," as the name of the C.G.S. unit of intensity, which is already extensively used in the United States, we beg to point out that if the term were more generally used, it would render impossible such misconception as it appears to us your editorial article contains in the passage:—

"The authors employ it for both the unit of H and the unit of B. We venture to regard these two quantities as being as distinct from one another as amperes are from volts."

The volt and the ampere are, of course, essentially different physical quantities, having the respective conventional dimensional formulas $L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-2}$ and $L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1}$, and are, therefore, properly designated by different names. The unit of magnetising force (H), and of magnetic flux intensity (B), are essentially the same physical quantity, having the same conventional dimensional formula $L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1}$, and are, therefore, properly designated by the same name. They are each the unit intensity of magnetic flux, and the fact that a magnetic intensity which we arbitrarily symbolise by H, when acting upon iron, aligns the molecular M.M.F.'s in such a manner that the iron introduces a new magnetic intensity (B – H), does not produce any difference between the nature of B, the resultant, and of H, the prime, intensity.

We fail to understand why you should suppose that H is less readily measurable than B. The earth's magnetic force H is measured in many parts of the world. In every case the removal of iron from an electro-magnetic circuit leaves a flux density H or "magnetising force" which is just as readily measured as B, except in regard to magnitude.

If the definite name "gauss" be employed instead of the indefinite "C.G.S.," such confusion between the natures of the fundamental magnetic quantities as that into which it appears to us that you have fallen, would, we believe, be prevented; for the use of the term could not fail to impress the fact that magnetising force H, field intensity H, and magnetic induction B, are all the same physical quantity, differing only in direction and magnitude, from whatever source they may be derived.—Yours, &c., Houston and Kennelly.

Philadelphia, June 10, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Your editorial remarks in the issue of May 31st on the new names for magnetic units are very much to the point.

When the names "gauss," "weber," &c., were proposed in the American Institute of Electrical Engineers, one of the chief arguments of their advocates was that the ordinary mind (especially in callow youth, when most studying is done) is greatly assisted by "concrete" names for the "abstract" ideas with which it has to deal, and that the adoption of the proposed names would tend to promote accuracy and precision of thought and to diminish error.

Some of us suggested at the time that people perversely insist upon making mistakes with units which already possess "concrete" names. For instance, the expression "watts per second" is not uncommon, and was once used by a college professor, so I am informed.

Arguments of this kind, however, were considered frivolous by the Committee on Units and Standards, and in consequence the Institute provisionally adopted the names.

As a crucial test of the utility of these "concrete" names in suppressing all looseness and vagueness of thought, and in developing and bringing to the front clear-cut and accurate ideas, nothing can serve better than the use of the name "gauss" by the Chairman of the Committee on Units and Standards, which you criticise adversely.

Messrs. Houston and Kennelly, however, are not the only ones to use the name "gauss" for both magnetic force and magnetic induction. The table published in the *Electrical World* of August 25, 1894, corrected by M. Hospitalier, and afterwards issued on separate cards, gives the name "gauss" three times,—once for magnetic induction, once for magnetic field intensity, and once for magnetising force. The second and third of these quantities are related in a manner somewhat similar to the quantities electromotive force and difference of potential, both of which are measured in volts. The first, however, is a different quantity, as your editorial truly remarks, and as the advocates of this use of the name "gauss" understand. The position of the last-named gentlemen is, so far as I have inquired, that it is mere purism to make any radical distinction between magnetic induction and magnetic force, and although it may be well enough as a philosophical exercise to differentiate them, in practical work it is too much in the nature of hair-splitting. If this be truly hair-splitting, I remain, yours hair-splittingly,

June 14, 1895. Townsend Wolcott.

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WAVE FORM SYNTHESIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The interesting Paper by Messrs. Barr, Beeton and Taylor, begun in *The Electrician* of June 21st, has a special attraction for me, as for some time past I have been occupied with investigations on similar lines. In the spring of this year a report was sent in by me to the City of London Electric Lighting Company, describing the investigations made to determine the various losses in transformers of different types when worked on alternators of different kinds. As this report is no longer my property, I cannot communicate, without permission, the details of the experiments and the results obtained; but there will be no objection to my saying that, by the use of the curve tracer described by me in *The Electrician* some months ago, a very full examination was made of the losses of transformers two kinds on different alternators and on the same alternator with different loads. Generally speaking, it was found that the iron-core loss in any transformer was greatest on that alternator the electromotive force curve of which most closely approximated to a sine curve. Differences to the extent of 10 per cent. and 15 per cent. in the iron-core losses were found when the same transformer was tested off alternators giving electromotive force curves of different kinds. It was also found that the form of the curve of the magnetising current of the transformer, as well as the power factor, was altered by any change in the electromotive force curve.

In these experiments we had not at our disposal the means of altering the form of the electromotive force curve at pleasure. It is obvious that this, however, could be easily achieved by means of a special alternator. It is easy to show from considerations of symmetry that in a periodic curve, symmetrical with regard to the time axis, only the odd harmonic terms can be present, and that for the majority of curves likely to be met with in practice a synthesis can be effected by taking the first three odd terms of the Fourier series.

We have at University College two alternators, the shafts of which are connected, but in which the armature bobbins can be set in any relative position. In order to be able to synthesize most practical forms of curve, it would be necessary to have fixed on the same shaft three alternator armatures giving frequencies in the ratio 1, 3, 5, when the shaft was rotating at one definite speed. This could be achieved by making three armatures having respectively 8, 24 and 40 bobbins. These armatures must be capable of being set in any relative difference of phase, and it would be very easy with a compound alternator of this kind to build up electromotive force curves formed of simple periodic curves with wave lengths in the ratio 1, 3, 5, and having the requisite relative amplitudes.

I entirely agree with your "Editorial Note" in emphasising the practical importance of studying the effect of the form of the primary electromotive force curve on the iron-core losses in transformers, and on the power taken up in alternating-current arcs. This has by no means the mere abstract interest which many have supposed, but has a very practical aspect in connection with alternate-current working. The last word has not yet been said upon the subject of alternating transformers. We have got beyond the stage of providing them with what was once wittily called "ready-made suits of mathematical clothing," and we are now happily in the condition in which current curves of different kinds can be "made to order," and the problem before us is how to make to order in the most economical shape.—Yours, &c., J. A. FLEMING.

RE MR. HOWELL'S PAPER READ BEFORE THE NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The report giving the substance of my remarks at the recent meeting of the Northern Society of Electrical Engineers has been condensed by the omission of so many important passages that I was hardly able to recognise parts of it. It puts words into my mouth regarding alternating currents which, when read without the other remarks which preceded and followed them, convey a totally false impression. I was at considerable pains to explain that the outcome of the long conflict which has raged between the advocates of continuous and alternating systems of supply has been to show that, however well suited alternating currents, whether monophase or polyphase, may be for power transmission, or even for transmitting the energy for lighting purposes up to distribution centres, they are not well suited for employment in the distribution network, *i.e.*, from these distribution centres up to the consumers' lamps. That this was on account of those very peculiarities inherent in alternating or pulsating currents which on account of the interesting problems involved, so endear them to the minds of professors and students, but which introduced practical difficulties in giving a perfectly regular and steady light free from pulsations.

I pointed out that the most successful way of dealing with these difficulties was to confine the alternating system to the transmission of energy up to the distribution points, to interpose the accumulators at this point, and consequently to use nothing but continuous currents in the network, and I pointed out that the very latest and best Continental practice pointed in this direction.

All this matter, which was certainly given by me at as great a length as I have here written it, has been condensed by the report into five lines, in which I am made to say that I am strongly an anti-alternator man, and that alternating currents were no doubt a splendid thing in their way for professors and school boys, but nasty things to deal with in central stations.

I need hardly point out that such are not my opinions, and that I believe that alternating currents are playing and will play an important part in the electrical industry, and the brief summary of my opinions given in your "Notes" is both unfair to me and misleading to your readers.

Trusting, therefore, that you will allow this letter to appear as a correction,—I am, yours faithfully, R. E. CROMPTON.

London, June 26, 1895.

[We find that the portions of Mr. Crompton's speech relating to alternate currents were inserted by us just as they were received from the Northern Society of Electrical Engineers.—ED. *E.*]

LEGAL INTELLIGENCE.

Sandon v. The Chelsea Electricity Supply Company (Limited) and Fowler v. the Same.

These cases came before Mr. Justice North in the Chancery Division, on Friday, last week, and were brought against the defendant company to restrain an alleged nuisance by means of vibration and noise. By arrangement, the cases were treated as the trials of the actions, the defendants submitting to perpetual injunctions in both cases.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices:—*

LABORATORY NOTES AND FORMS.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett *(now ready)*. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

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TENDERS INVITED.—The Electric Lighting Committee of the Corporation of St. Helens (Lancs.) invite tenders for the supply and erection of boiler and engine-house plant, switchboard and instruments, underground work (including cables, boxes, culverts, &c.), transformers and fittings, meters, and overhead crane for their electric lighting station. Tenders are to be sent in to Mr. W. J. Jeeves, Town Clerk, Town Hall, St. Helens, by Tuesday next, July 2nd.

——— The Town Council of the Borough of Richmond, Surrey, require tenders for an extension of the fire call system within the borough, the extension to consist of three call points. Specifications, &c., can be obtained of Messrs. Urquhart and Small, 17, Victoria-street, Westminster, S.W. Tenders must be sent in to Mr. Frederick B. Senior, town clerk, Town Hall, Richmond, Surrey, by 2 o'clock on Monday, July 8th next. Our advertisement columns contain some further particulars.

——— The Directors of the Manchester Ship Canal Company invite tenders for the necessary work for the permanent electric lighting of the Manchester and Salford Docks, including the supplying of alternators and dynamos, arc and incandescent lamps, cable, wires, &c. Particulars may be obtained at the engineer's office, 41, Spring-gardens, Manchester, and tenders, addressed to the secretary (Mr. A. H. Whitworth) must be in by July 10th. Some additional information is given in our advertisement columns.

——— The Visitors' Committee of the Bristol Lunatic Asylum, Fishponds, Bristol, require tenders for supplying and fixing wires, lamps, &c., for lighting the Asylum by electricity. Particulars may be obtained from Mr. R. Withycombe, clerk of works, and tenders must be in by July 15th. Some further particulars appear in our advertisement columns.

——— The Corporation of Portsmouth invite tenders for the supply and erection of conduits and india-rubber covered electric mains, and for the supply and erection of "compound" covered high-tension electric mains. Some information is given in our advertisement columns. Copies of the specification may be obtained from Mr. Alexandar Hellard, Town Clerk, Town Hall, Portsmouth; and any further information required from the engineers, Messrs. Kincaid, Waller and Manville, 29, Great George-street, London, S.W. Tenders must be sent in to Mr. Hellard by 6 p.m. on July 10th.

——— The Urban District Council of Clevedon require tenders for the public lighting of their district. Tenders are to be for one, two, or three years, and must be sent in to Mr. H. C. Fry, Clerk of the Council, Clevedon, by Monday next, July 1st.

——— The Urban District Council of Wellington (Salop) invite tenders for lighting the district by electricity or gas. Some particulars will be found in our advertisement columns, and all further information can be obtained from the surveyor, Mr. G. J. Monson, 45, Walker-street, Wellington. The tenders have to be sent in before noon on Monday, July 15th.

——— Tenders are invited until August 11th by the Municipal Authorities of Ille-sur-Tet (Pyrénees Orientales), France, for the concession for the electric lighting of the town. Tenders to the Mairie.

——— The Dewsbury Pioneers' Industrial Co-operative Society require tenders for wiring their premises. Tenders must be sent in to Mr. J. B. Mitchell, borough electrical engineer, Bradford-road, Dewsbury, by July 8th.

TENDERS ACCEPTED.—In our issue of June 14th we gave particulars of the acceptance by the Chester City Council of the tender of Thomas Parker (Limited) for the supply of plant and apparatus for the electric lighting of that city. The following is the complete list of tenders:—

Continuous-current Supply	
Thomas Parker (Limited) (accepted)	£14,200
Electric Construction Company	14,847
Alternate-current Supply.	
Brush Company (street lighting not included)	8,922
Electric Construction Company	11,755
Manchester Edison-Swan Company	12,446
Siemens Bros. and Co.	14,800
J. Fowler and Co. (Leeds)	14,893

——— On May 31st it was announced in this journal that the Worcester Corporation had, against the recommendation of a Sub-Committee appointed to consider the subject, decided to accept the tender of a local firm (the New British Installation Contractors, Limited) for the wiring and fitting up for the electric light of the Victoria Institute for the sum of £849. It has now, we learn, been finally decided to accept the offer of Messrs. Graham and Biddle, London, for £768, in accordance with the Sub-Committee's original proposal.

——— The Brighton Town Council have decided to accept the tender of Messrs. Mackenzie Bros., Edinburgh, for the supply of 45 cast-iron upright posts with bracketed canopies, for supporting the arc lamps, for £1,530.

TENDERS ACCEPTED.—The Manchester City Council have accepted the following tenders for plant and apparatus for electric lighting extensions:—

B. Goodfellow, compound condensing engines	£12,440
Electric Construction Company (Limited), dynamos	7,381
Heaton and Son, Lancashire boilers	5,371

——— The tender of Messrs. Clay Bros. has been accepted for the electric lighting of the County Brewery, Cardiff, for £1,337. 17s. Eleven tenders, varying in amount from £1,245 to £1,705, were received.

——— The Bedford Urban Sanitary Authority have accepted the tender of Messrs. Johnson and Phillips for the supply of two transformers and accessories for the sum of £150.

SALE BY AUCTION.—Mr. Wooller Jennings has been instructed by Mr. James Duff, the Receiver and Manager of Andrews and Preece (Limited), to sell by auction, at the Borough Mills, Manchester-road, Bradford, on Wednesday and Thursday next, July 3rd and 4th, at 11 o'clock each day, the whole of the valuable plant of engineers' tools and effects, stock-in trade, &c. Detailed catalogues can be obtained from Mr. Jennings, 66, Thornton-road, Bradford.

BUSINESS FOR SALE.—As will be seen from our advertisement columns, Mr. J. M. Macleod (liquidator under the sequestration of the estate of Mr. J. Scott, trading as D. and G. Graham) has for sale the business of electrical engineers, bell-hangers, &c., hitherto carried on by Mr. Scott, at 134 to 140, Douglas-street, and of wholesale and furnishing ironmongers at 201, Byars-road, Glasgow, together with the stock in trade, plant, machinery, and book debts. The business has been established over 50 years. The stock, plant and machinery may be seen on application to Mr. J. Macleod, 101, St. Vincent-street, Glasgow, who will give facilities for inspecting the works.

WORKS FOR SALE.—There is for sale by private contract, or to be let, the extensive range of buildings known as the Great Bridge Engineering Works, West Bromwich, of which particulars will be found in our advertisement columns. It will be seen that the property contains no less than 8,963 square yards, and abuts on the Birmingham Canal. All further particulars can be obtained of Messrs. Joseph Cooksey and Son, Surveyors, of Lombard-street West, West Bromwich, or of Messrs. Edwards, Son, and Bigwood, Colmore-row, Birmingham.

APPOINTMENT VACANT.—The Governors of the Northern Polytechnic invite applications for the post of principal. After the 25th March next the stipend will be at the rate of £500 per annum, and from September 29th next to March 25th at the rate of £300 per annum. Some further particulars will be found in our advertisement columns, and applications must be sent in to Mr. E. Griffiths, secretary, St. Mary's Vestry Hall, Islington, N., before July 15th, on forms which, together with all further information, can be obtained at the Vestry Hall.

LIQUIDATIONS.—On the 14th inst. it was resolved that the Archer Pipe Company (Limited) be voluntarily wound up. Messrs. John Cocks and Robert Ewing were appointed liquidators.

——— At a meeting on the 5th inst. it was decided to wind up the Telpher Cable and Cliffe Railway Syndicate (Limited) voluntarily, and Mr. J. W. H. Byrne, 81, Gracechurch-street, London, E.C., was appointed liquidator.

COMMERCIAL CABLE COMPANY.—We have received from the Commercial Company four well-illustrated, well-written pamphlets, entitled respectively "How Atlantic Cables are Made," "How Atlantic Cables are Laid," "How Messages are Flashed under the Atlantic Ocean," and "How Atlantic Cables are Repaired." It is a good policy on the part of the Commercial Company to endeavour to interest the public in its doings.

AGENCY.—Messrs. Francis and Spilsbury have been appointed sole agents for the sale of Messrs. J. H. Tucker and Co.'s "crank" switches in Ireland and the east, south and west of England. Mr. Baker continues to represent Messrs. Tucker and Co. in London.

PUSHES.—Messrs. G. Wingrove and Son send an illustrated sheet of Dale's bayonet-joint electric bell push, of which they are the sole manufacturers. This push is usually constructed without a screw, threads being entirely done away with. It is stated to have been highly approved by practical electricians, and is made in four patterns, all of which can be made with screws if preferred (10 threads to the inch).

PETROLEUM GAS APPARATUS.—Messrs. Moeller and Condrup, of London, send us two of their latest sheets of Swedish petroleum gas apparatus. The illustrations include the "Ætna" and "Vesuvius" brazing lamps, "Hekla" portable furnace, and the "Primus" and "Ultraprimus" petroleum lamp stoves. This apparatus burns paraffin oil without wick, and is claimed to be free from smell, soot, or smoke. The "Ætna" lamp, which is recommended for use by electricians, is so constructed that the gas cannot get into the oil tank, and pumping is required only occasionally after

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the lamp is once started. The lamps are made in sizes varying from two pints to half-a-pint.

THE "SWEET" AUTOMATIC LAMP SWITCH.—Messrs. J. B. Stone and Co., who are the sole London agents for this switch, inform us that they are now in a position to execute orders.

WRIGHT'S PATENT HEATER CONDENSER COMPANY'S PROCESS.—We have received a handy brochure, descriptive of Wright's Heater Condenser Process for softening and purifying water for boiler feed and other uses. The apparatus is made in a variety of forms and sizes, suitable for the various operations in which water softening is necessary. The cost of working such a plant will, of course, depend on the degrees of hardness and impurity of the water treated; but we learn that the average cost is not more than about 1d. per 1,000 gallons.

PRICE LIST.—We have received a four-page price list of the "Interior Conduit" system recently introduced into this country by the General Electric Company.

CATALOGUE.—Mr. R. W. Blackwell sends us a copy of his latest (No. 4) Catalogue, which contains illustrated particulars of a variety of engineering and electrical plant and apparatus, for which Mr. Blackwell is representative in this country. The pamphlet contains an introductory Paper, entitled "How to prevent Electrolysis and make complete Metallic Circuit for an Electric Railway."

ALSAGER (STOKE-ON-TRENT).—The District Council have decided to engage Mr. G. R. Peers, of Bolton-le-Moors, to prepare estimates of the cost of lighting the district by electricity.

BRISTOL.—The Electric Lighting Committee of the Corporation have been successful in an appeal against the rating of the electric lighting works. The assessment was at the rate of £3,000 gross and £1,850 net; and the result of the appeal was that this latter sum has been reduced to £1,500. In the course of the inquiry Mr. Wise, on behalf of the appellants, stated that the figures upon which they based their appeal showed that the number of private lamps fixed on December 31st was 15,000, and they estimated for an increase of about 2,300 for the current year. They obtained an average revenue of 6s. 11½d. per lamp, with discounts varying from 5 to 20 per cent., bringing the net revenue from private lighting to about £5,880. There were 90 public lamps bringing in a net revenue of £3,008, or a total of £8,888 altogether. The cost of production came out at £5,808, and, after further deductions for various items in the accounts, the net annual value of the whole undertaking was £1,545. Notwithstanding considerable opposition, the appeal was, as stated above, successful.

BURNLEY.—Mr. J. B. Clerke last week held a Local Government Board inquiry into the application of the Town Council for power to borrow £50,663 for various improvements, including £1,000 for wiring and fitting up the Town Hall for the electric light, and £5,500 for additional plant, mains, &c., for electric lighting extensions.

CARDIFF.—An application has been made to the Local Government Board for powers to borrow £5,385 to carry out extensions of the electric lighting mains.

CHURCH LIGHTING.—The Deacons' Court of Sandgate Free Church, Ayr, have unanimously agreed to light the church electrically.

COMMISSION OF SEWERS (LONDON, E.C.).—At the meeting of the Commissioners on Tuesday last, the Streets Committee presented a report on the lighting of the minor streets in the City by electricity. They also submitted a report from the electrical inspector thereupon, and recommended that certain experiments therein suggested be made, the City of London Company charging only the actual cost to them of the work, estimated at about £386. This recommendation was approved.

CROYDON.—Major-Gen. C. Phipps Carey held a Local Government inquiry on Wednesday last into the application of the County Council for sanction to borrow £27,000 for electric lighting purposes. Mr. Alderman Miller, J.P., the Chairman of the Electric Lighting Sub-Committee, stated that, from personal inquiries, he found the electric light was much desired in the borough. The Corporation were erecting a new town hall and other public buildings and would be large consumers of current. The inspector said he thought the Local Government Board would require more details, and pointed out that no plans of the proposed buildings had been put in. The Town Clerk said Prof. Kennedy, who was advising them, would undertake to supply the plans in a fortnight.

FIRE.—Too late for our last issue, Messrs. New and Mayne inform us that there is only a very slight element of truth in the report of a fire having occurred on their premises last week.

FULHAM (LONDON, S.W.).—The adjourned discussion on the report of the Electric Lighting Committee was resumed at the last meeting of the Vestry, and an amendment that the matter be referred back to the Committee to report whether there was reasonable ground for supposing that a combined electric lighting and dust destructor scheme could be installed and worked at a profit without any addition to the rates. Should the Committee be in a position to report favourably on this point they are to select three engineers, or firms of engineers, one of whom is to be consulted by the Vestry on the scheme. An expenditure for this purpose, of £50 is authorised.

INTERNATIONAL RAILWAY CONGRESS.—On Wednesday last the Prince of Wales opened the fifth session of the International Railway Congress at the Imperial Institute, and in the course of his opening remarks referred to the work before the Congress, and pointed out that members would be asked to consider not only the acceleration of passenger trains, but the means of providing for the comfort of passengers, including improved methods of heating and lighting. Arrangements would have to be considered for adding to the safety of the travelling public in such matters as signalling, interlocking, &c., before the members separated. The subject of electric traction and its advantages and disadvantages would doubtless form the subject of careful criticism; and the important topic of light railways, which has lately come to the front in this country, would also be carefully considered. The Prince alluded to the important industries with which the delegates were associated, and hoped that the result of the Congress would be that these interests would derive benefit from the gathering together of so many of those who were in daily touch with the working of the great railway services throughout the world. Mr. Bryce, the ex-President of the Board of Trade, addressed the assembly, and called attention to the examples of engineering skill which the delegates would be invited to visit during their stay in this country. The Congress will sit from June 26th to July 9th. Under the authority of the English section a journal is to be issued daily, giving a full account of the proceedings. The members of the Congress include delegates from all parts of the Continent, America, and the British Colonies and India.

KILLARNEY.—The Town Commissioners are still at cross purposes on the electric lighting question, but Mr. Moriarty at the last meeting succeeded in obtaining the support of the members for a resolution "That, inasmuch as it has more than once been decided in favour of the electric light, we decline to entertain any proposal to retain gas, except for a period of six months." The Killarney Gas Company have been invited to send in tenders for lighting the town for six months.

KINGSWOOD, BRISTOL.—In reference to a statement that the District Council were prepared to treat for the purchase of the electric lighting installation on the Parfitt system at Keynsham, the Chairman of the Council at the last meeting said that there was evidently some misunderstanding. He had only stated, at a previous meeting, that the Council were taking into consideration the extension of their lighting scheme. It was therefore resolved to reply to a letter received on the subject that the Council did not contemplate the immediate purchase of the Parfitt plant. It is stated, however, that the extension of the electric lighting in the district will shortly be considered by a committee specially appointed.

LEEDS.—What may be described as a tolerably fair and very able criticism of electric traction is given in the *Yorkshire Post* of Monday last. The occasion of this *critique* is the presentation of the report of the Tramways Sub-Committee on the question of the system of tramway traction to be adopted by the Leeds Corporation. The report has not received the unanimous assent of the Sub-Committee, and may be taken, the *Post* thinks, as mainly the report of the city engineer, Mr. Thomas Hewson. Exception is taken to some of Mr. Hewson's figures, on the ground that they are unduly favourable to the electric system of traction as against the cable system, which is evidently the one which finds favour with the writer of the article. On the subject of working expenses the writer takes Mr. Hewson severely to task, not so much for his estimate of the working cost of electric cars in general, but for the application of the estimate to the case of the Leeds Corporation tramways. Mr. Hewson's figure of 5·4d. per car mile for the whole of the city of Leeds system is, in the critic's view, an underestimate of not less than 25 per cent. The figures for annual working expenses given in the city engineer's report compare with those of the *Post* as under:—

	Cable.		Electric.
Mr. Hewson's estimate	£101,819	...	£90,072
Revised estimate	83,609	...	108,019

The latter figures are based upon an estimated car mile working expenditure of 7d. for the electric line and 5½d. for the cable line. The writer objects to the comparative figures given in the report, on the ground that there is no electric line in existence working under Leeds conditions. Altogether the criticism is very full and is calmly expressed. If newspaper criticisms on electrical subjects were usually as carefully thought out as this one, the arguments for and against electric traction which from time to time appear in some of our leading journals would be better worth perusal.

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LIVERPOOL.—A petition of the Corporation to Parliament for leave to introduce a Bill to acquire the undertaking of the Liverpool Electric Supply Company (Limited) came before the Examiner of Private Bills in the House of Lords on Monday last. The Examiner decided to report that the petition had failed to comply with the Standing Orders. A petition on behalf of the Company has been referred to the Examiner of Standing Orders.

LONDON ELECTRIC SUPPLY STATIONS.—The London County Council, at their meeting on Tuesday last, sanctioned the erection of the County of London Company's generating station at Oak Wharf, City-road, and an addition to the Sardinia-street station of the Metropolitan Electric Supply Company; but, with regard to the latter, owing to the fire the complete re-erection of the station will doubtless have to be carried out.

MILE END (LONDON, E.).—The Works Committee of the Board of Guardians reported that they had considered the proposed arrangement of the boiler house, with a view to lighting the workhouse premises by electricity, and as the Board consumed gas to the extent of £1,000 per annum, the Committee recommended that the whole matter be referred back to them for consideration, and that the Vestry be informed that the guardians will be prepared to supply them with sufficient power for lighting the Vestry Hall at cost price subject to the approval of the Local Government Board. The report was adopted.

NATIONAL TELEPHONE COMPANY.—This Company have issued a circular calling attention to a practice, which has been brought to the Company's notice, where non-subscribers are allowed to use the telephone or subscribers receive messages on behalf of non-subscribers. The Company points out that this is in violation of the arrangements entered into between the subscribers and the Company. Although exception has been taken in some quarters to the issue of this circular the warning seems to us a very reasonable one, as doubtless many persons use the telephone who are not entitled to do so. It is only fair, when calling upon the Company to perfect its service and give subscribers full value for their money, that the Company's rights should not be entirely overlooked.

NOTTINGHAM.—The famous museum at Nottingham Castle, and the residence attached thereto, is to be lighted electrically. The work of wiring and supplying fittings has been placed in the hands of W. J. Furse and Co., of Burton-street, Nottingham.

PORTSMOUTH.—A little more than 12 months ago Portsmouth started using the electric light, and is now one of the best lighted cities in the country. Considerable extensions have recently been approved, including the addition of 150 2,500 c.p. arcs for street lighting. The Lunatic Asylum is also to be lighted electrically, and all the police stations are to be connected up with the town mains.

RANGOON.—Messrs. Henry F. Joel and Co. have recently fitted the new Government House for the electric light, to the order of H.M. India Office. Nearly 400 lamps are fitted, 11 of which are 200 c.p. The plant consists of two Joel dynamos and two engines and boilers of Messrs. Davey, Paxman and Co.'s make.

THE ROYAL AGRICULTURAL SOCIETY'S MEETING.—The Fifty-sixth Annual Exhibition of this Society was opened on Saturday last at Darlington, and, except for a disastrous atmospheric visitation on Wednesday, the Exhibition, which closes to-day (Friday), has proved a great success. Amongst the prominent exhibitors may be mentioned Messrs. Clarke, Chapman and Co., Clayton and Shuttleworth, Crossley Brothers, John Fowler and Co. (Leeds), Gilbert Gilkes and Co., Greenwood and Batley, E. S. Hindley, Marshall, Sons and Co., Ransomes, Sims and Jefferies, Robey and Co., and W. H. Willcox and Co. The exhibit of Messrs. Clayton and Shuttleworth includes a 7 B.H.P. petroleum engine which is specially designed for electric lighting, as well as a number of other steam and petroleum engines of various horse-powers. Messrs. Robey and Co. have exhibited a number of engines, including a patent oil engine which it is claimed has been greatly improved since the last Royal Agricultural Society's Show by the substitution of a specially designed lamp for starting the engine, by means of which only 10 minutes are occupied in getting the engine in full work. This firm also exhibited a beautiful model to scale of the compound Robey mining engine, which attracted considerable interest. Messrs. Clarke, Chapman and Co. included in their exhibit two oil engines, one of 8 and the other of 14 B.H.P., of extreme simplicity of design. These engines are entirely self-contained, and carry 10 hours' supply of petroleum, and have a special arrangement of air condenser for cooling the circulating water. One of this firm's compound-wound dynamos, of 150 16 c.p. incandescent capacity, was also on view. Messrs. Crossley Brothers showed both oil and gas engines, one of the former being a portable 7 H.P. nominal, which is claimed to be capable of giving 11 H.P. actual for a consumption of three-quarters of a pint of petroleum per actual horse-power per hour. This engine carries its own water tank exhaust box, &c., and is fitted with four travelling wheels and shafts. The working parts are similar to the stationary type of engine, but the reciprocating parts are so balanced as to ensure the engine running steadily. This engine also carries a supply of oil sufficient for a ten-hours run. At Messrs. John Fowler and Co.'s stand the exhibits included an 8 H.P. combined semi-portable engine specially adapted for electric lighting and similar work where steady running is essential. This firm also exhibited a number of traction and agricultural engines of their well-known make. Messrs. Gilbert Gilkes and Co. showed a variety of "Vortex," "Little Giant," and "Hercules" turbines, including a portion of a 266 H.P. "Vortex." A number of electric motors, from ¼ H.P. to 6 H.P., and a 6-unit dynamo were shown by Messrs. Greenwood and Batley, and Mr. Hindley's exhibit included combined engines and boilers, hoists, pumps, saw benches, &c. At Messrs. Ransomes, Sims and Jefferies' stand, which formed one of the largest exhibits on the ground, engines, combined engines and boilers, and examples of the extensive variety of agricultural machinery and implements for which the firm have so high a reputation were on view, and Messrs. W. H. Wilcox and Co.'s exhibit consisted of an excellent collection of pumps, drilling machines, boiler fittings, oil filters, oils and general engineering accessories.

SHOREDITCH (LONDON, E.C.).—At a meeting of the Vestry on Tuesday last the tenders for the dust destructor apparatus, to be erected in Pitfield-street, in association with the electric lighting scheme, were discussed. Eleven tenders have been received on Mr. Manville's specification, and five of these tenders were selected and laid before the Vestry. The Committee appointed to deal with this matter and Mr. Manville agreed in recommending that the offer of Messrs. Manlove, Alliott and Co., for the sum of £13,250, with an additional £2,500 for the provision of Boulnois and Brodie's patent hydraulic lifts and automatic charging apparatus. This was the lowest tender sent in, and included a system of thermal storage. The recommendation that this tender be accepted was adopted.

SPORTS.—On Saturday last the Athletic Club in connection with Messrs. Crompton and Co.'s Works, at Chelmsford, held their sixth annual bicycle and athletic meeting, and the prizes were afterwards awarded to the successful competitors by Miss Crompton. A liberal prize list and a firework display in connection with the event ensured success.

ST. GEORGE'S (LONDON, W.).—At the last meeting of the Vestry, Mr. Macdonald said he would like the surveyor to prepare a rough estimate of the cost of lighting up the principal thoroughfares of the parish by electricity, so that they might be able to compare the cost with the charge now made for gas. He also complained that the Vestry Hall was still lighted by gas, although almost every other council chamber in the principal towns of the country was lighted electrically. Another vestryman (Major Grimston) suggested that electric light should be provided at the stables, as it would be much safer than gas. The question is to be further discussed before the Joint Committee.

ST. PANCRAS (LONDON, N.W.).—At the meeting of the Vestry on Wednesday a special committee reported against the proposal to borrow £75,000 for electric lighting purposes by means of a public issue of Three per Cent. Bonds guaranteed by the rates. The Vestry, however, refuse to accept this decision as final, and they are making further inquiries as to the cost of negotiating such a loan. Hitherto the London County Council has lent the Vestry money at 3½ per cent.

STOKE.—As a result of the interview between the Chairman and Electrical Engineer of the North Staffordshire Tramways Company and a Sub-Committee of the Stoke Town Council, it has been decided that, subject to the whole of the local authorities in the district being of the same mind and to satisfactory replies being received to inquiries to be made by the Town Clerk from places where overhead traction had been adopted, the Corporation should consent to the introduction of electrical traction by means of overhead wires, subject to the Company giving a satisfactory undertaking to apply for a Provisional Order to extend the present terminus in London-road to Hanford Bridge within a period of two years from the date of the granting of such Order, and that with respect to the undertaking required by the Tramway Company as to the Corporation not exercising their option of purchase under the provisions of the Tramways Act, 1870, at the end of 21 years, the same remain over for further consideration to enable the Corporation to ascertain what such purchase would include.

THEATRE LIGHTING.—The Princess's Theatre, Glasgow, has recently been entirely redecorated and installed with the electric light. The lighting of the auditorium is effected by 130 incandescents of 16 and 32 c.p. Two groups of 15 bulbs are fixed on the ceiling, and by the aid of polished brass and mirrors give an exceedingly brilliant light. The passages, offices, &c., have been fitted up with the electric light, and the stage is shortly to be similarly illuminated. Messrs. Duncan, Stewart and Co (Limited), of Glasgow, have carried out the work, under the superintendence of their engineer, Mr. H. Lyon.

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THE LIGHTING OF NEWSPAPER OFFICES.—The offices of the *Nottingham Express* are being fitted for the electric light by Messrs. Calvert and Co., of Manchester, the current being generated on the premises.

THE PACIFIC CABLE.—In opening the Queensland Parliament on Tuesday, Sir H. W. Norman, the Governor, said that the question of the Pacific cable was receiving the most earnest consideration of the Queensland Government, and should the researches of the proposed Joint Commission of Great Britain, Canada and Australia justify it, and if the Australian Colonies show further hesitation, the Queensland Government would be prepared to recommend that the Pacific cable be constructed by Great Britain, Canada and Queensland alone.

WALSALL.—The electric current will shortly be supplied to consumers in this town, and the occasion has been taken by the Corporation to issue a pamphlet dealing with the advantages of the electric light over other forms of illumination, and pointing out the various uses to which the electric current can be put. It is stated that the price per unit has been fixed at 6d.

YORK.—In *The Electrician* for May 11, 1894, we gave particulars of the tenders received by the City Council for the electric lighting of this town. A resolution was come to by the Council in that month to the effect that no scheme for lighting the town on the low-tension system be entertained; and the tenders which had been received in response to the Council's advertisement were then reduced to four, viz., those from the Electric Construction Company, the Brush Company, Siemens Bros. and Co., and C. A. Parsons and Co. On May 3rd last we gave particulars of the scheme which then found most favour. This was the proposal sent in by the Electric Construction Company, under which that Company undertook to supply plant, apparatus, and fittings for lighting the city electrically for the sum of £10,865, and to work the plant for a term of three years on the terms set out in the note referred to. At the meeting of the City Council last week the matter was further discussed, and after motions had been made and rejected inviting the Council to adopt the tenders and schemes sent in by the various competitors, it was finally decided that the report be referred back, with instructions to ascertain from the four companies on what terms they would complete the installation and work the plant for a term of years.

"WALKS IN BELGIUM."—An advance copy of a handy little illustrated guide book, entitled "Walks in Belgium," edited by Mr. Percy Lindley, has been sent us. Now that the holiday season is upon us the book should prove useful.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

June 14, 1895.

11,594. M. BINSWANGER and F. G. BELL. London. Improvements in telephone receiver fittings.

11,633. C. W. R. CAMPBELL. London. Improvements in or connected with ceiling roses, lamp holders, and other electrical fittings.

11,641. H. LAVILLE and J. PLISNIER. London. Improvements in electrical alarums.

June 15, 1895.

11,659. J. T. NIBLETT. London. Improvements in elements for secondary batteries.

11,672. J. G. VINE. London. The positive and negative lightning conductor.

11,700. W. C. JOHNSON and L. J. STEELE. London. Improvements in alternating-current machines.

June 17, 1895.

11,708. R. PIPPETTE. London. Improvements in electrically and directly-controlled switches for electricity.

11,728. W. SHAW. Glasgow. Improvements connected with galvanic batteries and switches therefor.*

11,748. F. HODGSON and G. A. EDWARDS. London. Improvements in the application of telephones to electric-bell systems.

11,752. E. ANDREOLI. London. Electro-deposition of gold and silver.*

11,758. C. D. TORRE and F. MANCINI. London. Instantaneous automatic electric lighter for all kinds of gas burners.

11,770. A. J. BOULT. London. Improvements in or relating to telegraphic transmitters and recording apparatus therefor. (C. Spiro, United States.)

June 18, 1895.

11,817. A. CAMPBELL. London. Improvements in apparatus for measuring or indicating the frequency of alternating or pulsating electric currents or potential differences or other periodic disturbances.

11,832. A. J. BOULT. London. Improvements in or relating to secondary batteries. (N. H. Edgerton, United States.)

11,842. P. A. NEWTON. London. Improvements in rheostats and other circuit controllers. (C. Willms, United States.)*

11,864. P. RIBBE. Liverpool. An improved plate for electric accumulators or storage batteries.*

June 19, 1895.

11,892. C. M. HEPWORTH. London. A hand-feed lamp or regulator for the electric arc light for projection purposes.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

10,463. MOFFAT. Electric batteries.

13,700. KINGSBURY (Western Electric Company). Telephone switchboard mechanism.

1895.

3,178. MACPHERSON. Testing boxes, &c., for electric mains.

4,497. VON MORSTEIN. Electromagnetic apparatus for operating indicators, &c.

5,700. MACINTIRE. Electric arc lamps.

6,249. BOULT (Kilmore). Aërial electric railway systems.

7,142. MANCHESTER EDISON-SWAN COMPANY and OTHERS. Alternating currents.

7,795. DE DORMAEL. Electric accumulators.

8,590. CARTER. Magnetic ore separators.

NEW COMPANIES, STATUTORY RETURNS, &c.

WIRRAL ENGINEERING COMPANY (LIMITED).—This Company was registered on June 18th, with a capital of £3,000, in £1 shares, to carry into effect an agreement between William Alexander and William E. Thompson, engineers, of Birkenhead, and to carry on the business of mechanical engineers, metal workers, metallurgists, manufacturing chemists, electricians, suppliers of electricity for the purposes of light, heat and motive power, and manufacturers of and dealers in electrical apparatus and appliances.

ELECTRICITY AND ELECTRICAL ENGINEERING NEWSPAPER COMPANY (LIMITED).—On the 11th inst. notice was given by the authorities of Somerset House that this Company had been struck off the register. This step does not in any way affect the present position of our contemporary, the undertaking having been purchased from the Company by Mr. Sidney Rentell more than 18 months ago.

RICHMOND (SURREY) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—An agreement, dated March 30th last, made between James Worley, of 27, Leadenhall-street, London, E.C., Receiver in the debenture-holders' action of "Clapham v. Latimer Clark, Muirhead and Co. (Limited)," and the liquidator of the said Company (referred to as "the Receiver"), Latimer Clark, Muirhead and Co. (Limited), and this Company, states that whereas the Richmond Company was registered on July 8, 1892, with a capital of £50,000, in £5 shares, to acquire the benefit of a certain contract dated December 8, 1891, between the Corporation of the borough of Richmond and Latimer Clark, Muirhead and Co., for the erection of electric light works and the supply of electric light and power at Richmond; and the Richmond Company have issued 4,067 shares of £5 each, including 1,200 subscribed for by Latimer Clark, Muirhead and Co.; and whereas the latter firm had contracted to acquire certain property and to do certain work for the Richmond Company, but had gone into liquidation while carrying on such work (which work was continued by the Receiver); and whereas the Receiver has therefore a claim of £13,400 (fixed at that amount by arbitration) on the Richmond Company, it has been agreed that of that sum £11,000 shall be paid in cash, and that £2,400 should be credited in respect of calls owing upon the said 1,200 shares. An agreement, dated May 6th, between the Richmond Company and the County of London and Brush Provincial Electric Lighting Company (Limited) (referred to as "the County Company") states that whereas the County Company have agreed to pay the sum of £11,000 referred to in the above-mentioned agreement, it is therefore determined that 2,200 fully-paid shares of £5 each shall be allotted to that concern in full satisfaction for such payment.

SOUTH AFRICAN LIGHTING ASSOCIATION (LIMITED).—The annual return to May 15th has been filed. Out of a nominal capital of £50,000, in £10 shares, 4,070 shares have been taken up, of which 105 have been issued as fully paid. The full amount has been called on the remaining 3,965 shares.

TELEPHONE COMPANY OF EGYPT (LIMITED).—The annual return to May 7th last has been filed. The nominal capital is £100,000, divided into 16,000 Preferred and 4,000 Deferred shares of £5 each; 12,071 of the former and all the latter have been taken up, and 12,000 Preference and the Deferred have been issued as fully paid. The full amount of £355 has been called and paid on the remaining 71 Preference shares.

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THETFORD ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return to September 30, 1894, has just been filed. Out of a nominal capital of £5,000, in £1 shares, 3,680 have been taken up, and the full amount paid.

THOMPSON, RITCHIE AND COMPANY (LIMITED).—The annual return to May 3rd has been filed. Of the nominal capital of £5,000, in 200 Preference and 300 Ordinary shares of £10 each, 200 Preference and 140 Ordinary have been taken up, and one-half of these have been issued as fully paid. Upon the remaining shares the full amount has been paid.

VEALE AND COMPANY (LIMITED).—The annual return to December 31, 1894, has been filed; 4,904 shares have been taken up out of a nominal capital of £10,000 in £1 shares, and of these 3,839 have been issued as fully paid. The full amount has been paid on the remaining 1,065 shares.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The annual return to June 6th has been filed. The nominal capital of £1,500,000 is divided into 66,871 shares of £15 each, and 66,258 shares of £7 10s. each; 64,243 of the former and all the latter have been subscribed for and allotted, and the full amount has been called. The total amount of shares for which share warrants comprising five shares each is outstanding is £1,725, and comprising one share each, £180.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The annual return to June 5th has been filed. The nominal capital is £2,445,000, in 600,000 Ordinary, 34,563 First Preference, and 10,000 Second Preference shares of £10 each; 88,321 Ordinary, all the First Preference, and 4,669 Second Preference shares have been subscribed for and allotted. The full amount has been called.

WIGSTON ELECTRICAL AND ENGINEERING COMPANY (LIMITED).—The statutory return to March 4th has been filed. The nominal capital is £25,000, in 2,000 Ordinary and 500 Preference shares of £10 each. Of the 525 Ordinary shares which have been taken up 200 have been considered as having £6 per share paid, and upon the remaining 325 shares £6 per share has been called.

WILLANS AND ROBINSON (LIMITED).—The annual return to April 24th has been filed. The nominal capital is £300,000, divided into 30,000 £5 per Cent. Cumulative Preference shares of £5 each, and a like number of Ordinary shares of similar value; 21,038 of the former, and 19,672 of the latter, have been taken up and allotted, and of these 14,463 Preference and 14,462 Ordinary have been issued as fully paid. The full amount has been called on the remaining shares.

CITY NOTES.

ANGLO-PORTUGUESE TELEPHONE COMPANY (LIMITED). — Coupons No. 15 of the First Mortgage, and No. 10 of the Second Mortgage debentures of this Company will be paid, less income-tax, at Parr's Banking Company and the Alliance Bank (Limited), Bartholomew-lane, London, E.C., on and after the 1st prox.

CALLS DUE.—There is a call of 40 per cent. on £60,000 Debenture stock of the Chelsea Electricity Supply Company (Limited) this day (Friday). To-morrow (Saturday) a call is due of 40 per cent. on £200,000 Debenture Stock of the City of London Electric Lighting Company (Limited); and of £2 per share on the Preference shares of the County of London and Brush Provincial Electric Lighting Company (Limited).

CENTRAL LONDON RAILWAY COMPANY.—During the week this Company, which has been formed for the purpose of constructing and equipping an electric railway between Shepherd's Bush and Liverpool-street, has issued a prospectus inviting applications for 285,000 shares of £10 each. The offices of the Company are 16, Great George-street, London, S.W., and the secretary is Mr. T. Matesdorf. The lists opened on Monday and closed on Wednesday last.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended June 23rd were £794, as against £863 in the corresponding week of 1894, being a decrease of £69. The total receipts for the half-year amount to £23,093, against £22,618 in the corresponding period of 1894, an increase of £475.

CORPORATION STOCK.—To provide for the repayment of debenture bonds issued under the powers of the Local Loans Act (1875) and falling due, and for street improvements, electric lighting, tramways, fire station, and other purposes, the Newport (Mon.) Corporation invite applications for £300,000 Three per Cent. Redeemable Stock, the repayment of which is secured on the whole of the revenues of the Corporation, and ranks as to security with all other securities of the Corporation. The lists closed yesterday (Thursday).

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend of 6 per cent. for the half-year on the Preference Shares. The dividend is calculated from the due date of payment on the £2 per share paid up, and is payable on the 30th inst. The transfer books will be closed from 1st to 14th July inclusive.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend for the quarter ended March 31st last of 2s. 6d. per share, free of income-tax, payable on the 15th prox. The share register will be closed from July 6th to 13th inclusive. The coupon on the Company's Five per Cent. Australian Government Subsidy Debentures, due July 1st, will be paid on and after that date at Messrs. Barclay, Bevan and Co.'s Bank, 54, Lombard-street, London, E.C. Coupons must be left three clear days for examination.

ELECTRIC ORGAN COMPANY (LIMITED).—Last week this Company issued a prospectus inviting applications for no less than 55,000 Six per Cent. Preference and 37,660 Ordinary shares of £1 each, a total subscription of £92,660, payable 2s. 6d. per share on application, 7s. 6d. on allotment, and the balance three months after allotment. The authorised capital of the Company is £110,000, and particulars of the registration, objects, &c. were given in our last issue. The Company, if it proceeds to allotment, will take over and carry on upon an extended scale the business of a previously incorporated concern called the Hope-Jones Electric Organ Company (Limited). The offices (*pro tem.*) are 17, Coleman-street, London, E.C., and the Secretary is Mr. A. W. Speed.

GREENWOOD AND BATLEY (LIMITED).—The annual general meeting of this Company was held on the 22nd inst., at the London offices, 16, Great George-street, S.W., Mr. Arthur Greenwood presiding. The Chairman, in moving the adoption of the Directors' report, said he regretted to state that the results of the past year's trading had not been satisfactory, although they were more so than those submitted last year. They had earned the interest on debentures and, in addition, a small profit. Fortunately, there was no actual loss to record, and they had been able to make some allowance for depreciation, which they were unable to do last year. With reference to the item of stock in hand, which amounted to £63,234, the proportion of machines finished, in progress, and the actual orders showed a decrease of £11,000. As the result of the year's working, instead of a loss of upwards of £8,000, shown in the previous year's accounts, there was a small profit. In the current year they had secured many more orders up to the present time than in the corresponding period of last year. The report was adopted.

LIVERPOOL ELECTRIC SUPPLY COMPANY (LIMITED).—A meeting of the shareholders of this Company was held on Saturday last, at Exchange Station-buildings, Liverpool, when resolutions were passed (1) confirming the agreement entered into with the Corporation for the sale of the Company's undertaking; (2) authorising the application to Parliament in the present session for the necessary Act to carry the above agreement into force, and for the appropriation and distribution of the assets of the Company. The sale is subject to the extension of the city boundaries being carried through in the present session, and it will enable the Company to distribute among its shareholders a sum equal to £8. 2s. per share. The resolution will require confirmation at a subsequent meeting.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 23rd inst. amounted to £1,245. The amount for the corresponding week last year was £820. Increase, £425.

SALT LAKE AND OGDEN GAS AND ELECTRIC LIGHT COMPANY (LIMITED).—Notice is given that the coupons of the Six per Cent. First Mortgage bonds of this Company, due July 1st, will be paid at the National Provincial Bank of England, Bishopsgate-street, London, E.C.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation for, 10,277 Ordinary shares (Nos. 1 to 10,277) and £60,000 Four and a-Half per Cent. Debenture Stock of the Chelsea Electricity Supply Company (Limited).

WEST COAST OF AMERICA TELEGRAPH COMPANY (LIMITED).—The coupons due 30th inst. on the debentures of this Company will be paid by Messrs. Barclay and Co., Lombard-street, E.C., and should be left three days for examination.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended June 21st, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,436.

WESTERN UNION TELEGRAPH COMPANY.—The following is the report of this Company for the quarter ended June 30, 1895:—The following statement exhibits the condition of the Company at the close of the quarter ended March 31, 1895:—

Surplus January 1, 1895, as per last quarterly report		$7,531,628. 92
Net revenues, quarter ended March 31, 1895		1,163,781. 08
		$8,695,410. 00
From which—deducting for dividend of 1¼ per cent. paid April 15, 1895...	$1,191,936. 25	
Interest on bonded debt	223,400. 00	
Sinking funds........................	19,991. 00	
		$1,435,327. 25
Left a surplus April 1, 1895, of		7,260,082. 75
The net revenues of the quarter ended June 30th, based upon nearly completed returns for April, partial returns for May, and estimating the business for June, will be about		1,600,000. 00
		$8,860,082. 75
From which, appropriating for—		
Interest on bonds	$223,400. 00	
Sinking funds	20,000. 00	
		243,400. 00
		$8,616,682. 75
It requires for a dividend of 1¼ per cent. on capital stock issued, about		1,191,940. 00
Deducting which leaves a surplus, after paying dividend, of..		$7,424,742. 75

In view of the preceding statements, the Committee recommend the payment of a dividend of 1¼ per cent. on the capital stock of this Company on July 15th next, which may be collected through any bank on or after that date.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, June 19.		Price Wednesday, June 26.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending June .6. Highest	Lowest
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	10/0	Anglo-American	46	48	47	49	4 1 8	Jan., Apr., July, Oct.	46½	..
£2,993,560	Stock	20/0	Do. Preferred	86	87	88½	89½	4 9 5	" "	89	86
£2,993,560	Stock	5/0	Do. Deferred	8½	8¾	8½	9	..	" "	8⅝	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	103	106	103	106	3 16 11	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	13	13½	13	13½	4 16 4	Mar., June, Oct., Dec.	13½	13¼
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 8 11	June and December	..	..
10,000,000	$100	1¼%	Commercial Cable Capital Stock	154	158	165	170	4 2 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	3½	4½	3½	4½	4 8 11	April and October	..	—
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10¼	9¾	10½	4 7 7	" "	—	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	105%	108%	105%	108%	4 3 4	" "	..	—
60,710	20	2/0	Direct United States Cable, 1877	9¼	9¾	9¼	9¾	4 0 5	Jan., Apr., July, Oct.	9½	..
400,000	10	2/6	Eastern	16¼	16¾	16¼	16½	3 18 9	" "	16 1/16	16¼
70,000	10	6%	Do. 6 per Cent. Preference	17¼	17¾	17¼	17¾	3 7 7	" "	..	—
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	123	126	123	126	3 3 6	May and November	123	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	109	106	109	4 13 6	February & August	..	..
250,000	10	6/6	Eastern Extension	16¾	17¼	17	17¼	4 1 2	Jan., Apr., July, Oct.	17 3/16	16 15/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	124	127	124	127	3 3 0	February & August	124½	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	104	108	104	108	4 14 9	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	104	108	104	108	4 14 9	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	107	110	107	110	3 13 11	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	111%	114%	111%	114%	3 10 6	May and November	..	..
180,227	10	2/3	Globe Telegraph and Trust	10	10¼	9⅞	10⅛	4 8 11	Jan., Apr., July, Oct.	10 1/16	10
180,042	10	6%	Do. 6 per Cent. Preference	16¾	17	16¾	17	3 10 7	" "	16⅞	16⅞
150,000	10	7/2	Great Northern	22	22½	22	22½	3 11 1	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	105	..
17,000	25	37/6	Indo-European	44	47	47	50	5 0 0	May and November	47⅞	..
37,548	10	2/6	London Platino-Brazilian	5	7	5	7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	106	110	106	110	5 11 1	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	107	110	107	110	3 14 1	..	..	..
11,839	8	4/0	Reuter's	3½	4½	3½	4½	..	April and October	3½	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	124	129	124	129	4 13 0	" "	128	127
15,609	10	5/0	West African Telegraph	4½	5½	4½	5½	..	January and July	..	—
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	102	105	102	106	4 15 8	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	100	105	100	105	7 12 5	June and December	..	..
88,321	10	6d.	West India and Panama	¾	1	¾	1	..	..	¾	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	9¾	10½	9¾	10½	5 6 8	May and November	10⅛	9 15/16
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9	6 13 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110	113	110	113	4 10 6	June and December	..	..
64,242	15	6/0	Western and Brazilian	10½	11	10½	11	4 1 11	May and November	10⅞	10 9/16
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½	6¾	6½	6¾	..	—	6½	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4¼	4¾	4¼	4¾	..	..	4⅜	..
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	103	107	103	107	5 14 6	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	103	107	103	107	5 14 6	" "	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	5 19 8	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 17 8	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	—	..	..	..
224,850	10/0	1¼d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	—	May and November	..	—
171,504	£1	8·215d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	..	..
484,597	5	2/6	National	5½	5¾	5½	5¾	4 6 11	June and December	5¾	5 9/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15½	16½	15½	16½	3 12 9	" "	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½	15½	14½	15½	3 17 5	" "	..	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¾	6	5⅞	6⅛	4 1 8	—	5 15/16	5⅞
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	105	107	104	106	3 6 0	January and July	106½	105
58,000	5	1/0	United River Plate	1½	2½	1½	2½	..	" "	2 3/16	1¾
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	87	92	87	92	5 8 8	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	14	15	14½	15½	1 13 4	—	15¼	15
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15¾	16¼	15¾	16¼	3 13 10	..	16⅛	15⅞
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	133	136	130	135	3 14 1	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	—	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	..
8,322	£5	..	House-to-House Electric	—		—		..	—	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		—		..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	—	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7¼	7⅞	7¾	7⅞	..	—	..	..
111,000	5	..	London Electric Supply	..		..		..	—	..	—
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	10¾	11¼	10¼	10¾	2 15 10	..	11 1/16	10¾
£150,000	Stock	4½%	* Do. 4½% Debs.	117	119	115	117	3 16 11	June and December	117½	..
6,452	£10	2/0	Notting Hill Electric	8	8½	8	8½	..	..	..	..
19,980	£5	4/6	St. James and Pall Mall	8¼	8¾	8¼	8¾	..	—	8⅜	8½
20,000	£5	7%	Do. 7 per Cent. Preference	8¾	9¼	9	9½	3 13 8	—	9 5/16	..
59,900	5	5%	Westminster Electric Supply (fully paid)	7¾	8¼	7¾	8¼	3 2 6	—	..	—
			ELECTRIC MANUFACTURINC, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2¼	2½	2¼	2½	6 0 1	—	2½	..
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅜	2⅝	2⅜	2⅝	5 1 1	—	2⅝	2½
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	112	115	112	115	3 19 4	March & September	114½	113½
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2	2½	2	2½	..	January and July	..	—
12,139	5	—	Edison and Swan United	1¾	2¼	1¾	2¼	..	..	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		—		..	..	—	..
120,000	2	..	Electric Construction	½	¾	⅝	⅞	..	..	..	..
12,845	2	2/9½	Do. 7 per Cent. Cumulative Pref.	1½	2	1¾	2¼	..	..	1 15/16	1⅝
91,195	2	10/0	Elmore's Patent Copper Depositing	1	1¼	1	1¼	..	..	1 3/16	1⅛
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1¼	¼	¾	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21½	22½	17	19	5 5 3	February & August	22½	22
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 7 5	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..	—	..	..
16,000	£10	..	Do. 8 per Cent. Preference	—		..		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	—	⅛	..	⅛	..	..	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	43	45	43	45	5 6 8	March and July	43½	43
£150,000	100	5%	Do. 5 per Cent. Bonds	106	109	106	109	4 11 9	January and July	..	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,870	10	12/0	W. T. Henley's Telegraph Works Ordinary	10½	11½	10½	11½	5 4 4	..	11½	11
£30,000	10	7%	Do. 7 per Cent. Preference	14	15	14	15	4 13 4	..	14¾	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1¼%	City and South London Railway	42	44	42	44	2 16 10	May and November	..	..
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	..	—
£67,130	Stock	4%	Do. 4% Perpetual Debenture	132	134	132	134	2 19 9	May and November	..	—
37,500	£10	2%	Liverpool Overhead Railway	9 15/16	10 1/16	9⅞	10	1 19 10	—	..	..
6,295	10	5%	Do. 5% Preference	14¾	15¼	14¾	15¼	3 5 7	..	..	..
125,000	Stock	4%	Do. 4% Debenture	111	113	109	111	3 10 2	January and July	—	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 894. [No. 10. Vol. XXXV.] **FRIDAY, JULY 5, 1895.** PRICE SIXPENCE.

NOTES.

We understand that the Telephone Committee, in view of the Dissolution, will not make any specific recommendations to Parliament. Had it done so it would, we believe, have been a case of Balak and Balaam. Instead of anathematising the National Telephone Company and all its doings, the Committee would in all likelihood have pronounced something not altogether unlike a blessing. As it is this unexpected consummation will be avoided, and the evidence taken will be merely reported to Parliament.

Our Paris Correspondent announces this week the passing of a law relating to electric light and power conductors. The only noteworthy feature of the *projet de loi* just adopted by the Senate is the institution of a permanent Advisory Council, half the members of which are to consist of representatives of the electrical industry. The function of this Advisory Council will be to assist the Minister of Commerce in drawing up the inevitable rules and regulations, and to solve all electrical problems which that official may find too difficult for his own unaided capacities. This rigid organisation of a body of advisers by formal legislative act is very characteristic of the French fondness for precision, and the spasmodic and informal way in which the Board of Trade seeks outside advice whenever and wherever it is required is equally characteristic of our own preference for flexibility.

Certainly in adopting the French plan the electrical industry could no longer complain that all rules and regulations emanated from the fertile brain of a single official. But in that, we think, lies the sole advantage of a regular Advisory Council. With us, after a due period of brooding, the Departmental regulation egg is hatched, and the unfortunate young chicken is sent out into the electrical world, which has an official permission—nay, a positive invitation—to criticise and grumble, up to a certain date, without stint. By this rude process, supplemented by a Round Table conference, we ultimately secure a set of rules which, if they do not command universal assent, have at any rate gone through the fire of universal criticism. On the other hand, a permanent Advisory Council, such as is proposed across the Channel, would in all probability prove a stumbling block and rock of offence by reason of its very permanency. In such an august body youth and freshness would in all probability be at a discount, and the Board of Trade, instead of obtaining the advice of the entire electrical industry as it does now, would only have the benefit of out-of-date opinions. Rough and ready criticism would, moreover, be discountenanced as something disrespectful to such a venerable and representative body. And withal *sub-rosâ* grumbling would not be prevented; the Advisory Council would, we may be sure, contain either too many professors or too many manufacturers, or too many consultants, or too many theorists to please this section or that section of the industry. So long as the Board of Trade shows itself open to advice to the same extent as hitherto, we need not envy our French friends their Advisory Council of electrical engineers.

We are quite at one with municipalities in resisting the disfigurement of handsome thoroughfares by the erection of ugly contrivances intended to facilitate public locomotion, and even a Pottery township would not be without excuse in opposing anything in the shape of the hideous American span system of running trolley wires. On the other hand, it would have to be a remarkably handsome street the appearance of which would suffer appreciable injury from a row of delicate-looking ornamental rolled-steel columns run down the centre of the roadway, and supporting on either side a wire no thicker than No. 00 B.W.G.; indeed, the minutest demand from the public for more rapid transit should outweigh such a bare possibility of æsthetic debasement. That being so, it is difficult to see what it is the Dublin Corporation has to congratulate itself on in preventing the introduction of electric traction on the overhead wire system into the sacred precincts of the Irish capital. As related in our "Parliamentary Intelligence" this week, the net outcome of their opposition to the Bill of the Dublin United Tramways Company has simply been that the various clauses relating to Dublin and to the townships of Rathmines, Rathgar and Pembroke have been struck out, thus making the Bill apply only to the cacophonous but level-headed localities of Clontarf, Drumcondra and Glasnevin, Kilmainham and Rathfarnham. A very small dose of the spirit of compromise should have enabled Dublin to have been as up-to-date as Kilmainham, and nevertheless to have preserved the amenities of its streets.

Those who are still concerned about the old A. T. *v.* B. T. controversy will note with some interest the skirmish which recently took place before a Select Committee of the House

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of Lords. Much was said as to the suitability of alternate currents for transmission purposes and as to the large number of alternate-current transmission plants in existence in America and on the Continent; but as the point at issue was the suitability of alternate-currents for distribution to printing-press and medium-sized motors, the relevancy of such evidence is not altogether apparent. However, as the Strand Company secured its Order the irrelevancy of much of the opposition evidence has only an academic interest.

"The Bidard Battery. No lead, no sulphuric acid, no paste." On reading this portentous announcement one is tempted to exclaim "Eureka!" and to hasten to learn how to escape from lead batteries, with their attendant ills. The description of the Bidard battery, however, tends to chasten one's enthusiasm; it is a zinc-carbon couple in a sulphate of zinc solution, an arrangement we seem to have heard of before. But, according to the inventor, the chemical reactions in his cell are a little remarkable, oxygen being given off at the positive electrode, while suboxide of zinc is deposited at the negative. Prof. Bidard mentions that the generally received theory is that zinc oxide is composed of zinc and oxygen, but he prefers to regard it, on the strength of the working of this cell, as a compound of a suboxide of zinc and oxygen. Recently we have had the gravity Daniell cell discovered in a very slightly modified form by an Italian doctor, and also the original Planté cell composed of two thin sheets of lead wound spirally round each other; and now we have the brilliant discovery of the French *savant* recorded above, and yet there are people to be found who are not impressed by the rapid advance which science is making at the close of this 19th century.

"One of the most remarkable episodes in municipal government ever known came to an end last night," says the New York correspondent of *The Times* in a cablegram dated June 30th. "Since February 13th, the Mayor of New York has been an autocrat, with power of official life and death. A Bill then passed by the State Legislature gave him power to remove heads of city departments and subordinates, this being thought the only way in which Tammany officials could be weeded out and pure government insured. . . . Out of 16,000 municipal servants, less than 3,000 have been removed, and of these less than 300 were of high rank. The changes, none the less, amount to a revolution." We trust that the necessity for a municipal Dictatorship may never arise on this side of the Atlantic; but its occurrence in New York might well give pause to that extravagant laudation of municipalisation, especially if it seems likely to lead to the giving out of contracts, which is so much met with in some electrical quarters. We can understand the contractor's and consultant's predilection for the municipalising of all things, but that is no reason for anyone else to short-sightedly advocate the multiplication of municipal functions with its inevitable corollary the multiplication of municipal functionaries.

The life's labours of the late Prof. Huxley had indeed nothing to do with electrical science, but it may, nevertheless, be permissible to point out in this connection that if modern science is to make sure of the ground it has so painfully conquered, the popularisation of science must not be neglected. It is not every scientific mind that can profitably apply itself either to original research or to practical or educational work; and with the example of a Huxley before him no man need think it beneath him to bring the leading lines of scientific thought attractively within the comprehension of the average man. Unless it be broad-based upon the people's understanding the scientific edifice we are all so proud of will ever be liable to be toppled over like a house of cards by a wave of ignorant prejudice.

Cable Interruptions.—There are no cable interruptions to report this week.

King's College, London.—The Michaelmas term of this college commences on October 3rd. Further particulars will be found in our advertisement columns.

International Telephonic Communication.—Negotiations are, it is reported, in hand with reference to the establishment of a telephone line between Constantinople and Sofia.

Personal.—Viscount Peel, Viscount Wolseley, and Sir John Pender, M.P., were presented on Wednesday with the freedom of the burgh of Kirkwall, at a public meeting held in the Town Hall.

Electric Lighting Provisional Orders Bills.—In the House of Lords on Thursday, June 27th, the Royal Assent was given in the usual manner to the Electric Lighting Provisional Orders Bills Nos. 1, 2 and 3.

The Manhattan Railway.—It is announced that the Westinghouse Company have received the order for the electric equipment of the Manhattan elevated railroad in New York. The cars are to be heated as well as lighted by electricity.

The Parallel-Series Control.—On Sunday the legal term of existence of Dr. John Hopkinson's patent No. 2,989 of July 7, 1881, will come to an end. The subject of this patent is the coupling of two or more motors in series or parallel for varying the speed of vehicles.

The Niagara Falls Scheme.—The New York correspondent of *The Times* states that the first power electrically transmitted for commercial purposes from Niagara Falls was sent on Monday to the aluminium works a mile distant. Four thousand horse-power was delivered and used.

The London County Council's Tramways Bill.—The Bill of the London County Council, empowering them to work the tramways acquired by them, was to have been considered by Lord Belper's Committee, but it has been withdrawn from the group, and will not be further proceeded with this Session.

Telephonic and Telegraphic Communication in Switzerland. At the end of 1894 the length of the Swiss State telephone lines amounted to 7,843 kilometres, this being an increase of 1,071 kilometres on the year. On the other hand, the State telegraph lines decreased during the year to the extent of 65 kilometres, the total length of the telegraph lines now in operation being 7,203 kilometres.

Calcium Carbide.—In a recent number of the *Révue Générale des Sciences* M. Moissan claims priority over Mr. L. Wilson, of America, in the commercial preparation of calcium carbide. M. Moissan states that whilst his first research on an electric reverberatory furnace with movable electrodes was published in the *Comptes Rendus* of December 12, 1892, Mr. Wilson only took out his patent in America on February 21, 1893.

Electric Elevated Railways for Chicago.—It is stated on good authority, says the *Western Electrician* of Chicago, that the Directors of the Lake Street Elevated Railroad Company of Chicago have definitely decided to work the line by electric power. A contract has been entered into by which the West Chicago Street Railway Company will furnish electric power to the Lake Street people at 10 per cent. over the cost of production.

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Institution of Civil Engineers.—The new edition of the list of members of the Institution of Civil Engineers contains the names of 19 honorary members, 1,873 members, 3,726 associate members, 351 associates, and 816 students—together 6,785. Mr. H. L. Antrobus, Dr. William Pole, F.R.S., and Mr. James Forrest have been reappointed to the posts they have held for so many years as treasurer, honorary secretary, and secretary respectively.

Obituary.—The death is announced of Mr. Henry W. Frye, late of the *Electrical World's* editorial staff. He died at Folsom, New Mexico, on June 20th. Last September Mr. Frye had an attack of pneumonia, and in January of this year went to New Mexico to recuperate. Mr. Frye graduated from Colby University, Maine, and took the electrical course under Dr. Louis Duncan, at Johns Hopkins University. He joined the staff of our contemporary in April, 1892.

London, Walthamstow, and Epping Forest Railway.—Earl Morley's Committee of the House of Lords has passed the London, Walthamstow, and Epping Forest Railway Bill, under which power is conferred to improve the scheme as authorised last year by tapping the Tottenham and Hampstead Junction Railway. The measure also authorises the creation of £280,000 additional share and loan capital, which, added to that already sanctioned, makes a total of £2,410,000 share and £770,000 loan.

German Wiring Rules in Austria.—At a recent meeting of the Elektrotechnischer Verein of Vienna, the German wiring rules proposed by the Verband Deutscher Elektrotechniker (see *The Electrician*, May 24th, p. 116) were discussed, and several amendments were proposed. The Verein has asked the opinion of the larger electrical firms of Austria, and they all agree with the proposed amendments. The German rules, it is thought, will be of considerable importance to the Austrian electrical trade on account of the great trade with Germany.

Absolute Measurement of Electrical Resistance. — A Correction.—In the concluding paragraph of our report of Prof. Viriamu Jones' lecture (*The Electrician*, June 21st, p. 257) the following sentence occurs:—"With such a machine standards of from a thousandth to a two thousandth of an ohm may be measured to nearly the same percentage accuracy." The sentence should run—"With such a machine standards of from a thousandth to a two hundred thousandth of an ohm may be measured to nearly the same percentage accuracy."

Double Refraction of Electric Rays.—In *Wiedemann's Annalen* for June, Prof. A. Righi, of Bologna, makes reference to Herr K. Mack's communication on this subject (see *The Electrician* of February 22, 1895, p. 502), and states that on May 27, 1894, he himself presented a Paper to the Bologna Academy of Science on the same subject describing the same kind of experiments. Prof. Righi believes that his own Paper was unknown to Herr Mack at the time of his experiments, and he is glad to see his own results on the double refraction of electric rays confirmed.

Current Views on Energy.—In the current number of *Wiedemann's Annalen* a special note is published by the editors with regard to the subject proposed for discussion at the next annual meeting of the Society of German Naturalists and Physicians which is to held at Lübeck on September 17th. At last year's meeting at Nuremburg it was resolved that the subject should be made known beforehand, especially when theoretical discussions have to take place. The subject for this year's meeting is "A Survey of the Current Views on Energy," by Prof. Helm, of Dresden.

The Hookham Meter.—Notice has just been given under the Patents, Designs and Trades Marks Acts, 1883 to 1888, that Mr. George Hookham has applied for leave to further amend the specification of his meter patent, No. 4,225 of 1887. Any person may give notice of opposition to the amendment at the Patent Office within one calendar month from the 26th ult. The claims of the patent are ten in number, and it is desired to strike out the second claim, which is for "compensating for magnetic drag or friction, or for both, by compound winding either the armature or the magnets." The reason given for this striking out is that the patentee is advised that the subject matter of the claim was not novel at the date of application.

Fire-Damp Explosion in an Austrian Mine.—In his report on the "Johannschacht" explosion Dr. Riel maintains that the fire-damp was exploded by a broken miner's glow lamp, the parts of which were found on the spot. Herr Feilendorf states, on behalf of the lamp makers, that after the most elaborate experiments with a miner's electric lamp, he found that he could not fire explosive gases even by breaking the bulb. This statement is, however, contradicted by Herr Spoth, who says that as far back as 1890 Le Chatelier ascertained that a filament at white heat easily explodes any gas or damp. In some experiments made with a small glow lamp for 5·6 volts and 0·5 ampere, when a small hole was made into the bulb no explosion took place, but with a larger hole it occurred at once.

Condensers on Electric Light Mains.—In our issue of June 14th our Paris Correspondent called attention to the fact that some Boucherot condensers were in commercial use on the mains of the Secteur Électrique des Champs Elysées. We understand that so far only two condensers have been used, and these experimentally. One condenser, having a capacity of eight microfarads—that is to say, giving at a pressure of 3,200 volts and a frequency of 40 ∾ the apparent output of 20 kilowatts—remained for one day upon the mains, but owing to heating it had to be cut out. The second condenser, of 2·5 microfarads, or 6·6 kilowatts apparent output, remained on the mains for 12 days, when it had to be cut out owing to an accident. It is proposed after modifications to replace these condensers.

Beetles and Arc Lights.—It seems that the arc lights in the little American town of Lancaster have recently attracted the attention of an immense swarm of what a local entomologist defines as "members of the family of water beetle." What possible interest a flood of water beetles can have in an arc does not transpire, but certain it is that the inhabitants of Lancaster awoke one morning to find carcases of these aquatic Coleoptera lying by bushels at the base of the lamp-posts. "The bugs," as the Americans impolitely call them, "would charge in solid column" against the arcs, filling the interiors of the globes to the total interruption of their normal duty. When daylight came, the remnant which was to be saved returned to its native pond and hid itself "in the deep mud." Similar visitations have been reported from time to time from other towns using arc lights.

Electric Drilling.—An interesting application of electricity to drilling is recorded by the *Street Railway Gazette*. The Glens Falls (N.Y.) Street Railway Company have built a portable electric drill, which, while a somewhat homely combination so far as appearances go, has answered admirably the purpose for which it was constructed. It is used in drilling holes for bonds in the webs of rails. The electric motor which furnishes the power has a capacity of ½ H.P., and is mounted on a platform wheelbarrow. Current is secured from the overhead trolley wire and ground connection is made to the rail. The armature is connected with an intermediate shafting to reduce the speed. From the latter a flexible shafting extends which is connected with the drill. The feed is regulated by a thumbscrew located at the back of the drill. It is stated that by the use of this device a hole can be bored in the rail in less than a minute.

The Telephone in Sweden.—A correspondent of the *Daily News* states that the Swedish State telephone authorities are about to combine the telephone with the State telegraph system. In Sweden everybody is, as we know, "on the telephone." In future every subscriber will be allowed to make use of his telephone address as his telegraph address. The letter "Rt" (Rikstelefon) will be transmitted free of charge, and the telegraph office receiving a message will look up the addresses in the telephone register, and send it on. This will save two or three words in every telegram. Further than this, telephone subscribers will be allowed to telephone on their messages to the telegraph offices for transmission, and they can, if they so desire, have their telegrams telephoned on to their house immediately they arrive. The State hopes to save by this arrangement, as the number of messengers will be reduced. They also hope to do an increased telegraph traffic.

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An Electrical Pumping Plant.—A novel electrical pumping plant at Monroe is described in a recent number of the *Engineering and Mining Journal* of New York. The great variation in height of water in the river rendered it necessary to have a changeable location for the pumps in order that the suction pipe should be always sufficiently submerged. With this end in view a railway reaching well into the river at low water was built. Upon this railway, mounted on a four-wheeled truck, a pump house was constructed. This house contains an 8in. by 10in. triplex power pump, driven by a 15 H.P. slow-speed electric motor. With the rise and fall of the water the position of the pump house on the railway is changed by means of the windlass at the head of the railway. Necessarily in such an installation as this, provision had to be made for connecting the pumps and discharge pipe, and this has been accomplished by extending the main the entire length of the railway and putting flanged tees at regular intervals. At these points the connection between the pump and main is made. In order to supply the necessary current for operating the motor a pole line was erected alongside the railway. On this are strung the wires which carry current to the motors.

Magnetic Asbestos.—In an article on the above subject in the current number of *Wiedemann's Annalen*, L. Bleekrode, of the Hague, says that experimenting with some of Bell's asbestos he found that its magnetic properties were even more marked than was the case with the sample mentioned by Mr. A. C. C. Swinton in *The Electrician* of September 7, 1894, inasmuch as no strong electro-magnet was necessary, but an ordinary steel magnet was sufficient to demonstrate the existence of magnetism. It is remarkable, he continues, that though this material has been handled so much in the last few years, its magnetic properties have remained unobserved. Faraday, in his investigations on the magnetic behaviour of different substances, classed asbestos as a slightly magnetic material, which is rather remarkable, as he used a strong electro-magnet. Even in 1778 Brugmans, who discovered the magnetic properties of bismuth, described asbestos as fairly strongly magnetic. He mentioned that the steel magnet used would carry on each pole about 1·5 kilogrammes. He knew also that different kinds of asbestos were not equally magnetic. L. Bleekrode, employing an electro-magnet having a tractive effort of 5kg., found that asbestos strips 40mm. long and 3mm. wide were attracted even at a distance of 10mm. These strips afterwards exhibited slight polarity. L. Bleekrode points out that of course the substance may contain iron, but he has boiled some grey asbestos for several hours in concentrated sulphuric acid and it still retained its magnetic properties.

A Central Station in a Thunderstorm—Mr. T. P. Wilmshurst, borough electrical engineer at Halifax, has sent us the following interesting account of a recent experience at the Halifax Corporation Electricity Works, which seem to have come in for an undue share of attention from the terrific thunderstorm of Wednesday afternoon last week. About 5:30, during the height of the storm, two house transformers about 1½ miles from the works appear to have been struck and broken down to earth, blowing their fuses. A few minutes after a blinding flash appeared to strike the alternator which was running, and disabling three armature coils, went to earth by jumping the air space, and thence through the shaft and bed-plate. Two of the staff who were leaning against the guard rails (which, however, were not connected to the alternator) at the same moment experienced sharp shocks. By this time the water was rushing in torrents down the steep slope leading from the tower to the works, and entering the boiler house, quickly rose within a few inches of the fires. By dint, however, of pluck and hard work, the staff on duty were able to stem the torrent and save the fires. In addition to this one of the sub-stations became flooded to a depth of over 5ft., completely immersing the 20-kilowatt transformers, low-tension switches, and circuit fuses. These were under water for 15 hours, during which time they took no harm, supplying current to the network as usual, and when examined next day were found perfectly dry inside the cases. They were supplied by Messrs. C. A. Parsons and Co., Newcastle. It is satisfactory to learn there was no interruption of the supply except for a few seconds required to put on another alternator.

The New Caledonia Cable.—We take the following extract from an exceedingly interesting article on New Caledonia which recently appeared in a London local paper. The article is from the pen of an Englishman associated with the New Caledonia cable-laying expedition :—

"The project of connecting New Caledonia by cable is not of recent origin. In 1878, after the great Canaque insurrection, when over 200 whites were massacred in one week, the French Parliament voted a grant towards it, but upon the suppression of the insurrection, and as the fear of the Canaques gradually died out, so the scheme receded into the background, to be revived from time to time, but only carried into execution last year after prolonged negotiations initiated, and played a prominent part in by the Hon. Audley Coote, who for so many years now has advocated cable communication between Canada and Australia across the Pacific. The cable follows the shortest route between New Caledonia and Queensland, connecting Gomen Bay in the north-west point of the island with the town of Bundaberg (some 180 miles north of Brisbane), which promises shortly to attain considerable importance through the growth of the sugar-producing industry in this district. It is owned by the Société Française des Télégraphes Sous-marins, and is worked by them under joint subsidies from the Governments of France, New South Wales, and Queensland, having been constructed and laid for that Company by the Société Générale des Téléphones—now merged into the Société Industrielle des Téléphones. As regards the submersion of the cable, suffice it to say, that under exceptional difficulties of weather, the entire work was carried out to the satisfaction of the governments concerned, whilst the reception accorded to the expedition in Australia testified in itself as to its popularity there. One of its indirect advantages, from the Australian point of view, is that it will enable the escape of convicts to be made known at once in Australia, thus checking, if not preventing, their landing on those shores. At the instance of the Queensland Government, meteorological bureaus, working in conjunction with their own meteorological department, have been established in the island, whence, through the courtesy of the Cable Company, weather observations are now exchanged with the Australian continent several times daily by cable. This international work is expected to prove of essential service on both sides in forecasting storms and hurricanes, the latter of which are often most disastrous in their effects locally. What would our own meteorologists not give for such an advanced post 800 miles out in the Atlantic? In every respect will New Caledonia benefit in having at length realised that means of communication with the outer world, which by its far-reaching effects has so revolutionised the diplomatic and social intercourse and the commercial dealings of nations."

Telephonic Development in Germany.—The *Elektrotechnische Zeitschrift*, in a recent issue, published some interesting tables showing the present state of telephony in Germany. At the end of 1894 there were 398 urban telephone systems, with 100,441 subscribers. These were composed in the following way:—13 towns with more than 1,000 subscribers, 11 towns from 500 to 1,000, 79 from 100 to 500, 64 from 50 to 100, 194 from 10 to 50, and 27 only from 2 to 9 subscribers. The total number of messages per day is, on an average, 1,041,581. The following detailed figures with regard to the more important figures, are of interest:—

	Subscribers.	Total No. of messages per day.	Messages per subscriber.
Berlin	22,069	223,211	10
Hamburg	8,995	153,903	17
Dresden	3,265	57,689	17
Leipzic	3,290	95,812	29

If we compare these figures with the English ones as given in *The Electrician* of May 31st we find that the number of messages per subscriber is higher in Leipzic than in any town in England; Leeds, the most talkative town, only coming up to 26 messages per subscriber. There are in Germany in all 165 long-distance telephone lines, having a total length of about 8,000 miles. The longest lines are: Berlin-Memel, 620 miles; Berlin-Cologne, 390 miles; Berlin-Munich, 450 miles; Berlin-Vienna, 410 miles; Berlin-Frankfort, 390 miles.—Herr Vollmer, of the Imperial Telegraph Service, speaking at a recent meeting of the Electrotechnische Gesellschaft of Frankfort-on-the-Main on the development of long-distance telephony, said that in 1885 Herr Münch proposed to cross the conductors, and the results were so favourable that on the Berlin-Magdeburg line, which is about 186 miles long, not the slightest noise was perceptible. With the introduction of bronze wires a great impetus was given to long-distance telephony. The first silicium-bronze long-distance conductor in Germany was that between Berlin and Hamburg, which was 3mm. in diameter. Later on conductors of 1·5mm. were used.

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MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 219.)

To Determine Steam Consumption when Non-Condensing.—To determine the weight of steam consumed by an engine when it is not fitted with a condenser, or when it has a jet condenser, the feed water must be measured. In this test it is, of course, essential that the boilers shall supply no other engine than that under test. Even then, however, the test is liable to be vitiated to some extent by the fact that some of the feed water will not pass into the engine, but will escape through the safety valve or the pipe joints or by condensation. To make the test successful, therefore, attention must be paid to these points, and precautions must be taken to minimise the losses arising from them.

The usual preparations for this test are as follows: The feed pumps are arranged to take their supply of water from a large temporary tank, shown at A in Fig. 72, through the pipe B. Over this large tank a somewhat smaller tank is placed, there being a delivery pipe and stop valve, C, communicating between the upper and lower tanks. The bottom of the upper tank should be so shaped as to allow of the whole

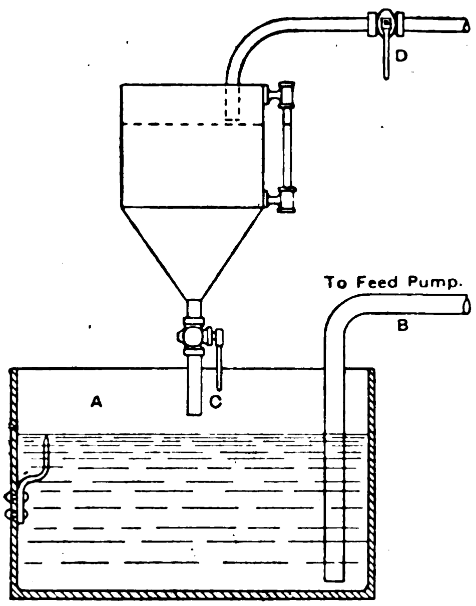

Fig. 72.

of the water in that tank freely flowing through the delivery pipe. A supply pipe, D, connected to the water main and provided with a stop valve, is arranged to supply water to the upper tank at intervals. There is a gauge glass in the side of the upper tank, with a mark near the top of the glass; and there is an index on the inside of the lower tank, to show when the water in it is at standard height. Both the tanks should be of ample capacity in relation to the size of engine, or the fillings are liable to be too hurried and error is likely to arise. The capacity of the upper tank, at the level of the gauge mark, is carefully measured; and the supply of feed water is passed into the lower tank by alternately filling and emptying the upper tank, care being taken that the upper stop valve is quite closed before the lower one is opened, and *vice versâ*.

These preparations completed, the boilers and engine must be run for a considerable time before the test is commenced. When everything is arrived at a fairly steady condition of working, the test may be commenced. At this moment the level of water in the bottom tank must be accurately brought to the standard gauge mark, by letting a little water flow into it from the upper tank or by baling a little out. At the same time, the level of water in the boiler gauge glasses must also be carefully noted, as it will be necessary to stop the trial at the same level. As it is impossible to measure the boiler water level very accurately, it will be necessary to reduce the importance of any change in the level of the water in the boiler to a very trifling quantity. This is done by carrying on the test for a very long time, generally exceeding eight hours. For example, suppose the difference of boiler level represents 500lb. of water, this would be a serious item in a short trial, because it would bear so large a proportion to the weight of water measured in the tanks; but if the trial is double or treble this length, the seriousness of the variation of water in the boiler becomes proportionately diminished. A very long trial makes it negligible. It will be seen, too, that the length of the trial must to some extent depend on whether the boiler is bulky or of small capacity in proportion to its steaming power; but it is rarely wise to place confidence in a trial of less than six or seven hours' duration.

During the test, the times at which the upper tank is emptied into the lower must be tabulated. It will be well to take indicator cards from time to time, and to note the times at which they are taken. If the steam consumption per horse-power is to be determined, the engine must be kept at as constant a load as possible during the test, and frequent repetitions of Tests I. and II. should be made. When the test is nearing its completion, everything should be gradually brought back as nearly as possible to the condition at the start, *i.e.*, the boiler pressure and water level must be adjusted, and the feed pumps should be regulated to their former speed. When the test ends, the level of water in the lower tank must be the same as at starting; or, if it is not, the quantity of water required to make it so must be measured.

To Determine the Quality of Steam.—Nothing, perhaps, is more reprehensible, from the scientific point of view, than the practice which is common among engineers and engine makers, of specifying the merits of an engine in terms of its consumption of steam without giving any information whatever about the quality of the steam. Yet, it is not at all an uncommon thing to compare two engines merely by quoting their relative steam consumptions in pounds of steam per hour. Whether the steam supplied is wet in one case or dry in the other; whether it is at a high pressure or at a low pressure; whether it is or is not superheated, are matters very rarely entered into in the comparison. Yet they are matters of supreme importance. To obtain a complete thermal balance-sheet both the quality and the quantity of steam must be determined.

If the steam is known to be superheated, the degree of superheat can quickly be obtained by taking the pressure and temperature of the steam with calibrated thermometer and gauge. A comparison with Regnault's table gives the result. If the steam is saturated, the dryness factor can be determined in one of two ways: by calorimetry, or by means of a good separator. The latter method, which consists in passing the steam through a separator and weighing the amount of water abstracted, the weight of steam being determined by condensing it or in any other convenient way, is suited to cases where there is much wetness, or where the steam is required to be only roughly tested. Where accurate results are desired, or where the dryness factor is likely to be high, some form of calorimeter must be used.

Steam calorimeters are, in general, of two kinds: the condensing and the throttling calorimeter. Fig. 73 shows a form of Barrus condensing calorimeter, made by Messrs. Musgrave and Sons. The sample of steam is drawn from the steam-pipe—which Prof. Carpenter recommends should be vertical, not horizontal—through the bent pipe E. From this it passes the thermometer I, which will indicate its temperature, and the gauge, which will show its pressure, to the spiral tube or worm D. This worm is contained within a cooling chamber, A, through which cold water is kept flowing; and the condensed steam in the worm passes away, past the thermometer G, to a weighing tank. The condensing water is let into the chamber A, past the thermometer F, and it passes the thermometer H on leaving it. The difference between the readings on these two instruments, therefore, gives the rise in temperature of the cooling water. After passing H, the cooling

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water flows into a weighing tank; or it may be metered into the instrument. Calling k the required dryness factor, L the latent heat of the steam at the pressure shown on the gauge, w the weight of condensed steam, W the weight of condensing water, and t_1, t_2, t_3, and t_4 the thermometer readings on I, G, F, and H respectively, then we have—

Heat lost by steam condensed $= w\,(k\,L + t_1 - t_2)$, and

Heat gained by condensing water $= W(t_4 - t_3)$.

Assuming there is no loss of heat by radiation, or in any other way, these two amounts of heat are equal, whence—

$$k = \frac{\frac{W}{w}(t_4 - t_3) - (t_1 - t_2)}{L} \quad . \quad . \quad . \quad . \quad . \quad (95)$$

Before any measurements are commenced, it is necessary that the calorimeter shall be in action long enough to raise every part to a steady temperature. It will also be necessary, where accurate results are desired, to have the pressure gauge tested against a mercury column, and to have the thermometers calibrated.

The wire-drawing calorimeter was first proposed by Prof. Peabody. Its action depends upon the drying and superheating effect when steam is throttled. The sample of steam is throttled through the calorimeter, and its pressure and temperature are measured, the degree of throttling being adjusted to produce a few degrees of superheat. It will be

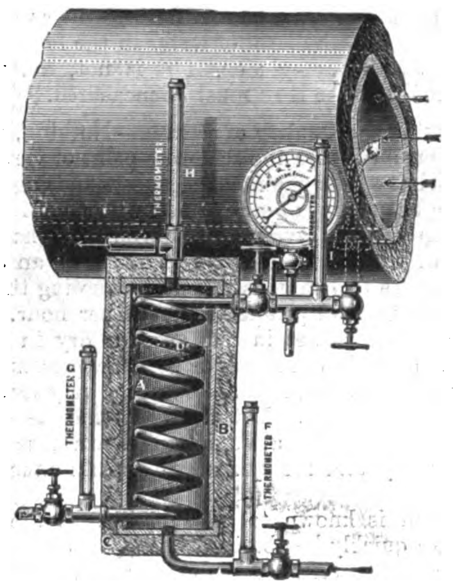

FIG. 73.—Musgrave Steam Calorimeter.

seen that, unless the dryness factor is very high, the amount of throttling which is available may be quite insufficient to dry the steam. In fact, the method is of very limited application.

Some attempts have been made to estimate the degree of wetness of steam by the so-called "salt test." This test consists in introducing a known weight of a given salt into the boiler, and then estimating the percentage of salt contained in the sample of steam drawn off. It will readily be seen that the comparison of the amount of salt primed over with the steam is no guide whatever to the degree of wetness of the steam, since some or all of that wetness may be due to subsequent condensation of dry steam. More than this, the salt test seems to be utterly unreliable; repetition of the test upon the same boiler, under precisely the same conditions, giving results which may differ as much as several thousands per cent.! Clearly, the salt test is not worthy of its name, and the publication of results obtained by it should be received with great caution.

Some care must be directed to the method by which the sample of steam is drawn from the steam-pipe. There is no little risk of the orifice of the tube, inserted for the purpose of obtaining a sample, acting as a kind of steam separator, drawing off too great a proportion of steam, and allowing the water to fly past the test tube uncaught. This will chiefly happen if the orifice of the test tube is in the plane of the motion of the steam. On the other hand, if the test tube is bent, as shown in Fig. 73 at E, so as to oppose its orifice directly to the stream of steam, the action of the edges seems liable to draw more than the fair proportion of water with the sample of steam. Under no conditions should the orifice of the test tube be expanded into a funnel or horn. On the whole, the most reliable results seem to be obtained with a test tube carried into the very centre of the steam-pipe, and bent at right angles, as shown in Fig. 73. To some extent the error due to the action of the orifice might be eliminated by working with two different sizes of test tube inserted consecutively.

The $\theta\,\phi$ Diagram.—We shall conclude this section by describing some of the more practical uses of the temperature-entropy diagram in steam engine testing. The reader is advised to refer back to Vol. XXXII., p. 545, for particulars of this diagram in its general thermodynamic relations, before passing on to consider the following applications to steam and steam engines.

From equation 68 it follows that when unit mass of water is raised from a temperature θ_1 to a temperature θ_2, the increase in entropy will be

$$\phi = \log_\epsilon \theta_2 - \log_\epsilon \theta_1 \quad . \quad . \quad . \quad . \quad . \quad (96)$$

Accordingly, the $\theta\,\phi$ diagram of water is a logarithmic curve. In Fig. 74, let one pound of water be taken at an absolute temperature of 600°F., and let its temperature be

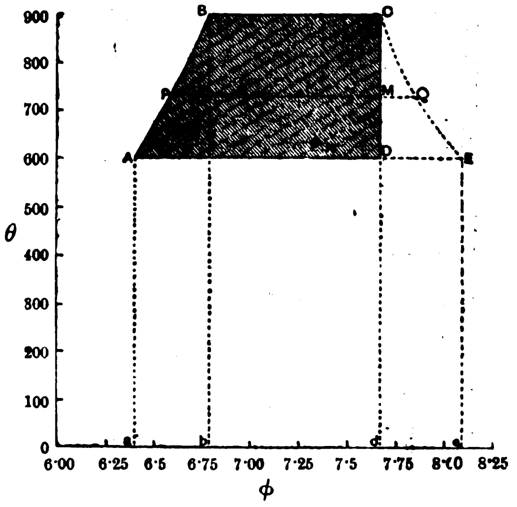

FIG. 74.

raised to 900°F.; then the $\theta\,\phi$ diagram of the process will be represented by the curve, A B. When at the condition, B, let this pound of water be converted into dry steam, at constant pressure. The process is isothermal; therefore, a horizontal line, B C, will represent it in the diagram, the length of this line being, by definition of entropy, equal to the ratio of L—the latent heat at 900°F—to the temperature at which the change takes place, *i.e.*, 900°. At the point, C, we have one pound of dry steam. A total amount of heat equal to the area a A B C d has been supplied to the water, of which the area b B C d represents heat spent in turning it into steam. To transfer this pound of dry steam to the cylinder of an engine need involve no change either in temperature or entropy, so that the point, C, will represent steam at the point of cut-off in the cylinder. Expansion now follows, and the character of the further portion of the diagram will depend on the character of the expansion. Let us first assume that this latter is isentropic or adiabatic; and let the steam be expanded down to the temperature at starting, *i.e.*, 600°F. Evidently the vertical line, C D, will meet the case, and at the point D we have adiabatically expanded steam—partly steam and partly water—at a temperature of 600°F. The line D A represents the conversion of the whole of the steam into water, the initial state A being now arrived at, and the cycle being completed.

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During the condensation an amount of heat represented by the area D A *a d* is given up by the steam to the cooling agent, and is wasted. The shaded area A B C D, therefore, represents the mechanical work done in the cylinder.

Now let us suppose that instead of being expanded adiabatically the steam is expanded so that it remains dry saturated steam throughout the period of expansion. The expansion curve will be represented by C D, such that any point, Q, on it is at a distance, P Q, from the horizontally opposite point, P, on C D, which is equal to the ratio of latent heat to the temperature corresponding to the point. In other words, the relation of Q to P will be exactly the same as that of C to B. Therefore, C E is the dry steam expansion line, or the saturation line on the $\theta\ \phi$ diagram. As a consequence, the horizontal distance, M Q, at any point will represent the wetness of the steam at that point, when adiabatic expansion takes place; the ratio of M Q to P Q being the proportion of water, and the ratio of P M to P Q being the proportion of true steam, to the total mass of wet steam. And the ratio of A D to A E will represent the final dryness factor of the adiabatically expanded steam.

These considerations hold whatever the form of the actual expansion line. If, instead of either C D or C E, it takes another course, the horizontal departure of that line from the line C E will always enable the degree of wetness of the steam to be determined, the assumption being that the steam is initially dry. A further point is afforded by these considerations, namely, that although more work can be obtained by means of the saturation expansion than by means of the adiabatic expansion—the total area of the diagram of work being A B C E, instead of A B C D, in the former case—the efficiency is lowered by the change; for the ratio of the area of *work* to the area of *total heat expended* is diminished.

(*To be continued.*)

TWO-PHASE PLANT AT THE PANTIN WORKS OF MM. WEYHER ET RICHEMOND.

BY GASTON ROUX.

A very interesting two-phase plant has recently been laid down in the workshops of MM. Weyher et Richemond at Pantin, near Paris. MM. Weyher et Richemond, who have acquired a good name as makers of machinery, last year bought the Brown patents, and in making use in their workshops of a two-phase system of power distribution, they desired not only to prove the advantages of the system, but also to avail themselves of such advantages.

The Weyher and Richemond works consist of a number of buildings covering an area of about 25,000 square metres (6 acres), and they originally derived their power from three steam engines, viz.:—One fixed single cylindrical condensing 80 H.P. engine, one fixed compound condensing 120 H.P. engine, one semi-fixed compound condensing 50 H.P. engine. Although the new plant has been in operation for about seven months, the change over has only been made bit by bit, and is not yet finished, so that the compound engine is still running until the last 45 H.P. motors under construction are erected.

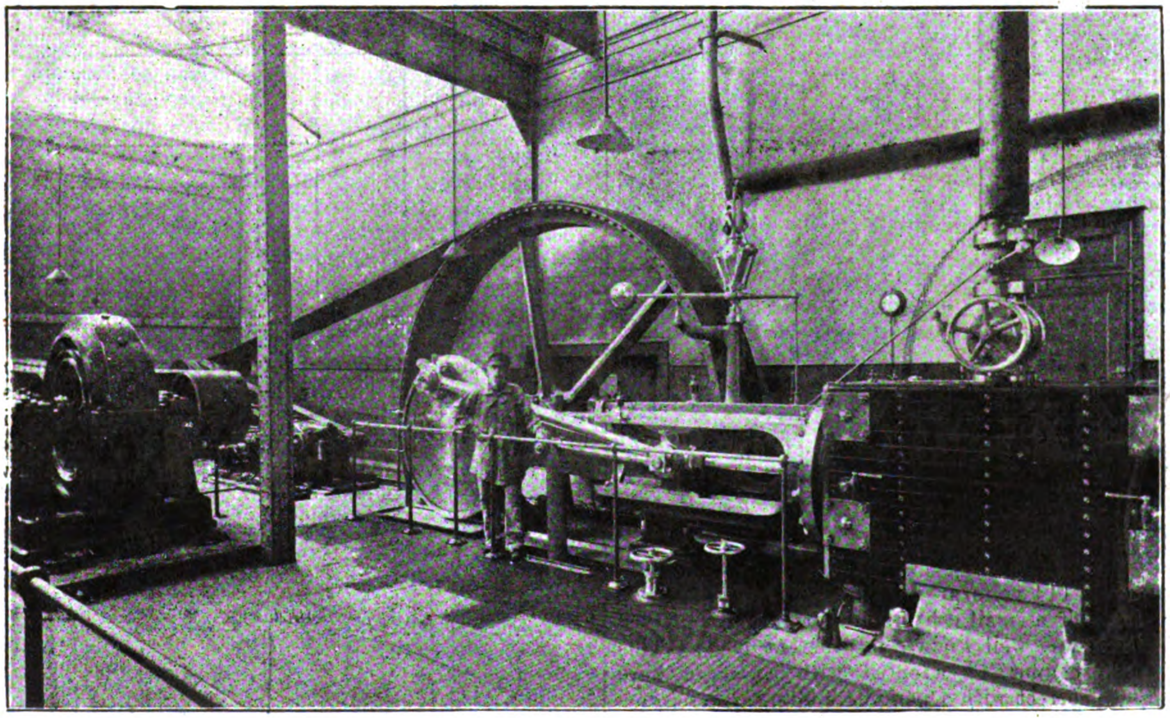

FIG. 1.—400 H.P. Steam Engine driving the Two-phase Plant at the Pantin Works.

The new plant includes five boilers, three of which are sufficient to supply the steam to the engine; the two others are used for the purpose of making steam-engine tests in the room adjoining the boiler room, and to feed a vertical steam engine for testing the dynamos. The single steam engine for the power plant is of the horizontal single-cylinder type (*see* Fig. 1), provided with four valves. It can generate 400 H.P. at 60 revolutions per minute, its point of economical consumption being at 200 H.P. It operates a line of shafting furnished with pulleys for—(1) A continuous-current 110-volt 100-ampere dynamo used as an exciter for the alternators, and capable of yielding 50 additional amperes for electrical tests; (2) a small three-phase machine originally used to operate an electric crane, now made to serve for tests on three-phase motors in the testing room; (3) three 130 H.P. alternators. One of these alternators is provided with a "Bovet" magnetic clutch (see *The Electrician*, Vol. XXX., p. 509, March 3, 1893). The shafting extends on the right side in the dynamo testing room, and a pulley attached to its extremity enables it to be operated by

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means of the 150 H.P. vertical engine in the event of the horizontal engine proving defective; but during the seven months it has been in operation such a necessity has not arisen. This shafting is certainly superfluous. It is quite probable that one alternator on the flywheel would have given as satisfactory results as a high-speed alternator. But at the time when the installation was organised the arrangement described was found preferable.

All the alternators are of 88 kilowatts, and give 110 volts and 400 amperes; they are provided with 12 outside poles, and at 400 revolutions per minute give 40 ∿. The following is a comparison of these machines with continuous-current dynamos of the same power and same speed, and, of course, of the same manufacture. Firstly, as to price, they are cheaper by 10 to 15 per cent.; they are very light (about 4½ tons) and of great simplicity. As to their efficiency, it is the same as that of continuous-current dynamos. A polyphase alternator works absolutely under the same conditions as a dynamo; it is a dynamo less the collector. Efficiency measurements have been obtained by measuring (*a*) the necessary excitation to obtain 110 volts at full load, (*b*) the resistance of the armature hot, (*c*) the loss by friction, resistance of the air, hysteresis and Foucault currents, the machine reversing in the same field as

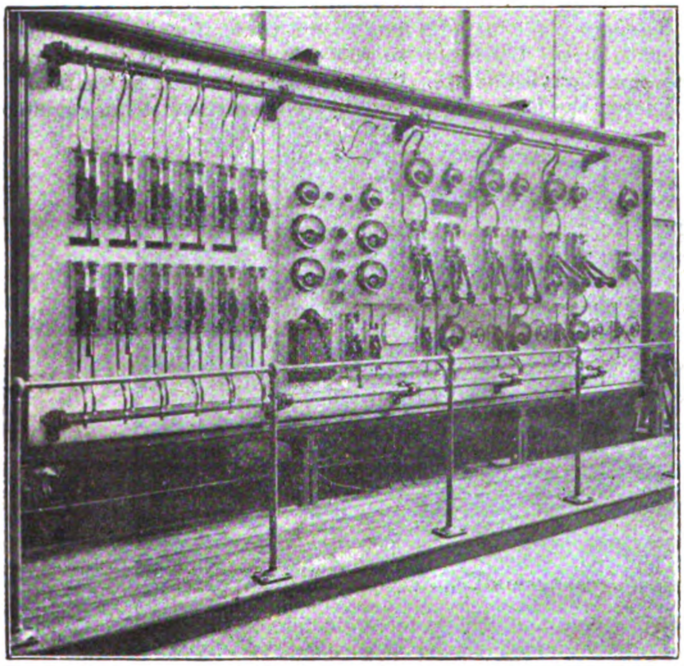

Fig. 2.—Switchboard.

that which produces 114 volts at no load. These losses were measured by means of a small continuous-current dynamo, the efficiency of which was well known at different loads. This proceeding, which cannot be adopted with a single-phase alternator, is quite correct with a polyphase alternator.

The following table gives the results of these tests:—

—	Full load. (Watts.)	Half load. (Watts.)	One-tenth of load. (Watts.)
Loss in the armature	2,280	570	20
Loss in inductors	1,520	1,460	1,400
Friction	640	640	640
Air resistance	1,000	1,000	1,000
Hysteresis	1,160	1,130	1,100
Foucault and internal currents	1,760	1,700	1,600
Utilised power	88,000	44,000	8,800
Total power	96,360	50,500	14,560
Efficiency per cent.	91·3 %	87·2 %	60·5 %

By suppressing the movement of the air produced by the arms of the armature, the efficiencies would be respectively 92·3, 89, 65 per cent. It has not, however, been found advisable to suppress this movement of the air, which keeps the machine room well ventilated. In taking into account the efficiency of the exciter, the figure 91·3 decreases to 91·2.

The paralleling of the alternators is effected by means of incandescent lamps according to the well-known plan. This operation is very easy, and is effected on the switchboard, where

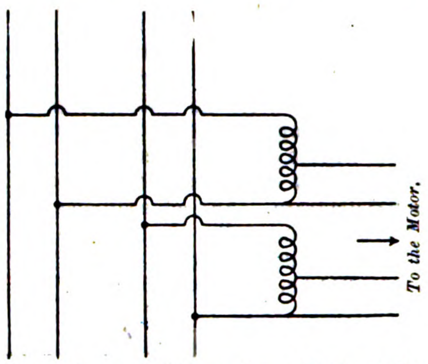

Fig. 3.—Diagram of Connections of Motor at Start.

are to be found (*see* Fig. 2) on the right the switches of the machines running to "bus" bars, on the left the switches of the different circuits, and in the middle the measuring and synchronising apparatus. Paralleling experiments have been tried several times in my presence, and have always been successful.

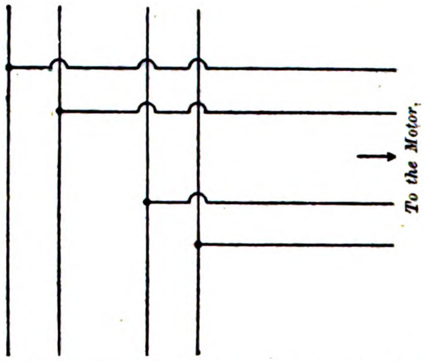

Fig. 4.—Diagram of Connections of Motor when Running.

The distributors consist of eight cables, 75 square millimetres in section, two by two in parallel. The cost of the line is of so very little importance, in comparison with other expenses, that there was no hesitation, in order to completely separate the two phases, to carry out the distribution with four

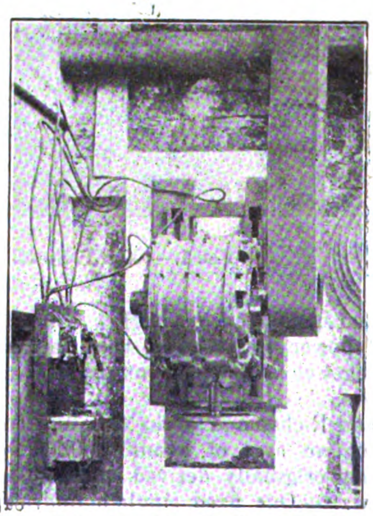

Fig. 5.—30 H.P. Motor Provisionally Erected in the Brazing Shop.

double wires, when it would have been sufficient to use three double wires of the same individual section. The multiplication of cables must not be set down to the use of the two-phase system, but to the awkwardness of having to deal with cables of more than 100 sq. mm. cross section.

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The motors employed are of two types, "squirrel cage" and with resistance in the armature. The starting of the "squirrel cage" motors is carried out in the following manner. In order that no disturbance may be produced in the mains, the starting current must not exceed the normal current, but then the torque is one-quarter or one-fifth of that required. It is necessary to send into the motor a current greater than that derived from the line. To obtain this a self-induction coil, provided with five or six layers of wire, is placed in shunt on each section of the line; the motor is then inserted between the first and

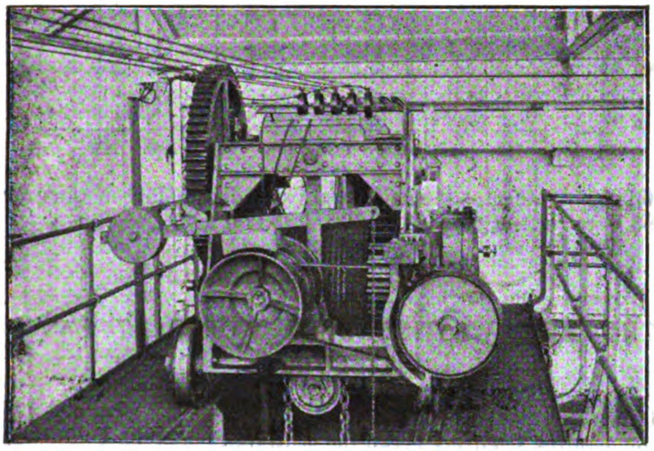

Fig. 6.—Hoisting Gear of Electric Travelling Crane.

third layers, and the desired result is obtained. As soon as the motor has attained its normal speed, the self-induction coil is suppressed by the movement of a switch, and the motor is placed directly on the main line. This apparatus is similar in principle to the "compensator" of Elihu Thomson used for three wire alternating distribution. The sketches (Figs. 3 and 4) show the connections of the motors on starting and when speeded up The starting of the motors with resistance in the armature is done in the same way as that of continuous-

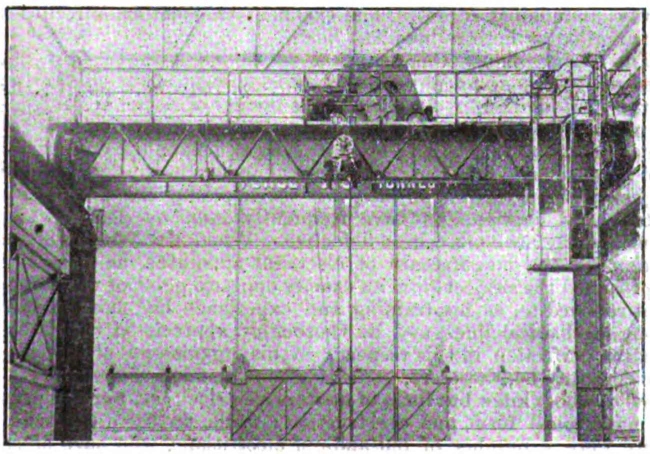

Fig. 7.—General View of Electric Travelling Crane.

current shunt motors. Nevertheless, before starting either of these motors it is preferable to stretch the belt so that the motor attains its normal speed more rapidly.

Two generators work all day in parallel at 200 H.P., and as this load corresponds to the point of most economical consumption of steam, the average result is excellent. At night the third alternator, used in the day time as a reserve, is brought into operation for supplying the lighting current, the lighting being carried out by 60 arc lamps and 600 incandescent lamps.

This plant has been erected by M. P. Boucherot, and does the greatest credit to this young engineer, who has already acquired fame for his novel applications of alternating current.

There are some 17 motors in the shops distributed in the following manner. (*See* also Figs. 5, 6 and 7):—

Workshops.	No. of motors.	Individual H.P.	Total H.P.	Commercial efficiency per cent.	H.P. absorbed.
Test room	1	30·0	30·0	91	33·0
Large brazing shop.	1	45·0	45·0	92	49·0
Small brazing shop.	3	13·0	13·0	89	14·6
Winding shop	3	1·5	4·5	74	6·1
Iron foundry.........	1	1·4	1·4	74	1·9
Erecting shop...... {	1	3·0	3·0	76	4·0
	1	5·0	5·0	83	6·0
Electric crane...... {	1	8·0	8·0	86	9·3
	2	1·4	2·8	74	3·8
Old adjusting room.	1	45·0	45·0	92	49·0
Pattern shop.........	1	20·0	20·0	90	22·2
Tool shop	1	30·0	30·0	91	33·0
Instrument room.. {	1	30·0	30·0	91	33·0
	1	20·0	20·0	90	22·2
			257·7		287·1

HYSTERESIS, FRICTIONAL AND EDDY-CURRENT LOSSES IN CONTINUOUS-CURRENT DYNAMOS.

BY GEORGE ADAMS.

The simple method of determining hysteresis, frictional and eddy-current losses, originated by Mr. Gisbert Kapp, is probably well known to most electrical engineers.

The method may be briefly stated as follows:—Run the dynamo as a motor, exciting the field from a separate source, and keeping the excitation constant. The speed of the motor may be varied by varying the voltage of the current supplied to the armature. The current required to run the

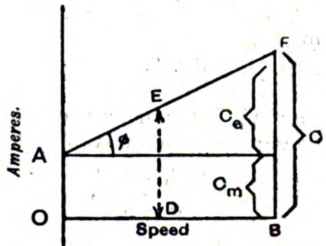

Fig. 1.

armature light is so small that the armature reaction may be neglected, and also its resistance. The measured voltage at the brushes may therefore be considered equal to the armature E.M.F. Take readings of speed (S), current (C), and voltage (e). By increasing the voltage we increase the readings. Plot the current readings as a function of the speed. Thus at B (Fig. 1) make B F equal to the current at speed O B. At any other speed D plot the corresponding current D E. Join the points F E, and produce the line backwards until it cuts the vertical axis at A. Then $OA = C_m$ represents the current at zero speed. The resistance due to hysteresis and friction is independent of the speed of the armature when once in motion, therefore we may consider the current C made up of two parts, namely, C_m required to produce the torque which just balances the resistance due to mechanical friction and magnetic hysteresis, and $C - C_m = C_e$ required to produce the torque which balances the resistance of eddy currents.

If W_m = loss in watts due to mechanical friction and hysteresis,

W_e = loss due to eddy currents.

We have the total measured loss—

$$W = W_m + W_e,$$
$$W = e\,C,$$
$$W_m = e\,C_m,$$
$$W_e = e\,(C - C_m).$$

We are thus able to determine by means of a simple experiment the eddy current, and frictional and hysteresis losses when the machine is on *open circuit*.

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For the same strength of field the hysteresis loss is proportional to the speed, and the same holds good for the frictional losses, provided the speed be not reduced too much. The eddy current losses being proportional to the square of the E.M.F.'s producing them, must for the same strength of field be proportional to the square of the speed. A diagram showing at a glance the relation between speed, volts, current and watts lost in hysteresis, friction and eddy currents, for a given dynamo, may be constructed as follows :—

Let the abscissæ represent the volt readings, or speed of machine, and the ordinates represent losses in watts. The abscissæ in Fig. 1 will to a suitable scale represent the volt readings, and we have the relation $\frac{C_e}{e} = \tan \phi$, ϕ being the angle included between the lines A C and A F in Fig. 1. Also $W_e = e\,C_e = e^2 \tan \phi$. Now, $\tan \phi$ is a constant which can be obtained from the readings taken of current and volts, and is, in fact, equal to $\frac{C - C_m}{e}$. Having experimentally determined the numerical value of $\tan \phi$, we can construct the curve O E (Fig. 2), from the equation $W_e = e\,C_e = e^2 \tan \phi$. The curve O E is a parabola having its axis at O Y.

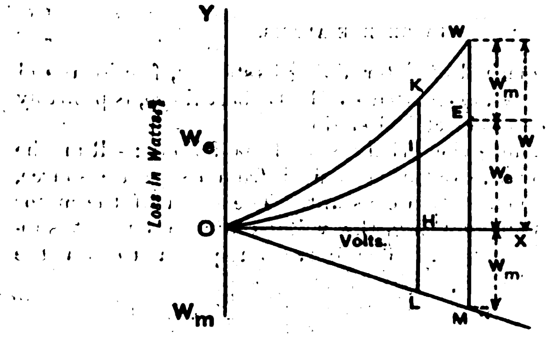


Fig. 2.

Now, $W_m = e\,C_m$, and C_m is found by the construction Fig. 1, or it may be obtained at once from the following formula :—

$$C_m = \frac{S\,C_1 - S_1\,C}{S - S_1},$$

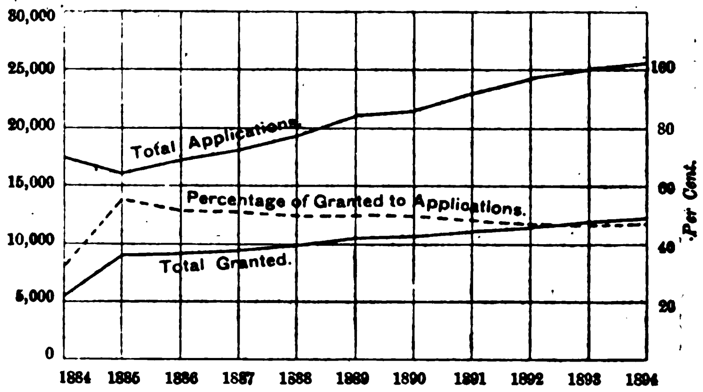
where S = speed corresponding to current reading C, S_1 = speed corresponding to current reading C_1. S should be about normal speed, and S_1 about half speed.

Next plot the value of W_m corresponding to any volt reading, and draw a line from this point through the origin O. Since the loss by friction and hysteresis varies as the speed, the ordinates of the line O M thus found will represent the watts lost in hysteresis and friction for the voltage represented by the corresponding abscissæ. If a curve O W be constructed by plotting the ordinates of the line O M, such as H L above the ordinates of the curve O E, and joining all the points thus obtained, the ordinates of the curve O W will represent the total loss in watts, including frictional, hysteresis and eddy-current losses, the abscissæ being either volts or speeds corresponding to the volt readings. The ordinates of the curve O E represent eddy-current losses.

PATENTS IN 1894.

During last year 25,386 patents were applied for as against 25,116 in 1893, an increase of a little over 1 per cent. It will be seen from the accompanying diagram that the number of applications for patents, which in 1884 amounted to about 17,000, have increased by 48 per cent. in 10 years. During 1894 the names of 11 gentlemen were added to the register of patent agents, the total number of agents upon the register now being 236.

The total income of the Patent Office in 1894 amounted to close upon £182,000, £163,447 being derived from patent fees alone. The total expenditure amounted, in round figures, to £96,000, salaries accounting for £55,000 and printing for nearly £20,000. The surplus for 1894 was, in round figures,



£86,000. The total income, total expenditure and surplus for 1893 were respectively £175,000, £95,000 and £80,000.

THE NEW WESTINGHOUSE WORKS AT EAST PITTSBURG.*

It is almost six months since the Westinghouse Electric and Manufacturing Company began the centralisation of its Pittsburg, Allegheny and Newark factories at its new plant in East Pittsburg. Owing to the vast amount of machinery and material to be transported, the transfer has been necessarily slow, but the new factory is now in complete operation. Soon after the consolidation of almost all the competing electric companies into the General Electric Company, the Westinghouse secured a plot of land adjoining the main line of the Pennsylvania Railway, 12 miles east of the city of Pittsburg. Here, as the result of a year's work and the investment of many hundred thousand dollars, there has been erected one of the largest and most complete manufacturing establishments in the world. The situation of Pittsburg is particularly advantageous for any manufacturing concern supplying the American market, for being well inland it is convenient to both the East and West; moreover, it is in the centre of a great coal-producing district; many raw materials are near at hand and consequently cheap; the labour market is of the highest grade and always abundantly supplied, and excellent transportation facilities are afforded by both railway and boat.

The Westinghouse Company was incorporated in 1886, and at present it has permanent representatives in most of the chief cities of the United States. A glance at the history of electrical development will show that the manufacturing branch of the business has been controlled very largely by those who also made the discoveries and inventions. Involving, as electrical apparatus does, a grasp of higher mathematics and physics, it is not surprising that mechanical details and construction have frequently been overlooked, and consequently have often been defective. When Mr. Westinghouse undertook the manufacture of electrical apparatus, he naturally approached the subject from an exactly opposite point of view from that referred to, as his training and experience had been largely along mechanical lines, and he thoroughly appreciated the necessity for perfection in this respect; in his organisation of the electric company he, therefore, gathered about him a staff of engineers, some of whom knew but little of matters electrical, but were experts on mechanical form and construction; while, on the other hand, there were a number of out-and-out electricians, who have since attained world-wide reputations. It is due to this associating together of the two classes of men that there has resulted an engineering department whose work has won for the Westinghouse Company the enviable reputation that its apparatus is as efficient mechanically as it is electrically.

After a detailed account of the engineering record of the leading men on the Westinghouse Company's staff our contemporary proceeds to describe the factory itself.

The main building of the Westinghouse plant is 754ft. in length, 231ft. in width and 67ft. high to the ridge of the central roof truss. Along either side of the building, 25ft. above the floor, run galleries 80ft. in width. The accompanying illustration (Fig. 1) gives a general view from one end of the shop, showing very clearly the interior arrangement. The warehouse is 574ft. in length, 76ft. wide and 62ft. in height. The building is of the same general design as the main building, and connected to the latter, on the

* Abstract from the *Electrical World* of New York, to whom we are also indebted for the blocks illustrating our abstract.

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second floor, by means of five enclosed bridges. Directly behind the warehouse is the power house. Behind the power house is a two-story building 258ft. long, 76ft. wide and 62ft. high, used, on the ground floor, for storing and annealing sheet iron. The second floor is devoted to the punching department, about 60 machines being there employed. One of the latest types of these is an armature ring press made by the E. W. Bliss Company. A special feature of this press is that the knock-out pads are operated by a device which obviates the use of springs and consequent strain at a time when the machine is doing its maximum work. For sharpening the dies of the larger presses a special emery grinder is used, made by the Springfield Emery Wheel Company, Springfield, Mass. ; the emery wheel of this grinder has an oscillating motion, so that each time the die being sharpened passes beneath it there is a change in the surface presented for grinding, thus ensuring an absolutely true ground surface. It is the intention of the Company to still further extend its works by the erection of an iron foundry in the rear of the main buildings. At present all the castings are made in the Allegheny factory, where also the Sawyer-Man incandescent lamps are being manufactured.

Between the main building and the wareroom is a brick and iron building, completely fireproof, four stories in height, 187ft. long and 25ft. wide, used as a paint shop, drying room, and oil house. Back of the main building is the temporary carpenter and box-making shop, 192ft. by 60ft. by 32ft. Alongside of the punch shop, and 300ft. east of the main building, is a blacksmith shop, and also a temporary brass foundry, the former 241ft. by 80ft. by 45ft., the latter 241ft. by 40ft. by 26½ft. The six principal and permanent buildings are of brick and iron fireproof construction throughout. The floors are slow burning, and designed to sustain 500lb. to the square foot. All the buildings are most pleasantly located and completely lighted by double windows 10ft. wide, situated every 16ft. along the side, and by large skylights every 32ft in the roof.

The arrangements for heating the buildings are of the most improved type. Steam radiators are located at points just under the roof, and 80in. Sturtevant blowers are used to force the heated air through distributing pipes 36in. in diameter at the heaters, and made gradually smaller as the air is distributed. There are two of these blowers in the warehouse, six in the machine shop, and one in the punch shop, all being driven by Westinghouse two-phase motors. For supplying the radiators exhaust steam from the engine is ordinarily used, but reducing valves are also connected so that live steam may be admitted to the pipes in case of necessity. Filtered drinking water is distributed throughout the various buildings by pipes connected to a 10,000 gallon filter. For the purpose of providing convenient and quick intercommunication between the various departments and offices there is a local telephone system, with instruments in each office, and a small exchange located in the west end of the warehouse. Long-distance lines connect the factory with the Pittsburg Central, and another local wire runs to the city office of the Westinghouse Company.

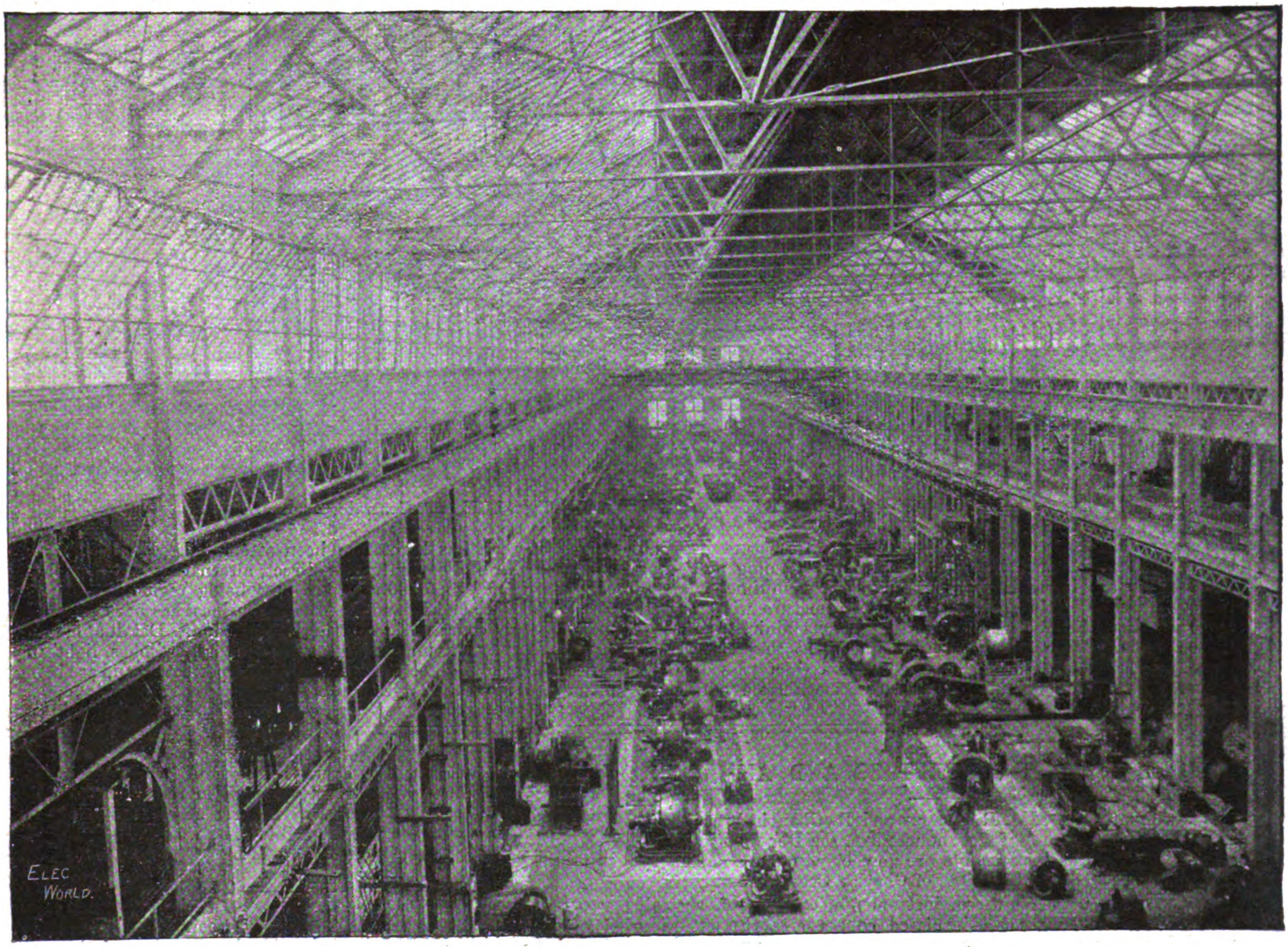

Fig. 1.—New Westinghouse Works at East Pittsburg, Main Aisle of Machine Shop.

All machinery throughout the factory is driven by two-phase electric motors conveniently placed. Despite the fact that motors are used for power, and that they are placed as near as practical to the machines they are to drive, there is necessitated, nevertheless, almost a mile of shafting in the machine shop alone.

Near the end of the main aisle of the machine shop is a new and large 122in. lathe, 30ft. between centres, made by Wm. Sellers and Co., Philadelphia ; the machine is shown (Fig. 2) boring the field of a 1,000 H.P. alternator and turning off the armature of a 1,050 H.P. direct-current machine, both at the same time. The Westinghouse Company has always made an object of having special tools for its work, thereby effecting economy in time and cost of manufacture and securing uniform and interchangeable parts ; for the new works many additional special tools have been designed, one of which noted in passing through the works, finishes off motor castings at one cut. For the purpose of making and repairing the

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tools required, there has been organised a very complete and extensive tool department, where over 130 employés are kept constantly at work making and replacing all sorts of tools, thus saving for the Company the profits which otherwise accrue to tool manufacturers. Another interesting department is the experimental room, where a number of the most capable men are constantly employed experimenting and carrying on original research. For their use has been fitted up a room most admirably adapted for its purpose. Here are conveniently available direct, alternating, and polyphase currents of any desired voltage, and of any number of alternations. There has also been erected a special glass-protected room for carrying on experiments with high potential currents running up to 50,000 and 60,000 volts pressure.

The entire arrangements in the factory are most admirably fitted for manufacturing apparatus quickly and with the minimum amount of labour. Take, for example, section "A," in which the street car motors are built. In one end of the section the armature discs and shafts are received and built up. The lathe turning and filing departments are immediately adjoining, so that no time or labour is lost in transportation. Next come the armature winders, and following them the men who are employed in machining and fitting up the fields. After the motors are assembled they are turned directly over to the testing department and then passed to the packers, so that the manufacture of these machines is an almost continuous operation from the building up of the armatures cores to boxing the motors for shipment. All the apparatus is manufactured in accordance with this same system, and in consequence there exists throughout the factory the most complete order and business-like *régime*. The organisation of the employés is equally thorough. There is a head foreman in charge of each of the general sections, and under him assistant foremen for the sub-divisions into which the work is divided. The system under which the men work and earn their wages is best fitted to make them industrious and energetic. The whole system has been most thoroughly studied and admirably developed and adjusted to meet the conditions for manufacturing on a large scale. In fact, in examining the operations of the factory one is impressed with the military-like organisation which everywhere prevails.

With the installation of the works at the new factory, the Company has undertaken the manufacture of a larger line of electrical apparatus than has heretofore been attempted. Every form and size of motor and generator for direct, alternating and polyphase currents, from $\frac{1}{8}$ to 5,000 H.P., are now being regularly manufactured. The arc and incandescent lamp business has been extended to meet every conceivable want in this direction. Detail apparatus such as fan motors, meters, current indicators, switches, lightning arresters, ground detectors, &c., have been perfected, and are being manufactured on the largest scale.

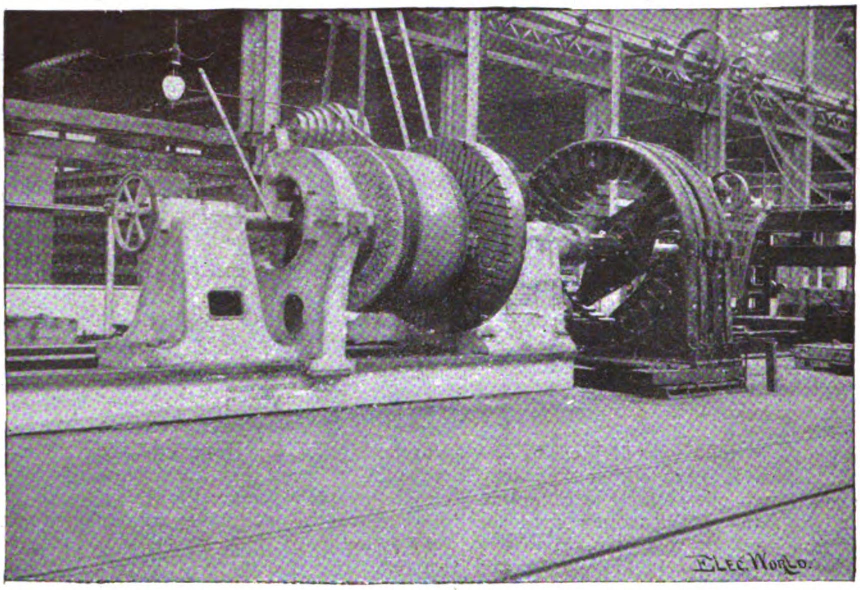

Fig. 2.—Boring a 1,000 H.P. Alternator Field and Turning a 1,050 H.P. Generator Armature.

ARNOUX-CHAUVIN VOLTMETERS AND AMMETERS.

A few months ago MM. R. Arnoux and R. Chauvin brought out in France some voltmeters and ammeters on the Deprez-d'Arsonval principle, and these instruments are now being made and sold by Messrs. H. M. Salmony and Co., of Charing Cross-road.

The moving part of these instruments consists of a small copper ring enclosing a silk-insulated copper coil, the enclosing ring being composed of two concentric strips of copper cut from an Elmore tube, the two ends of the silk-covered wire being connected respectively to the inner and outer copper strip. The idea of the copper strip is not only to give a certain degree of stiffness to the moving part, but to secure powerful electromagnetic damping. The copper ring is provided with two small steel pivots resting in jewelled bearings. Two spiral springs of non-magnetic metal bring the current to and take it away from the insulated coil, and develop at the same time the necessary opposing couple. The whole of the moving parts are encased in a flanged tube, which is shown in Fig. 1, with a portion cut away. Inside the copper ring, fixed by a brass projection to the enclosing tube, there is a steel bullet, the object of which is to concentrate the magnetic field. The magnetic field is obtained by means of a powerful tungsten-steel anchor-ring magnet, without pole-pieces. The inventors argue that pole-pieces not only increase the reluctance of the magnetic circuit, owing to the introduction of joints, but tend to give rise to stray field. The plain magnet, moreover, is cheaper and easier to make. The average magneto-motive force developed by the current traversing the coil and giving the maximum deflection of 90deg., is 1·8 ampere-turns. If we suppose this magneto-motive force to be uniformly ranged along the circuit of the magnet, the average length of which is 22cm., and to act as a demagnetising force, which in reality it only does when the pointer of the apparatus is near zero—that is to say, precisely when the current in the coil is at its weakest, the magnetising force under these conditions would be

$$H = \frac{4\pi n i}{10 \times 22} = \frac{4\pi \times 1\cdot 8}{220} = 0\cdot 1029\ ;$$

that is to say, the demagnetising force is about 400 times weaker than that necessary to reduce the residual magnetism of the permanent magnet to zero, and can only produce a variation of $\frac{1}{2000}$ in the value of this residual magnetism.

In the Arnoux-Chauvin voltmeters the moving coil has an average resistance of 75 ohms, and a current of 5 milliamperes is on the average sufficient to deflect the pointer through the whole length of the scale. In series with the moving coil there are, of course, resistances; for instance, the resistance of a voltmeter intended to measure up to 150 volts, with a deflecting current of 5 milliamperes, is 30,000 ohms, *i.e.*, 75 ohms of copper wire and 29,925 ohms of German silver wire outside the moving coil. It will thus be seen that the resistance of the copper wire of the moving coil is only $\frac{1}{400}$th of the total, so that the indications of the voltmeters are practically independent of temperature. These voltmeters are fitted with a reversing key, which enables them to be used if necessary as pole-finders.

In the ammeters the average resistance of the moving coil is 0 5 ohm, and an average current of 0·05 ampere is sufficient to deflect the pointer to the end of the scale. To measure larger currents than this 0 05 ampere the circuit of the moving coil is placed across the terminals of an appropriate shunt. These shunts as a rule consist of German silver strips 1mm. thick, carefully soldered at

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either end to blocks of copper provided with suitable clamping jaws (*see* Fig. 2). The galvanometer is connected to these shunts by means of flexibles, the two ends of which are provided with conical plugs fitting into similar conical holes at the ends of the shunts and at the terminals of the ammeter. It is thus impossible to make use of connecting conductors other than those provided, thus avoiding the danger of introducing undue resistance into the ammeter circuit. The inventors point out that the use of shunts enables a single instrument to be made use of over a wide range. A further advantage also is that with such instruments powerful currents may be measured at a distance from the circuit in which they are flowing without the use of heavy, clumsy cables. Instead of adjusting each shunt to each ammeter, a system of interchangeable shunts has been devised. All the ammeters have a German silver resistance in series with the moving coil, the total resistance being regulated so that when the pointer receives its maximum deflection the difference of potential which exists between the two ends of the flexibles is exactly 0·04 volt. On the other hand, the resistance of each shunt between the conical

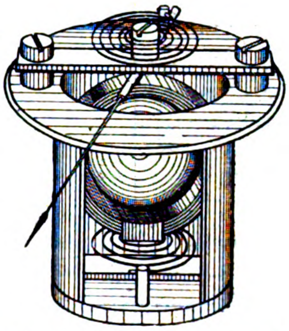


Fig. 1.—Working Parts of Arnoux-Chauvin Voltmeter.

plugs is made such that it is equal to 0·04 volt divided by the maximum current for which the shunt is intended, so that when the maximum current is passing through any shunt the difference of potential at its terminals is the same as that which gives the maximum deflection upon any ammeter. By this plan, when any shunt is connected to any ammeter, the value in amperes of the graduations of the instrument is arrived at by a simple calculation. For example, each division of an ammeter scale which is divided into 150 divisions corresponds to 4 amperes when the instrument is employed with a shunt stamped 600 amperes.

Another feature of the Arnoux-Chauvin voltmeters and ammeters, due to the powerful magnetic field in which the moving coil is

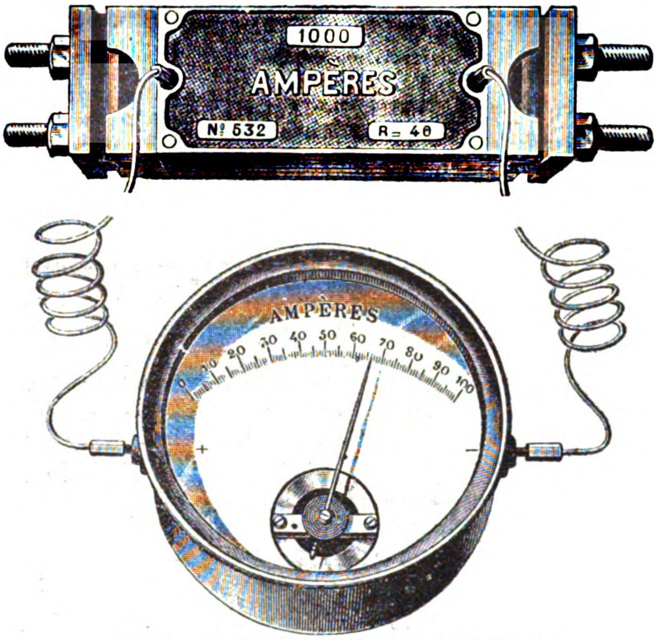
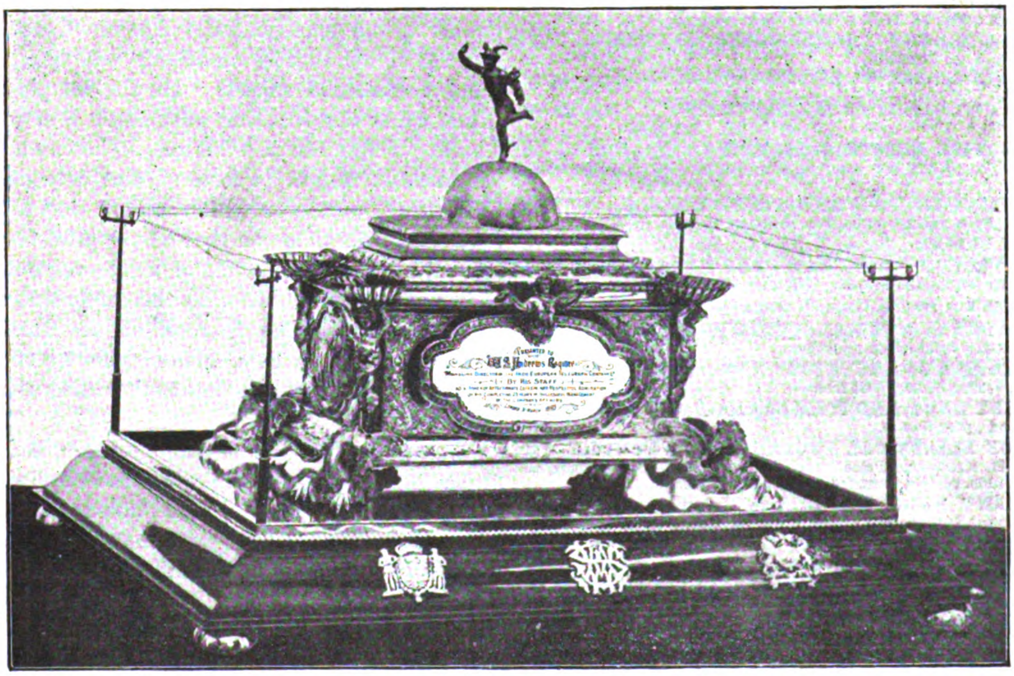


Fig. 2.—Arnoux-Chauvin Ammeter and Shunt.

placed, is that they are but very slightly affected by powerful currents in their neighbourhood. Thus a voltmeter when in circuit was placed against a cable through which 200 amperes were flowing, and the needle was not deflected more than $\frac{1}{10}$th millimetre on a scale 100mm. long, when the 200 ampere current was made and broken.

PRESENTATION TO MR W. S. ANDREWS.

As briefly mentioned in our last issue, the staff of the Indo-European Telegraph Company recently presented to Mr. Andrews, the Managing Director, a beautiful silver casket, to celebrate the twenty-fifth anniversary of the day when he assumed the direction of the Indo-European Company's affairs. During his long connection with the Company, Mr. Andrews has rendered great and valuable services to the proprietors in bringing the different departments of the service to an exceptionally high degree of efficiency; he has consolidated the various interests of the Company, and has thus brought it to its present high financial position. Whilst looking carefully and minutely after the interests of the Company, Mr. Andrews has always studied the wants and requirements of the public and the Press so far as compatible with the obligations of his Company under the International Telegraph Convention, and towards the various telegraph administrations in connection with whom the Indo-European line is working. The illustration shows a front view of the casket, all sides of which are engraved with apposite subjects.



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Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "Coutts and Co."

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"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices.*

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THE ANNUAL GENERAL MEETING OF THE TRAMWAYS INSTITUTE.

The keynote to the Annual General Meeting of the Tramways Institute, which was held last week, was given by a single sentence of the re-elected President's address. "It does not appear that anything new in the way of traction has been introduced." From the practical point of view this sums up the whole matter. But Mr. CARRUTHERS-WAIN in the course of his address dealt ably with the position in its legal and commercial aspects. He showed that since November last, when the Institute authorised him to bring under the notice of the Board of Trade "how much means of communication might be fostered and extended if the tramway companies were allowed fair play," that a favourable impression had been made on that all-powerful Government Department, and that the Board of Trade was now prepared to give favourable consideration to the important question of tramway traction. The Council of the Institute, he further added, had acted as a brake upon all efforts at legislation "which could have no result other than that of stopping all enterprise."

In common with most other speakers, Mr. CARRUTHERS-WAIN made out a strong case against the acquirement of the tramways by municipalities, and quoted Glasgow, Huddersfield, Plymouth and Leeds to prove that in no case had a municipal authority succeeded in making real profit. "They were all," he said, "working at a dead loss." It was true that the Glasgow Corporation claimed to have made a profit and to have paid it into a "common good" fund. The profit, however, was visionary. No President of the Tramways Institute is indeed likely to be in favour of municipalisation, but there is no gainsaying that so far municipal authorities have failed to show their capacity for dealing with tramway work, although

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they have the advantage of borrowing money at a cheap rate. Electrical engineers, moreover, have to remember that electric traction in this country needs every possible help. Local authorities have never been pioneers, and they are not likely to prove so in the matter of electric traction, although they will no doubt be quite willing years hence to take it up when private capitalists have shown them the way. It is to private enterprise that we owe the vast majority of our great public improvements from the New River Water Company to Central Electric Light and Power Companies, and such electric traction as we have is due to the same source.

Turning to practical matters, we notice that the usual new accumulator was on the *tapis*. We have no practical acquaintance with the I.E.S. storage battery, and such appears to have been the case with Mr. Scott Russell. Mr. Percy Sellon, however, says that the battery compares with the E.P.S. and the Epstein batteries, and "commends itself to every practical man." But as no tests have been made with these plates for traction purposes, it is evident that this is a pious opinion. The output for a given weight claimed by the makers is very high—at least twice as great as that ordinarily obtained, if we understand the figures rightly. Additional interest is given to this battery because Mr. William Neale, the Chairman of the Birmingham Central Tramways Company, expressed his intention to permit Mr. New to try it as soon as arrangements could be made. An admission of this gentleman in connection with the Birmingham line is not encouraging for the future of self-contained electric cars. His Company, he said, "had a good system of accumulators. Unfortunately that method had proved a great loss, not because of any inherent defect in the system, but probably because it was a suburban line and there was not a great deal of traffic for it to deal with." We should have thought that this was exactly the line on which accumulator cars would show to the best advantage. If they cannot pay here we fear there will have to be something like a revolutionary change in batteries before the self-contained car is a commercial reality.

Mr. George Cawley's Paper on the Thwaite-Cawley conduit system was received with some distrust. At a first glance it certainly seems a doubtful procedure to place the motor in a culvert with a slotted rail above it. The dummy has also many objections, although its use is apparently only necessary when ordinary horse cars are used as trailers. If the rolling stock were designed specially for the work no doubt the car under-carriages would be made sufficiently strong to bear the strain of the connecting bar and the gear appertaining to it. The scheme is of course only intended for use in towns, and possibly as an adjunct to a conduit line. We agree with several of the speakers that it is mere waste of time to discuss proposals of such a radical character before they have been put to the test of practice.

Reviewing the proceedings of the meeting we cannot find that anything of practical importance was elicited. That a certain amount of discussion should precede the actual application of an engineering innovation, is of course, to be expected and indeed to be desired, except possibly in America, where they apparently prefer the immediate adoption of novelties *nemine contradicente*, and to discover defects in practical operation. At the same time we must own to a feeling of weariness at the everlasting talk about electric tramway traction in this country and at the very little progress made.

It is now some six or seven years since electric tramway traction first began to get a firm hold in the United States, and to-day our American friends revel in tremendous totals of cars, horse-power, and motors. In England, on the other hand, the mileage of our *bonâ fide* electric street tramways approximates to the exceedingly modest figure of ten. We can certainly console ourselves with the progress made in underground and overhead electric railways, but this is likely to remain a restricted field, and it is upon the extensive application of electricity to ordinary street tramways that the future of electric traction in this country must mainly depend.

NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(*Continued from page 301.*)

Capacity Tests (*continued*).—The mixed-charge test is made with the slides, as in Fig. 135. The condenser and cable are shown connected respectively to two levers, which when at rest make contact with the upper studs, so connecting the condenser and cable together. When the levers are put into contact with the lower pair of studs (by pressing down K) the condenser is connected to one end of the slides and the cable to the other. As the opposite surfaces of the condenser and cable and the movable contact of the slides are to earth,

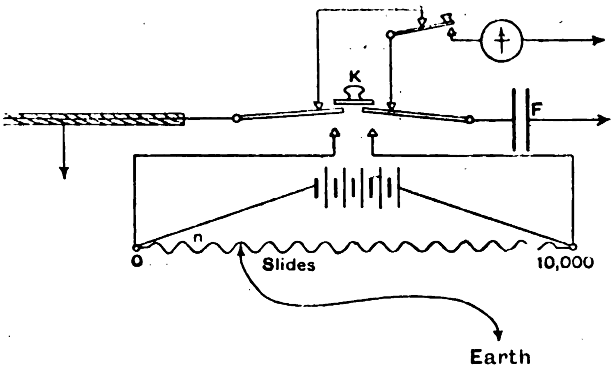

Fig. 135.—Mixed Charge Test.

it follows that when the levers touch the lower studs the cable and condenser are charged at potentials depending upon the position of the slides. After charging, the key K is released, so connecting the cable and condenser. If the charges received by each have been equal they will mix and neutralise each other, and the galvanometer will show no deflection on closing the key connected to it. If any deflection is noticed the slide contacts are shifted until a point is found at which the condenser and cable receive equal charges, as proved by their completely neutralising each other and leaving no residual charge which can affect the galvanometer.

The charges being equal, it follows that the respective capacities are inversely proportional to the respective differences of potential acting on each. The difference of potential acting on the cable and condenser respectively are in the proportion of the slide reading n to $10,000 - n$. Therefore the capacity of the cable is equal to

$$F\left(\frac{10,000 - n}{n}\right) \text{ microfarads,}$$

where F is the capacity of the standard condenser.

Lambert's key for this test is illustrated in Fig. 136. Both levers are pressed down at once by the insulated knob A for "charge," and on releasing A the cable and condenser are connected through the bar B and the charges mixed. The galvanometer is afterwards put in circuit by the small key shown, which connects the galvanometer with the bar B. This key is arranged to put only the condenser in circuit with the

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galvanometer, as shown in Fig. 135, in order that the more prolonged discharge from the cable due to its greater absorption may not appear on the galvanometer and affect the conditions of balance.

The "Silvertown" mixing key, designed by Mr. W. A. Price, is illustrated in Figs. 137 and 138. Two contact blades *a* and *b* are rigidly connected at their fulcrum by an insulated bar. A handle is attached to the bar, by means of which the blades can be moved up or down. The blades are connected respectively to the cable and condenser. The insulated handle is raised to "charge," which moves the contact blades downwards, making rubbing contact with the two outside blocks *c* and *d* connected to the slides. For mixing, the handle is pushed down, when the contact blades are raised and touch the middle block *e*, thus connecting the cable and condenser. A small key is provided for putting the galvanometer in circuit.

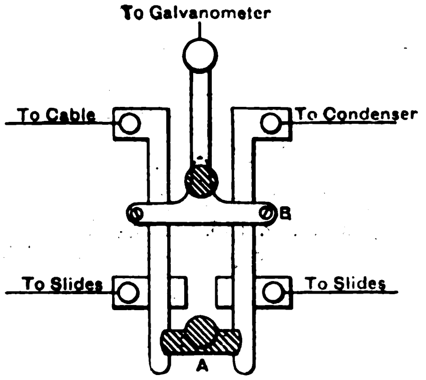

Fig. 136.—Lambert's Key.

In Gott's test the cable and standard condenser are connected to the slides, as in Fig. 139. The battery having been connected to the slides, the charge key is closed and balance obtained by adjusting the slides and tapping galvanometer key until a position is found (say *n* divisions from slide zero) at which the galvanometer is unaffected. The condenser and cable are then, as in the last test, charged with equal quantities, and we have, as before, the capacity of the cable equal to

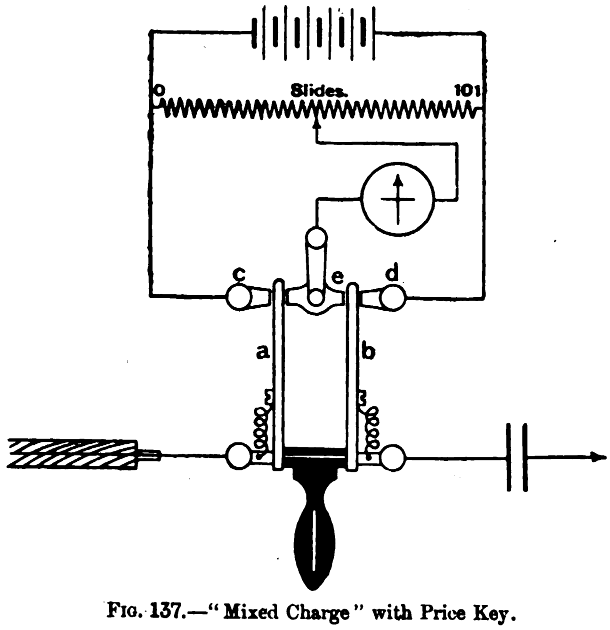

Fig. 137.—"Mixed Charge" with Price Key.

$$F\left(\frac{10{,}000 - n}{n}\right) \text{ microfarads,}$$

where F is the capacity of the condenser.

Dr. Alexander Muirhead has shown in *The Electrician*, Sept. 5, 1890, page 487) that the above formula is correct only when the balance has been obtained immediately after "charge" and before the difference in the absorption of the cable and condenser has had time to take effect. If there is delay in obtaining balance or reading on the slides, more charge will be absorbed, the potential V at the junction of cable and condenser will vary, and the apparent capacity of the cable will be increased. A certain time must, however, be allowed for the cable to charge, and Dr. Muirhead's correction overcomes the obvious difficulty of balancing to exactly the necessary time, as it is applicable to any period of charge. The test, with the additional observation for making the correction, is best made with the key designed by Mr. H. A. C. Saunders, Electrician-in-Chief of the Eastern Telegraph Company. It will be seen by the illustration (Fig. 140)

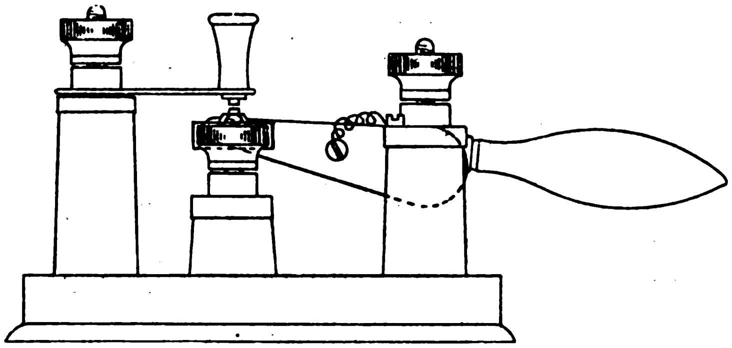

Fig. 138.—Price's Mixing Key.

that this key has two levers with two separate back stops and two front stops. The connections are as in Fig. 141. When the right-hand key is put down the condenser and cable are charged from the 10,000 end of the slides. The galvanometer key is then tapped and the slides adjusted until there is no deflection. The left-hand or discharge key is then put down, this action automatically lifting at the same instant the right-hand key. This is effected by a small ebonite rocking bar pivoted centrally underneath the levers, and shown in the illustration. This bar prevents both keys being down at the same time, which would cause a large discharge through the galvanometer, and upset the test. Its action in the test is to raise the right-hand or charge key at the same moment as the left-hand or discharge key is put down.

The charge key, when raised, puts the condenser to earth, and discharges both cable and condenser, but the point V (between cable and condenser) has still a potential above the earth, owing to the oozing out of the charge which has been absorbed by the dielectrics. It is this potential which produces a discharge deflection (hereafter called the absorption discharge

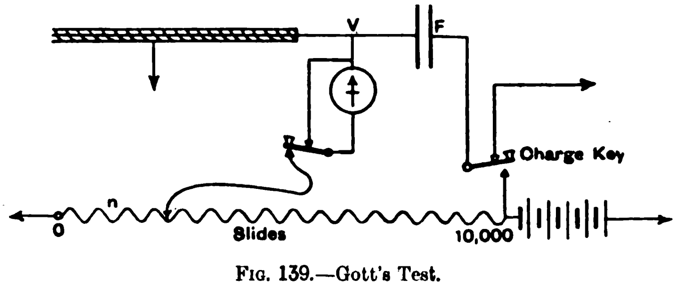

Fig. 139.—Gott's Test.

through the galvanometer to earth when the left-hand or discharge key is put down. The action, therefore, of pressing down the left key, and so raising the right key automatically at the same moment, is to obtain the absorption discharge immediately after the condenser has been put to earth. Dr Muirhead states that if the absorption discharge is not measured at once, before the oozing out of the charge absorbed by the dielectrics begins, it will slowly change and a wrong value be obtained—in other words, that the earthing period, or time allowed to elapse between the moment of putting the condenser to earth and the moment of reading the absorption discharge, should be nil, or as small as possible. On the other hand, Mr. Arthur Dearlove, in an able Paper on this test

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and its correction (*The Electrician*, March 6, 1891, p. 537) as applied to long cables, recommends an earthing period of three to four seconds for cables of from 1,000 to 1,500 knots length before taking the absorption discharge.

It only remains to put the absorption discharge (d) in terms of the slides in order to apply the correction to the slide reading n. This is done by running back the index of the slides nearly

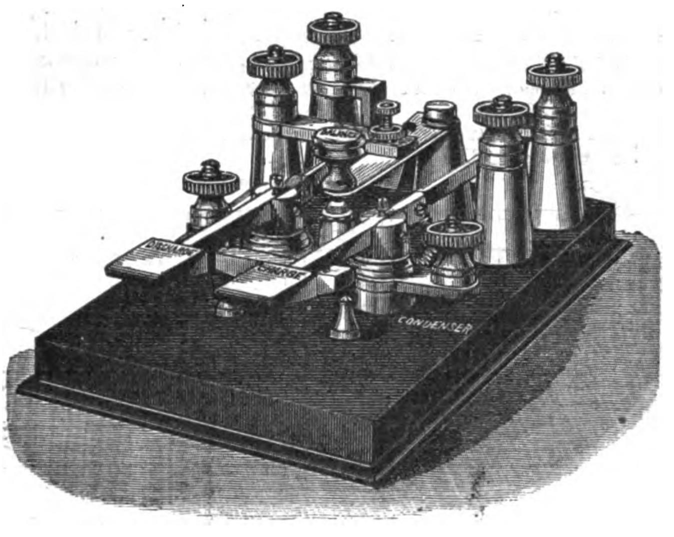

Fig. 140.—The Saunders Key.

to zero (the earthed end) and closing galvanometer key. The discharge lever of the Saunders key being still down, we have a deflection due to the potential difference between the index of slides and earth. The index is moved until this deflection is equal to the absorption discharge, the slide reading then observed being, say, p divisions. It is not necessary to repeat the deflection exactly. For instance, supposing we obtain a

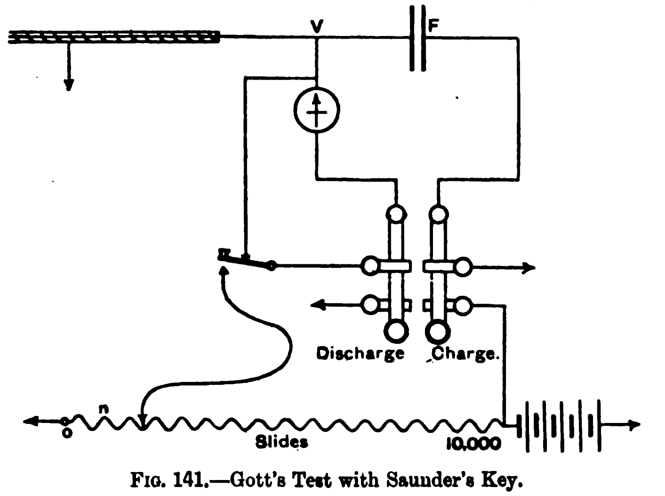

Fig. 141.—Gott's Test with Saunder's Key.

deflection d_1 with slides index at p_1, then the correct slide reading equivalent to the absorption discharge is

$$p_1 \frac{d}{d_1} \text{ divisions.}$$

If the deflection produced by the slides is *opposite* in direction to that of the absorption discharge, the slide reading p must be subtracted from the first slide reading n; if in the *same* direction it must be added.

The formula, with correction added, may therefore be stated as

$$\text{Capacity of cable} = \text{F}\left(\frac{10{,}000}{n \mp p} - 1\right) \text{ microfarads.}$$

Dr. Muirhead's article in *The Electrician*, above referred to, should be consulted for a further study of the subject.

(*To be continued.*)

THE HILL LONG-DISTANCE SUBMARINE CABLE SWITCH.

In working recorder on long cables it is found that sending through condensers, as well as receiving through them, improves the signals. It does not follow, however, that the same capacity which is used for sending through gives the best results when in the receiving circuit. At the Eastern Extension Company's Hong Kong station it is found that in working direct with Singapore, through a cable of about 2,000 knots, the best results are obtained when sending through 80 microfarads,

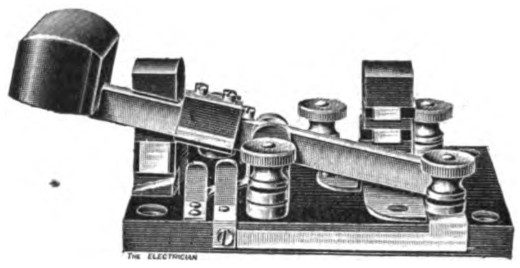

Fig. 1.—General View of Switch.

and receiving through 40. Now the ordinary recorder switch does not readily allow of connecting up in this way, and to avoid using separate condensers for sending and receiving (necessitating 120 microfarads in all), Mr. Alexander Hill, of the Eastern Extension Company, devised the following arrangement:—

The switch shown in Fig. 1 is the ordinary tumbler one in general use at cable stations, with two additional contacts which connect all the condensers together when the switch is to

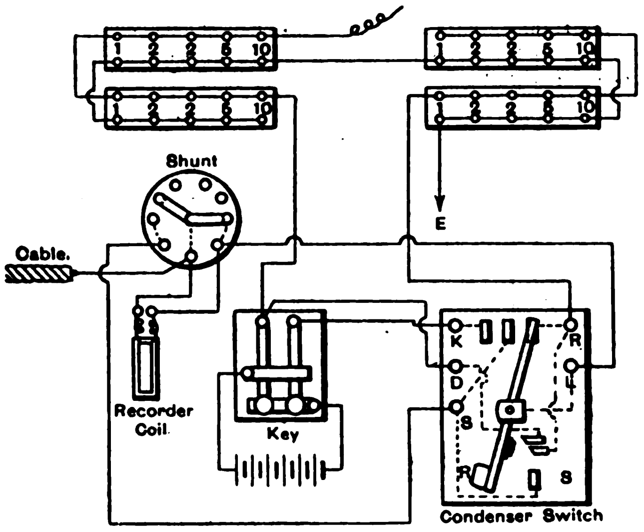

Fig. 2.—Diagram of Connections of Switch.

"send," but leave either the same or a prearranged number in circuit when the switch is to "receive." This is accomplished by the insulated piece of brass, carried by the lever, connecting the two springs connected to terminals D and R (Fig. 2). To prevent a sudden kick to the coil when the lever is moved, the middle back contact (usually connected to terminal D) is now connected permanently to the sending shunt terminal.

SOME WORK ON MAGNETIC HYSTERESIS.*

BY FRANK HOLDEN.

Having read the description of Prof. Ewing's latest apparatus for determining the hysteresis loss in sheet iron, it seemed that an account of work done some time ago in very much the same direction would be of interest.

During the last few weeks of the year 1892 there was built at the works of the General Electric Company, in Lynn, Mass., under

* *Electrical World* of New York of June 15, 1895. Two illustrations of the hysteresis meter have been omitted.

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methods of traction were concerned, he had found no system equal to steam, the use of which he originated in Leeds.

Mr. W. MASON, Director of the Bradford Tramways Company, referring to the municipal working of the Leeds tramways, said that he had seen a report for a period of 14 months' operation. The Corporation, he remarked, obtained their money at 3 per cent., had worked the lines for 14 months, and over and above what they had to pay for interest they had earned £56 ; and at the same time this result was on a capital which was only half that of the Company.

Mr. J. PLATT, of Southport, said that in that town horses were better than engines. That was due to the fact that if they had six horses, and if, during any part of the day, there was a rush of traffic, they could turn out three cars with those six horses, but they could not do so with one steam engine.

Mr. SCOTT RUSSELL remarked that it appeared that Mr. Laws, in setting about his report, started with the idea of making it in favour of the cable system, and that he prepared it with that object. If Mr. Laws had reported favourably on the cable system as being suited more to the requirements of Newcastle, no one could have said anything ; but the speaker submitted that the author seemed to have given himself the mission to find out what was the best system for all purposes, and that he had picked all the holes he could in all systems except the cable. It was unnecessary for the speaker to say anything of the underground conduit system, although Mr. Siemens had entirely demolished the arguments against it. Mr. Siemens had said that the slot system could be made $\frac{1}{2}$in. wide if necessary. Well, that was narrow, and was even narrower than was demanded by the Board of Trade. In connection with the series system at Northfleet, the slot was $\frac{5}{8}$in. wide, and no difficulty was experienced in regard to the width of the slot during the period of working for one or two years. There was not the slightest doubt that the conduit system could be worked with a slot of $\frac{5}{8}$in. or $\frac{3}{4}$in., which he thought would be the limit allowed by the Board of Trade. He thought the slot system would be likely to have a good future for it in this country.

Mr. PERCY SELLON thought that Mr. Laws had been misled in many directions which he would not have been if he had proceeded to the proper source to obtain his information. Many details which the author of that report had required of the Buda Pesth line had been furnished to him by Mr. Colam, whose views appeared throughout the greater part of the report. For instance, in March, 1892, in a discussion before the Society of Engineers, Mr. Colam had suggested that in time the wheels of the car would slip into the slot ; those words were repeated in Mr. Laws' report. The speaker stated, however, that no instance had been given, even in the case of the wide slot at Buda Pesth, of a car wheel dropping into the conduit. Perhaps the circumstances of Mr. Laws' report had led him to make one or two misstatements. Let them take the statement that the cable was the only thing of use in Newcastle on account of the narrow streets. The cable system, the speaker submitted, was not a proper method for the crowded and narrow streets, as at Newcastle. The electric car had an infinitely better governing capacity than that of the travelling cable, for the reason that the driver could not stop the car in the same regular fashion in the latter case as he could when using electricity. He could not see how the point was made that it was more dangerous to use an electric car on the slot or conduit system than the cable with its slotted conduit. The amount required for the installation and cable equipment as suggested by Mr. Laws would be so great as to absolutely prevent any profits accruing through the adoption of the system at Newcastle, for the reason that the cable could only be introduced in certain cases ; whereas in other streets outside the congested area a different method would have to be adopted. He suggested, therefore, that Mr. Laws' report could not commend itself to the consideration of tramway people.

Mr. WILLIAM TURTON, rising in connection with the Newcastle tramways, said that he had worked them with horses at a good profit for 16 years. It seemed that Mr. Laws thought the cable system would be more profitable, and he had therefore to make out the best case possible ; that he had done with help from London. The speaker was quite sure that the cable system would not do so well for Newcastle, as there was not enough traffic for it. If he had been permitted in Newcastle to have proceeded with the introduction of steam cars, he thought there was nothing could have equalled them.

Mr. WILLIAM NEALE, Chairman of the Birmingham Central Tramways Company, said that he represented a company which had steam, horse and electric cars and the finest cable line yet laid down. He differed from the opinions which had been expressed in connection with steam engines. His Company, which had three steam lines, would be glad to turn off every steam car and substitute the cable system. The use of the latter method did not necessitate the employment of so large a number of men as was the case with steam cars, and the only drawback to the system was that if anything went wrong the whole line was brought to a standstill until the repairs had been executed. In regard to the electric tramway, the Company had a very good system of accumulators. Unfortunately that method had proved a great loss—not because of any inherent defect in the system, but probably because it was a suburban line and there was not a great deal of traffic for it to deal with. Although speaking in favour of the cable system, that method would not do for the Bristol road line, because there was not sufficient traffic to pay for the initial cost of putting down the cable system. He quite agreed that the accumulator system had a great future before it, and with a reduction in the weight of the batteries he believed that method would run the cable very hard. The Company's horse lines were a loss every year, and if the Corporation would give permission, the horse cars would be withdrawn.

Mr. A. DICKINSON said that if they could run steam locomotives on the roads without the restrictions of the Board of Trade, he would agree that the method was as cheap as with electricity. But it was the difficulties introduced by the Board of Trade in the direction of regulation of speed, governing and the destruction of the steam by condensers which militated against that object. In Birmingham steam cost about 7d. a car mile and cable 4d.

The Thwaite-Cawley Conduit System.

Mr. GEORGE CAWLEY next read a lengthy Paper on the "Thwaite-Cawley System of Electric Haulage." In bringing forward this method, the author said he would submit a general outline of the system, leaving the arrangement of the details for any particular line to be subsequently determined. Bearing in mind the opposition on the part of local authorities to the trolley system for urban traffic and the large dead weight and high working cost of accumulator cars, the author submitted that some form of conduit system was likely to be adopted for town traffic in this country. The special feature of the system lies in the transfer of the electric motors from the car to the conduit, with the result of obviating the necessity of using heavier rails and stronger and heavier cars. The accompanying figure, which is a cross-section of the culvert and rail bed, and shows the hauling locomotive in position upon the culvert rails, gives a good idea of the method proposed. In the system in view a dummy is employed driven by the flat bar shown passing upwards through the slot, and affixed to the hauling locomotive in the culvert, and by a short link or connecting piece to the ordinary spring draw-bar of the tramcar. The dummy is equipped with the switches, rheostat and other controlling apparatus for regulating the locomotive running below it in the culvert, together with a hand-brake lever and spindle for stopping the car. The passage of the current to and from the dummy is effected by means of insulated flat copper strips embedded in the driving bar passing through the slot. The culvert represented in the figure is 2ft. 9in. wide and 2ft. 6in. high. Thus the culvert is sufficiently large for a man to get along it for examination and repairs. The culvert may be constructed with the floor and sides either of brickwork or concrete or of metal. As shown in the illustration, it is intended to be made of either wrought iron or steel. The width of the slot is $\frac{5}{8}$in., and the driving bar is $\frac{9}{16}$in. in thickness. The two girders forming the slot are kept equidistant and rigid by means of tie bolts connected to the webs of the tram rails, and also by angles riveted to the culvert plates and embedded in the concrete forming the culvert foundation. It will be seen from the cross-section that longitudinal wooden sleepers rest upon the floor of the culvert, to the sides of which they are bolted. Along the sloped roof of the culvert are placed at suitable intervals notched supports for carrying insulated feeders. The return portion of the circuit can be formed by an insulated conductor, with feeders similar to the conductor carrying the current from the generators to the motors. As will be observed, these conductors are made of a dovetailed section of channel iron. The conductors are held in position by means of porcelain insulators bolted to the roof of the culvert. Each rigid length of conductor is separated by an arranged distance from the adjoining rigid lengths, but is electrically connected by bow-shaped strips of copper. The E.M.F. proposed to be used is 500 volts. The current at this pressure can be conveyed to and from the motors by a pair of trolley wheels or by a single trolley wheel—where the return circuit is made by the rails—running along the conductors and kept in contact by means of a spring. The circuit connection between the culvert conductors and the motors can, however, be made by means of a slider or tongue-piece arranged to slide along the conductor. To the upper part of the hauling locomotive is attached a lever which carries a pair of wheels running against the lower flange of the slot girders. These wheels press upwards on their rail bed with a force in some arranged degree proportional to the tractive effort required to haul the car. Consequently when starting the car, or when the latter is ascending a gradient, a considerable downward force is thrown upon the locomotive wheels in addition to that due to gravity, and their tractive capacity is thereby increased. In order that this downward force may be maintained within safe limits, the fulcrum of the lever carrying the upper pair of wheels is made to rest upon a kind of spring buffer head which yields when a pre-arranged load is put upon the wheels ; and in that way any undue strain on the lever or culvert is prevented. A reference to the figure will show that the upper surface of the rails within the culvert is some distance above the bottom of the culvert. This arrangement allows of the hauling locomotive to be partly located below the rail level, and smaller driving wheels can, therefore, be employed than when the motor armatures are mounted upon the car axles, as is usually the case when gearless motors are used. The adoption of small driving wheels of this kind allows the motors to run at a higher speed, and to give a greater commercial efficiency than would be conveniently possible with a gearless motor fitted to the car axles in the usual manner. The wheels shown are slightly under 8in. in diameter. This size of driving wheel, when the car travels at a speed of eight miles an hour, enables the motors to run at not less than 352 revolutions, and at 12 miles an hour, 528 revolutions per minute, a speed which may be considered satisfactory for a direct connected motor. As regards the approximate cost of construction, if the making of the line is not materially interfered with by buried pipes, this comes out at about £12,000 per mile of single line complete, including paving, tramway rails, and the concrete bed, half of this sum being for the culvert proper. This estimate does, of course, not include the construction of the hauling locomotives. If it be desired, the dummy cars may be left out of consideration, and the controlling and brake regulating apparatus can be erected on the passenger car.

The I.E.S. Battery.

Mr. ANTHONY G. NEW then presented a Paper on "The I.E.S. Storage Battery for Lighting and Traction." In this particular type of plate the conductor, the author pointed out, was formed of lead shaped into a grid somewhat like a comb. The active material being laid on, the plate is then slipped into a perforated envelope of celluloid, which it fits closely. The plate is then ready for use, and after its first formation

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by charging it becomes a solid and compact plate, capable, however, of free expansion and contraction. As far as the lighting of tramcars is concerned, some figures are forthcoming of the annual cost of illuminating the cars recently equipped on this system for the North Staffordshire Tramway Company. The battery in this case weighs 54lb. for each car, and has a capacity of 40 amperes at 16 volts. The charging current for each battery charge is 800 watt-hours, or 1·072 E.H.P. hours. If the actual cost of generation is considered as 2d. per electrical horse-power, this represents a cost of 2·144d. When fully charged, the battery is capable of lighting one lamp of 5 c.p., two of 3½ c.p. and two of 2½ c.p. for 11½ hours, giving for that period a total light of 17 c.p. The cost per car hour is 0·1861d., and assuming 2,000 working hours per annum, the yearly cost for current is £1. 11s. per car. Under the present arrangement the tramway company hires the equipment at the rate of 2s. 6d. weekly per car. This means an annual addition of £6. 10s. per car, and including interest on the capital expenditure for plant and fittings at 5 per cent., the yearly cost works out at £8. 14s. 9d. per car. If, however, the company was to purchase the car equipments the total annual cost, after allowing 10 per cent. for depreciation and 5 per cent. interest on the extra outlay, would only be £3. 11s. 9d., as compared with £8. 14s. 9d. The author then gave estimates of the cost of battery traction.

The PRESIDENT, in reply to Mr. Scott Russell, said that the directors of the Birmingham Central Tramways Company intended to make a trial of the I. E. S. batteries, but that owing to the unfortunate accident which resulted in the burning down of the generating station they had not yet been able to place Mr. New in a position to demonstrate the capabilities of that type of battery. The Chairman of the Company was, however, willing to permit the projected experiments to be carried out as soon as possible.

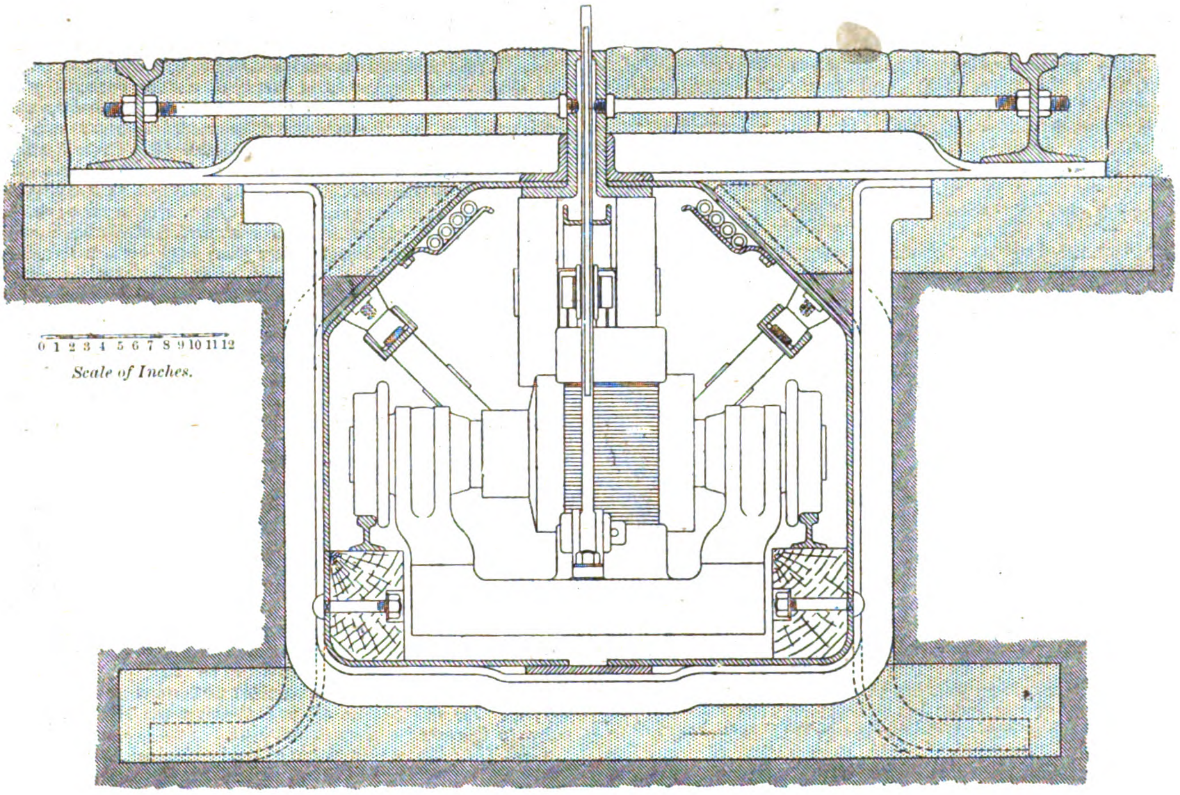
Mr. SCOTT RUSSELL submitted that as the batteries had not been tried in practical work the figures as to working costs were of no practical value. As far, however, as he understood the Paper, it was claimed that three times the electrical output was obtained as compared with other batteries. If that could be accomplished it would be an immense step in advance. He did not know that they could criticise it; the only thing they could say was that the promoters had not done it. With reference to the Thwaite-Cawley system, he failed to see any advantages beyond what they had already. It appeared to him that a conduit of that size must be more expensive than that at Buda Pesth or similar conduits. The fact of having all the working plant underground, where it might be affected by dust, dirt and water, &c., would be a great objection to the method. He failed altogether to see the advantage of the trolley in front. He thought all engineers had agreed in abandoning it. The advantage had been put forward of utilising existing cars, but he opined that anyone who had seriously attacked the problem would consider it better to start with a new and satisfactory plant throughout.

Mr. PERCY SELLON remarked that he had the same difficulty as the previous speaker in criticising any proposed new method of traction which had not received a distinct trial. The author wanted them to fall in with the suggestion that instead of having the motors on the car they should place them underground in a channel, dragging the car, similar to the traction adopted in the cable system. He had great difficulty in seeing where the advantages claimed for the system could possibly be. It had not been tried, but it might be they would see it put down and at work. As to the proposed use of gearless motors, as the conduit was very confined, he was afraid the author would have some difficulty in placing such a motor of sufficient power within those limited dimensions. It seemed to him that the Paper had not been put forward in a manner worthy of commendation. The systems brought before them should have money spent upon them and be shown in operation, so that a practical man could judge for himself what their likelihood of success would be. With regard to Mr. New's Paper, they were offered a battery which compared with the E P S. and Epstein accumulator, and which commended itself to every practical man. He hoped to see the batteries introduced on some line.

Mr. A. NEW said that only the latter portion of his Paper dealt with traction. The figures given in regard to lighting from the batteries could be taken as correct, and that particular type of cell was the accumulator which should be used. With reference to the Thwaite-Cawley system, he would like to know how the conductors were carried up from the motors so as to be controlled by the man on the car.

Mr. G. CAWLEY, in reply to the discussion, said that one of the advantages of the system was that the car was taken as it was, and it was not required to place the motors on the car. The method was not put forward as against the overhead system; it was submitted as a possible something which might be taken up in connection with the conduit system. As to the question of a sufficiently powerful motor, the cross-section showed that as the rails stood above the culvert bottom they could have any depth below the armature spindle which was thought proper. One advantage of putting the rails in the culvert was that they could carry the motor down below the rail level, and in that way they could get small wheels and have a large and powerful motor. He thought the culvert could be kept free from dust. Any dirt or dust falling through the slot fell into a shoot and dropped down towards the end of the motor. Concerning the means of conveying the current from the dummy down to the motors, a double slot was made in the bar, with two strips, along which the current passed up to be regulated and down again to the motor. The system was advanced as applicable for towns, but was not intended for use outside towns.

A vote of thanks to the President concluded the proceedings.



Cross-section of Thwaite-Cawley Conduit.

BOOKS RECEIVED.

"Proceedings of the Northern Society of Engineers." Vol. I., for the year 1894. (Manchester: B. Eastwood and Co.) Price 5s.

"Proceedings of the Royal Society." Vol. LVII. No. 346. Price 2s.

"Elektro-Metallurgie." By Dr. W. Borchers. (London: Williams and Norgate). Price 6s.

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PARLIAMENTARY INTELLIGENCE.

THE STRAND DISTRICT ELECTRIC LIGHTING ORDER CONFIRMATION BILL.

Last week, before a Select Committee of the House of Lords, presided over by Lord Camperdown, the Strand District Provisional Order Confirmation Bill was dealt with, the promoters being the Charing Cross and Strand Electricity Supply Corporation, and the opponents the Metropolitan Electric Supply Company. Mr. Pember, Q.C., and Mr. Claude Baggallay appeared as counsel for the promoters; and Mr. Cripps, Q.C., and Mr. J. D. Fitzgerald represented the Metropolitan Company.

Mr. PEMBER, in opening the case for the promoters on Monday, said that the proposal before the Committee was to confirm a Provisional Order issued by the Board of Trade to supply electricity within the district of the Strand Board of Works, which was at present supplied by the Metropolitan Company, and which had the monopoly of supply by the alternating current with very high tension. The Charing Cross Company was one of the numerous companies which supplied with direct current and at low tension. He detailed the steps which had been taken to obtain the consent of the Board of Works and the Board of Trade to the Order, and said that the objection of the Metropolitan Company, who were monopolists and were the only petitioners against the Order, was obviously unreasonable. A large number of the inhabitants and most of the important consumers of electricity in the district had petitioned in favour of the Order, as they thought that the price, quality, and quantity of supply, and the general efficiency of the electric supply in the Strand district, would be favourably influenced by the competition. Up to the present time he believed no satisfactory motor for the use of electricity supplied by alternating currents had yet been invented, and for motive power they must have the direct current at a low tension. The whole question of electric supply had been settled on the basis of competition as recommended by Major Marindin, who held the inquiry in 1889, and who thought the competition should be limited to two companies in one and the same district; but he particularly emphasised that the one company should supply by the alternating current and the other by direct current. Dealing with the petition of the Metropolitan Company, which stated that they were prepared to supply the district on both systems, he said that if they were to supply some people on the direct current and some upon the alternating they must have duplicate sets of mains, which must be carefully isolated the one from the other, which would entail extra cost and inconvenience.

Mr. SEALE, the Secretary and General Manager of the Charing Cross Company, was then examined in support of the Order, and, after giving financial details of the Company and the cost of the supply, said it was an advantage that there should be competition in the district. Apart from the question of price, in the case of a breakdown of one Company's system the consumers would be able to resort to the other Company. It was their practice to exchange with other companies, and in the case of the London County Council the London Company and themselves were jointly supplying a change-over switching apparatus to enable them to have the light from one or other of the Companies in the event of the failure of either.

In cross-examination by Mr. Cripps, the WITNESS stated that his Company did not belong to the Messrs. Gatti. Over the last 18 months or two years the Company had had nine or ten applications for motive power for the purpose of driving printing and other machines. They were also required to supply motive power to the National Telephone Company and the Electrophone Company for the purpose of their batteries.

Mr. CRIPPS: Do you know whether the Metropolitan Company have got continuous currents, and are prepared to supply motive power whenever required?

The WITNESS said that he believed they had a continuous-current station, but he did not know that they supplied much from it, and he believed the mains did not extend very far.

Mr. W. T. MADGE, of the *Globe* and *People* newspapers, stated that application had been made to the Metropolitan Company for motive power for driving the Linotype composing machines, but they had not been able to obtain it. He was advised that they could not use the alternating current for such a purpose.

Mr. A. H. VESEY, electrical engineer and consulting engineer to the *Graphic*, *Illustrated London News*, and other newspapers, said that he had been consulted with regard to the running of plant by electricity, and had applied, at the request of some of the proprietors of pap rs, to the Metropolitan Company, with a view of working the plant by electricity. The Metropolitan Company told him they could supply him with currents, but the mere fact of their being able to do so was not satisfactory to him because he could not run an alternating motor economically. They did not offer to give any other supply than the alternating current, and he advised his clients not to put an alternating motor in as he knew it would not be satisfactory. The alternating current was not suited for running machinery, because, in his opinion, the motor would only work efficiently at full load; it could not start by itself, and if they took off any of the load the motor was going ahead all the same, but they were then spending money and getting no benefit from it. He advised his clients that the Metropolitan Company's system was not suitable either practically or commercially. For arc lighting he preferred the direct-current to the alternating system, but he admitted that there was a great variance of opinion on that point.

In cross-examination by Mr. Cripps, the WITNESS stated that he had put up a great many installations all over England, but none with the alternating current. He had seen alternating currents in action and carried out experiments with them, so that he was able to say it was a practical fact that they were only efficient for full loads.

Mr. CRIPPS asked the Witness on what scientific fact he based his opinion that alternating motors were only efficient when they had a full load. He was told that that was nonsense from an electrical engineering point of view.

The WITNESS said that from a practical point of view it had been tried and found not to be economical. He had not been in charge of such motive power himself but he had heard so from other people. In the case of some motors for driving electric pianos at Hatton-garden they would not work satisfactorily because they could not control them.

Mr. CRIPPS: Has there been any case where you have really been in control or where you yourself have had experience of any substantial amount of motive power supplied by the alternating-current system?

The WITNESS: No. He admitted that he had years ago applied to join the staff of the Metropolitan Company, but he did not then know of the conditions of their supply by alternating currents, as they had not then started. He was not refused on the ground that he had not sufficient knowledge of electrical matters, but he himself refused on account of the long hours which the Company wanted him to work.

Mr. CLAUDE BAGGALLAY: With regard to these alternating-current motors, do you know as a fact whether there are many such motors in existence?

The WITNESS: I have not heard of very many. I do not know of one large one at the present time anywhere.

On Tuesday Mr. W. Emden, Chairman of the Strand District Board of Works; Mr. C. Mason, surveyor to the St. Martin's Vestry; Mr. H. Leslie, Manager *Pall Mall Gazette;* and Mr. J. Place, engineer to the Linotype Company, also gave evidence in support of the Charing Cross Company.

Mr. W. H. PATCHELL, engineer to the Charing Cross Company, stated that there was a demand for a supply of electric current by the Company for lighting purposes, motive power, and also for batteries. Though it was possible to use the alternating current for motors and battery work, it was not at present commercially practicable. There were difficulties in starting motors and in keeping them going when started. There were a few cases where the alternating current had been actually used for motors, but it was on an entirely different system to that used by the Metropolitan Company. The direct current was almost entirely used, he believed, for arc lighting, and it was undoubtedly the best for arc lighting, because it was steadier and gave a better light for the same amount of energy. Applications for motor purposes in the Strand district to the extent of 150 H.P. to 200 H.P. had been made to the Company.

In reply to Mr. Cripps, the WITNESS said that if the Metropolitan Company were to supply motors with direct current they would have to lay down fresh plant.

Mr. CRIPPS said that the Metropolitan Company could supply motors on the alternating system, but they were willing to supply them by the continuous system.

This closed the case for the Charing Cross Company.

Mr. F. BAILEY, managing engineer to the Metropolitan Company, was examined in opposition to the Order. He said that every application to their Company for a supply of current had been met, and with regard to the supply of motive power by continuous current, he stated that the Company would prefer to give a supply from an independent circuit, either continuous or alternating. They would be able to supply the direct current for motive power to anyone in the Strand district within a month or six weeks. The great difficulty in connection with motive power hitherto had been when one set of mains only was provided, the turning on of the motor introduced great fluctuations in the supply of the district. Therefore he preferred to have independent power circuits supplied from distinct sources. He did not at all understand what Mr. Vesey meant by there being no efficiency without a full load.

Lord KELVIN, who was one of the original advisers of the Metropolitan Company, said that they adopted the alternating system for supplying the Strand district after having consulted with him. The alternating current gave for ordinary purposes all the advantages of the rival system. He could not have told by the quality of the light whether it was coming from the alternating or the direct system. Either system might show dips or sudden diminutions or augmentations of the light through something going wrong in the engine room or battery room. When additional lights were thrown on the accumulator in the direct-current system there was a sudden change; with the alternating current, when the supply was shifted from one generator to another, there might be an instantaneous blink, but there was no more liability to such changes in the one system than in the other. Large and small motors could be supplied by the alternating system to practical advantage. He believed there was a certain percentage of saving in the cost of the direct system for large motors, but it would only be a question of 90 per cent. as compared with 92 or 93 per cent. He had seen electric motors working on the alternating system with perfect success and doing practical work. At Edinburgh and Brighton the two systems were at work very satisfactorily, and it was remarkable that at certain times of the day and year the two systems were interchanged; when it was not advantageous to work the direct current the alternating current was thrown on, and *vice versâ*.

In cross-examination by Mr. Claude Baggallay, Lord KELVIN said that the direct-current system was preferable for street lighting by arc lamps, and also for lighting in theatres, because of the slight hum there was in the electric arc lit by the alternating current. As to the merits of the two systems for motive power, he would scarcely like to say definitely, but the practical engineers who had had the question before them had provided an enormous amount of transmission of power by the alternating system He should personally prefer in every one of those instances to use the direct current, but there were some of the greatest engineers of Europe and America who were choosing the alternate system for the transmission of power and for the supply of motors, and if he had been in consultation with

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those engineers he might have been led by them to prefer the alternating to the direct. Brown of Baden, the Oerlikon Works at Zurich, and Ganz of Budapest, all used the alternating current system, and did very great things indeed in the way of the transmission of power and supply of motors.

Mr. R. E. CROMPTON gave evidence as to the cost of laying down mains. Mr. H. Cooper, Mr. C. Hobbs, and Mr. H. J. Cole, members of the Strand Board of Works, opposed the introduction of a second company into the district.

Mr. S. Z. DE FERRANTI was examined as to the inconvenience which had resulted in the St. Martin's and other districts when the London Company, of which he used to be the engineer, was in competition with other companies. He stated that it meant the breaking up of the streets twice, and sometimes three times, for the purpose of making house connections, and the ultimate result was that the Companies had practically come to a working arrangement by agreeing upon their prices, so that now it did not really amount to competition.

Without calling on the promoters to reply, the Committee, after having consulted in private, agreed to confirm the Order.

THE DUBLIN UNITED TRAMWAYS COMPANY'S BILL.

The Dublin United Tramways Bill came before a Committee of the House of Commons, presided over by Mr. Roby, on Tuesday, June 24th. Mr. Littler, Q C , Mr. J. D. Fitzgerald, Mr. Munroe, and Mr. Richardson appeared as counsel for the promoters ; and the petitioners against the Bill were represented as follows :—The Clontarf Township Commissioners by Mr. R. Whitelaw ; the Rathmines and Rathgar Improvement Commissioners and the Pembroke Township Commissioners by Mr. Pembroke Stephens, Q.C., Mr. J. W. Greig, and Mr. P. N. Fawcett ; and the Corporation of Dublin by Mr. Pember, Q.C., Mr. Gerald Fitzgerald, and Mr. John O'Connor.

Mr. LITTLER, in opening the case for the promoters, said that they proposed to use electrical power in connection with the tramways, subject to the usual clauses imposed by the Board of Trade. They also proposed to employ either insulated returns or uninsulated returns, so that there would be no danger to persons using electricity for other purposes. There were three methods of working electrical cars. One was to have accumulators ; the second was to carry the electrical current in a grooved receptacle, or along one of the rails ; and the third, which was the one the Company proposed to adopt, was to carry the wires overhead by means of posts, supporting the wires on arms which were carried over the line. He handed in views of the tramways at Walsall and Vienna, which were worked on that system, and said that the posts would be ornamental, and would cause no interference ; they were made in such a way as to be perfectly useful either for electric lighting or as ordinary gas lamp-posts, thereby getting rid of the other posts in the street. He explained that the streets of Dublin were especially inapplicable to the carrying of the current in grooves beneath the roads on account of the amount of the wet and dirt and dust, while to carry it along the rails they would have to take up the whole of the tramway system, which would lead to great expense and inconvenience. In fact, they did not honestly see their way to incur the expense of introducing electricity under those circumstances.

Mr. GERALD FITZGERALD, on behalf of the Corporation of Dublin, said that they were not hostile to the introduction of electric power, provided that they, as the road and municipal authority, had sufficient control over it. They objected to overhead wires.

Mr. LITTLER said that that was objecting to the whole Bill, because the overhead wire system was the only one that could be used with advantage. In the United States the overhead wires were everywhere succeeding the clumsy and inconvenient method of the slot system running under the streets, and if the Committee should be of opinion that overhead wires were not admissible they might just as well reject the Bill.

Mr. JOSEPH KINCAID, engineer to the Bristol Tramways Company, said that that Company was carrying out an electric system by means of overhead wires, the principal portion of the road being through narrow streets. He was also consulting engineer to the South Staffordshire Tramways running from Walsall to Darlaston, which were also worked by overhead wires. From his experience in those cases he could say that all reasonable requirements of the Local Authorities had been met. He explained to the Committee the different methods of working with overhead wires, and said that the one which the Dublin Company proposed to use was similar to that in use at Walsall, where they had one conducting wire fixed on brackets at the side of the road. That system was in use at Brussels and Havre, but at Frankfort the span system was used. The streets in Dublin would present great objections to the adoption of the conduit system, as it would be necessary to make a conduit which could be kept dry. There was some considerable difficulty in that, as there was constantly a great deal of wet and dust and dirt entering the conduit, which it was difficult to remove. The maximum pressure which the Company proposed to use was 500 volts, which was the amount authorised by the Board of Trade. The accumulator system was objectionable on account of the weight which the accumulators added to the cars and from the fact that when they got near the end of the journey the power gradually weakened, and it had been known to give out altogether.

Mr. H. F. PARSHALL said that he had given special attention to electrical traction, and was familiar with the various systems in use on the Continent and in England. Over 99 per cent. of the cars were operated on the overhead system, but the conduit system was at use at Blackpool and at Budapest. As to the best system for Dublin, he should say that there should only be one system, and that would be by overhead wires. His Company in America had undertaken to construct about 6,000 miles of overhead wires, many of which were now working successfully. They were working with the cross wires, or what might be called the birdcage system. He thought, however, that the single-wire system would be more suitable for people who were somewhat strict in their requirements as to the appearance of the streets. Although the conduit system might be successful in Budapest it was not successful in Cleveland, Ohio, on account of the rubbish and rain that got into the conduit, the result being that it was impossible to keep it insulated. A poor slot system would be three times as expensive to erect as the single-wire system, while the very best slot system would cost seven times as much.

Mr. C. E. SPAGNOLETTI, consulting electrical engineer to the Great Western Railway Company, said that he thought that the overhead system was the best that could be adopted for certainty of work and economy, and was as safe for the public as could possibly be. He thought that the underground system would be especially objectionable in Dublin, on account of the humid climate and the heavy rainfall. It would be difficult to provide for the disposal of the storm water, and if the conduits got full of water it would be fatal to the system. He thought the overhead system would cause less obstruction to traffic. As to the question of speed he did not think that 12 miles an hour, at present allowed by the Board of Trade, would be dangerous in the streets, and at that speed the car would be perfectly under control. The birdcage system he considered very unsightly. He knew of no instance where an accident had been caused by the electrical part of apparatus in connection with the overhead system. Wherever there had been an accident it had been purely from mechanical conditions which were in no way connected with the electrical apparatus.

The Committee then adjourned till Wednesday, when Mr. Dickinson, engineer to the Walsall Electrical Tramways, gave evidence to the effect that the Local Authorities of the town, now that the overhead system had been in working order for some time, and no doubt realising its advantages, were anxious for its extension. That system passed through the main streets of a very populous district, and he had never heard complaints arising from inconvenience to traffic. He concurred in the objections to the underground system. His experience of the Board of Trade was that they were more cautious in the matter of the use of electricity than the Local Authorities, and in view of the way in which they protected the public he thought the opposition which the Dublin Corporation were raising to this scheme could hardly be described as reasonable.

Mr. WILLIAM ANDERSON, secretary and manager of the Dublin Company, said that the system extended about 32 miles. A Committee of the Company had inspected the various electrical systems in England and on the Continent, the result of which was that the Committee came to the conclusion that electric tramways were worked more easily and expeditiously than any other kind, and cause no inconvenience to the public.

Mr. W. MURPHY, a Director of the Company, who formed one of the Committee of Inspection, also gave evidence.

This closed the case for the promoters, and Mr. Cripps addressed the Committee on behalf of the Dublin Corporation, urging that the Committee ought not to sanction the Bill in face of the opposition of the Local Authorities. In all such Bills it was strictly stipulated that the powers were not to be used except with the consent of the Local Authority, and if this Bill were carried it would be running in the teeth of every precedent.

The LORD MAYOR of DUBLIN was then examined in support of the objections of the Dublin Corporation, maintaining that the veto of the Local Authority ought to be sustained. For the purposes of the Bill openings would have to be made in the streets, and he looked upon that interference with the streets in the same way that he should look upon the laying of a new track. Until the Corporation came into that room they had not the faintest idea as to what system the promoters would adopt, and even now they were not certain what system really would be adopted if the Bill were passed. In cross examination by Mr. J. D. Fitzgerald, he said that the consent of the Corporation was a matter which was open to arrangement, and that an arrangement might be come to by payment. He did not see why any company who would make a profit by such a concession should not be made to pay for it. Wherever electricity was introduced it should be subject to the consent of the Local Authority.

Mr. J. D. FITZGERALD having replied on behalf of the promoters, the committee room was cleared, and, after a short private consultation,

The CHAIRMAN said the Committee had been very much impressed with a good deal of the engineering evidence, and if they were members of the Dublin Corporation they might be disposed to give a favourable hearing to the Company, but they were not prepared to allow this large change to take place without the consent of the Local Authorities, and consequently they had so far to find the preamble of the Bill not proved. Of course, Mr. Fitzgerald would tell them whether the Company were prepared to go on with the Bill with some words inserted to require the consent of the Local Authority.

Mr. FITZGERALD said he should like to consult his clients as to whether they would take the Bill at all or whether they would take it just so far as it applied to the townships which raised no objection.

The CHAIRMAN said that was quite reasonable, and the Committee adjourned till the following day.

On Thursday Mr. J. D. FITZGERALD said that what the promoters proposed to do was to strike the city of Dublin and the townships of Pembroke and Rathmines out of the Bill, and to amend the Bill so that it would only refer to those parts of the tramways with respect to which no objection was taken. The city of Dublin and those two townships being the objecting parties, and being entirely struck out of the Bill, the Bill would have no effect on them.

Mr. PEMBROKE STEPHENS asked if anything could be more senseless than to have a system of electrical working right up to the boundary of the city and then change it,

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The CHAIRMAN said that he quite agreed with that view, but as the Committee would cut out of the Bill all that related to Dublin, Pembroke, and Rathmines, he thought that was all that Mr. Pembroke Stephens could fairly ask for.

The clauses of the Bill were then gone through and amended in accordance with the decision of the Committee, and the Bill was ordered to be reported to the House.

PARIS NOTES.

(FROM OUR OWN CORRESPONDENT.)

PARIS, *July 18, 1895.*

Electrical Awards.—At the meeting of the Société d'Encouragement on Friday last, presided over by M. Mascart, the following prizes were awarded in the Electrical Section. A prize of 500fr. was given to M. Lartigues, head of the outdoor service of the Municipal Central Station at the Halles Centrales, and a similar prize to M. Gaston Roux, head of the Bureau de Contrôle des Installations Electriques, for their memoirs on the measurement of the insulation resistance of a distributing network of a central station when at work. A silver medal was also given to M. J. Laffargue, municipal electrical inspector, for his work on "Electric Fitting Machinery."

Electrical Legislation.—The Senate has just passed a Bill relating to the erection of electric conductors, and the aggressive decree of May 15, 1888, has been abrogated. By this law no electrical conductor, other than a telegraph or telephone line, may be established above or below a public road without prefectoral authorisation, which is to be given under advice from the Postal Telegraph Department. Overhead conductors are not to be placed closer than 10 metres to a telegraph or telephone line without special permission from the Postal Telegraph Department. The Minister of Commerce, after taking the advice of his electrical advisers, is empowered to draw up rules with regard to the existing conductors which are likely to interfere with the telegraph or telephone service. The owners of existing lines likely to interfere in this manner are to be informed, within six months from the promulgation of the law, of the alterations that must be made; and within a year of notification these alterations must be carried out. Perhaps the most noticeable feature of the law is the fact that the Minister of Commerce is authorised to form a permanent Advisory Council, one half of which is to be composed of representatives of the electrical industry. This Council is to advise the Minister of Commerce with regard to rules and regulations on all electrical questions upon which he may desire their opinion.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *June 28, 1895.*

Mr. A. E. Kennelly.—Mr. A. E. Kennelly has received from the Western University of Pennsylvania the degree of D.Sc. in recognition of his scientific work in connection with cable testing and alternating current. His recent contributions on the subjects of inductance and capacity, and the application of complex quantities and simple graphical methods in the consideration of these, are specially mentioned.

The Berliner Patent Litigation.—The opinion of the United States Circuit Court of Appeals, reversing the recent decision of Judge Carpenter declaring void the Berliner variable pressure constant-contact telephonic principle, is extremely positive in its tone, and displays little patience with the allegations of fraud and collusion in the issue of the 1891 patent in suit. Its conclusions are that the delay of 14 years in the issue of the patent is to be ascribed solely to imperfections in our patent system, and that as the issue of the patent was within lawful authority of the Commissioner of Patents, the question of its anticipation by the 1880 Berliner patent is one over which the Courts have no jurisdiction in the present action. The net result of the litigation thus far is to probably dispose definitely of the fraud issue, but leaves open the question of anticipation, with the weight of one adjudication against the Bell Company—that of Judge Carpenter—though the reversal of his decision on the fraud issue leaves this without effect. We learn that the recently-formed national organisation of telephone manufacturers proposes to test the patent by having one of its members become a defendant on an infringement issue, which will bring the matter before the Courts without the legal complications that have surrounded the Government suit.

The Westinghouse Electromagnetic Railway.—For several years it has been known that Mr. George Westinghouse, jun., has been experimenting with a novel electric railway system. It seems, however, that Mr. Westinghouse was anticipated in the Patent Office by another inventor, Jerome Wheless, and a few days ago the announcement was made that Mr. Westinghouse had purchased the patents of the latter from the owners, the Electromagnetic Traction Company, which has for some time been operating an experimental line in Washington. At the same time the details of construction and operation were made public, from which it appears that the system is of the class that employs a storage battery current in the car to operate a magnet that in turn switches on the motor current. The magnet and switches are situated in an underground box which may be placed under the sidewalk or wherever convenient. In the centre of the track are three fixed projections, with which, when the car passes over them, brushes on the car make contact. One brush conveys the current of a three-cell storage battery to a magnet in the switch-box, which switches on the motor current. This current then passes through the second contact pin and brush to the motor, whence through the third brush and pin it passes to the return cable. The electrical public will await with much interest the verdict as to whether this system contains the elements of commercial success, or is to be classed merely as an inventor's hobby.

CORRESPONDENCE.

WAVE FORM SYNTHESIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The idea of employing a special armature as suggested by Dr. Fleming, for the production of synthetic waves of potential difference or current, occurred to the writer some months ago. In considering the problem of constructing some simple form of harmonic synthesyser with Mr. Archibald Sharp, the writer suggested the idea of using an electrometer or galvanometer and tracing out with a light spot on a moving photographic plate any Fourier function which was to be made up by prearranged "harmonics"—the latter being electrical sine waves derived from a suitable source. It was proposed to employ an armature made up of separate parts—each being a complete Ferranti armature in itself—and the parts were to have respectively, say, 6, 12, 18, 24, 30, 36, &c., flat coils or bobbins, while the field was to have, say, 6 poles.

A rough idea of the arrangement is given in Fig. 1, a sketch made by the writer some time in February. Here three elemental armatures are represented in section. Armature 1 would have, say, 6 coils, 2 would have 18 coils, and 3 would have 30 coils. This is the arrangement proposed by Dr. Fleming, and was intended to give, when the elemental armatures were connected in series, as shown, a potential difference wave between T_1 and T_2 which would be the sine function of the fundamental, third, and fifth harmonics.

The rheostats R_1, R_2, R_3 enable one to adjust the relative amplitudes.

The writer suggested that for the automatic synthesyser (which was to be used for mathematical as well as electrical work) a small special alternator could be fitted with a set—say up to ten—of small thin coil elemental armatures, as described, so that any number or order of these could be fitted to the common shaft at will.

With the circuits of the elemental armatures connected in series we would have a wave form which, if drawn automatically

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upon a moving photographic plate, or, for current waves, by the tracing of a pen or pencil upon a moving screen, would give us a very simple means of plotting Fourier functions.

Messrs. Burnie and Rodgers, of the Central Technical College, and the writer, have been working out the details of a curve tracer for the above purpose for some months past, but we are not at liberty to give the particulars of this instrument in the present letter.

One difficulty with the employment of elemental armatures in a single field, which may not have occurred to Dr. Fleming, is as follows: For the fundamental wave armature and the lower harmonic elements the distance between the field poles

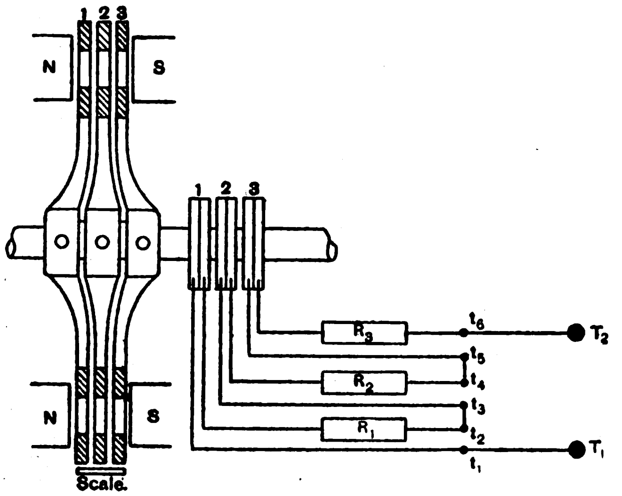

Fig. 1.

would be exaggerated, and hence the waves of low frequency could have a form something like that shown in Fig. 2, which is not a sine function. Practically speaking, with poles far apart there is a considerable angular distance midway between them, where the rate of change of lines is very low and nearly constant. Hence the wave of induced E.M F. is not a sine function.

For the mere production of *irregular* synthetic waves this would not matter, except that there would be no way of knowing the equation to the resultant graph.

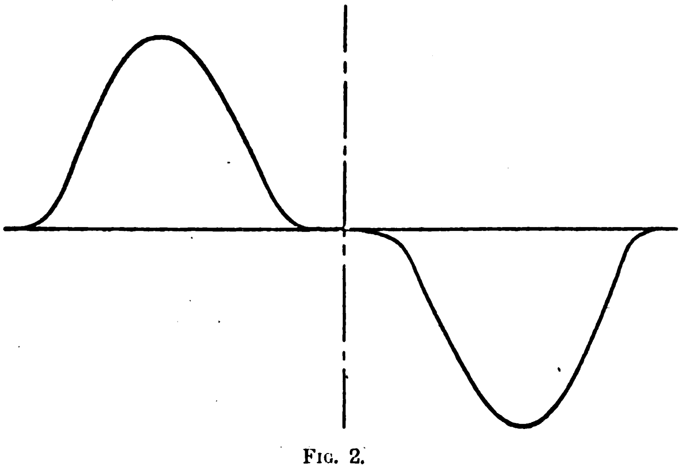

Fig. 2.

For the purpose mentioned by the writer it was therefore considered better to have separate field sets. It was also suggested to have sets of *similar* elemental armatures revolving in a common field, geared (with loose bearings on one shaft) to run at respective speeds which would give the successive frequencies required for the resultant graph sought.

A second method for producing synthetic electromotive force waves has been found feasible for use with the automatic synthesyser roughly described above, and the writer hopes to give the details later.—Yours, &c., JAMES MARK BARR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Kindly allow me to correct an error in Messrs. Barr, Beeton, and Taylor's Paper on the above subject, which appeared in your last issue.

At the bottom of column 2, page 287, they attribute to me a special method of connecting up an electrometer, which gives both proportionality and equal sensibility on the two sides of zero.

The method has been very frequently used during late years at the Central Technical College, but I can lay no claim to it, having come across the arrangement in Mascart and Joubert's well-known treatise.

I would also point out that the claim for greater sensibility mentioned in lines 8 to 11, column 1, page 288, presupposes that N and $\frac{a+b}{2}$ are of the same sign.—Yours, &c.,

T. MATHER.

SHIPBOARD GALVANOMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On reading Mr. Wilkinson's able article on "Shipboard Galvanometers," published in your last issue of *The Electrician*, I notice that he states, "the spot oscillates some time before coming to rest." This is, of course, due to the very small damping of the old system.

Mr. Wilkinson seems to be unacquainted with the new method devised by Mr. Weatherall and myself, which produces an almost dead-beat movement, the spot coming to rest well within two seconds. (This is made by Messrs. Elliott Brothers, where it can be seen.) The sensitiveness of the instrument is not to the slightest extent impaired—in fact, a much greater degree of efficiency is obtained.

Mr. Wilkinson also mentions the difficulty of reading electrostatic discharges on the marine galvanometer; this we have completely overcome, and they now can be observed as readily as with the ordinary astatic galvanometer. Further, by our method of damping, an ordinary testing instrument can be used for mirror speaking, and perfect signals can be obtained through lengths varying from 1 to 2,000 or more knots of cable. This method is an adaptation to the marine galvanometer of a system we have had in use with our astatic galvanometers for the last three years.—Yours, &c.,

THOMAS CLARK,
Electrician to the Telegraph Construction and Maintenance Company.

East Greenwich, July 2, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The instrument mentioned by Mr. Clark as designed by Mr. Weatherall and himself is of considerable interest and importance. I am quite sure that many besides myself would be glad to be referred to any published description of it. A few weeks ago a description of a damping arrangement designed by Mr. H. W. Sullivan appeared in this journal, which seemed capable of adjustment without bringing in too great a logarithmic decrement in discharge work. Results obtained, showing return to zero and absence of creeping, would be of great practical value.—Yours, &c., H. D. WILKINSON.

Wimbledon, July 4, 1895.

MAGNETIC SYMBOLS AND TERMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The interesting correspondence in your current number about magnetic symbols and the use of the term "gauss" shows that there is still some difference of opinion on this point.

I venture to suggest that instead of a unit of magnetic intensity **B**, what we really want is a unit of magnetic flux analogous to the ampere. The term "magnetic line of force," used by some as the unit of magnetic flux, does not convey an accurate idea of the nature of the quantity which is measured. The Kapp line is open to a similar objection.

For some time I have been in the habit of using in calculations the term "mag" to denote the C.G.S unit of magnetic flux, and have found it extremely convenient. **B** can be

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readily expressed in "mags" per square centimetre or "mags" per square inch according to the system of measurement in use, just as current density can be expressed in amperes per square inch or in amperes per square centimetre. The terms "erg" and "dyne," which are universally employed as the names of units, would form a precedent for the adoption of the term "mag" as the unit of magnetic flux.—Yours, &c,

J. A. Kingdon.

29, Marlborough-hill, London, N.W.,
July 1, 1895.

LEGAL INTELLIGENCE.

Edison and Swan United Electric Light Company v. Williamson.

In the Chancery Division of the High Court of Justice on Thursday the case of the Edison Swan Company v. Williamson was mentioned to Mr. Justice Stirling, it being an action to restrain the alleged breach of a licence.

Counsel for the plaintiff Company said that the defendant had given an undertaking in the terms of the notice of motion, and the action would be at once set down for trial, and the motion for an interim injunction would stand over on those terms until the trial of the action.

Counsel for the defendant said that the undertaking was given without prejudice, because his client contested the plaintiffs' case altogether. It was, however, a case in which there must be cross-examination, and that would best be taken at the trial.

His Lordship directed the motion to stand over on those terms.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices:—*

Laboratory Notes and Forms.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett (*now ready*). Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A Large-Sheet Table, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s. —each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

A Sheet Table showing Total Capital Outlay and Receipts and Expenditure for the year 1894 of the Statutory Electric Supply Undertakings of the Metropolis is now ready, printed on thick paper, price 6d. each.

"The Work of Hertz."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. nett, is now ready.

"Electrical Engineering Formulæ," a pocket-book by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"Drum Armatures and Commutators."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

Tenders Invited.—The Brighton Borough Council invite tenders for the supply and erection of steam and feed piping, cast-iron storage tanks, feed water filters, electrically-driven feed pumps, circulation economiser, coal elevator and sundries. Also and erection of evaporative brass-tube surface condensers, electrically-driven air pumps, exhaust and condenser piping. Specifications may be obtained at the offices of the Town Clerk (Mr. F. J. Tillstone), Town Hall, Brighton, and tenders, addressed to Mr. Tillstone, must be sent in by 10 a.m. on Monday, the 15th instant. Some further particulars appear in our advertisement columns.

——— From our advertisement columns it will be seen that the Metropolitan Asylums Board require tenders for the supply and running of mains in the grounds, and for the wiring of buildings now being erected at the North-Western Fever Hospital, Haverstock Hill, N.W. Copies of the conditions and specifications may be obtained at the offices of the Board, Norfolk House, Norfolk-street, London, W.C., and tenders must be sent in by 11 o'clock on Thursday, the 18th inst.

——— The chief of the I. Regiment "Cetate," in Focsani, Roumania, are inviting tenders for the supply of 5,000 metres of telephone cable and eight sets of station apparatus.

——— The municipal authorities of Cullera, Valencia, Spain, invite tenders until the 8th inst. for the concession for the electric lighting of the streets for a period of 20 years. Tenders to the Ayuntamiente de Cullera.

——— In connection with the recent decision of the municipal authorities of Dortmund to establish an electric supply station in the town, a competition for the carrying out of the scheme is announced. Competitions are to reach the Magistratsamte, Dortmund, by August 14th next. Conditions, &c., may be obtained on payment of 1s.

——— The Town Council of the Borough of Richmond, Surrey, require tenders for an extension of the fire call system within the borough. Tenders must be sent in to Mr. Frederick B. Senior, town clerk, Town Hall, Richmond, Surrey, by 2 o'clock on Monday next, July 8th.

——— The Directors of the Manchester Ship Canal Company invite tenders for the necessary work for the permanent electric lighting of the Manchester and Salford Docks. Tenders, addressed to the secretary (Mr. A. H. Whitworth) must be in by July 10th.

——— The Visitors' Committee of the Bristol Lunatic Asylum, Fishponds, Bristol, require tenders for supplying and fixing wires, lamps, &c., for lighting the Asylum by electricity. Tenders to be in by July 15th.

——— The Corporation of Portsmouth invite tenders for the supply and erection of conduits and india-rubber covered electric mains, and for the supply and erection of "compound" covered high-tension electric mains. Tenders must be sent in to Mr. A. Hellard, town clerk, Town Hall, Portsmouth, by 6 p.m., July 10th.

——— The Urban District Council of Wellington (Salop) invite tenders for lighting the district by electricity or gas. Tenders before noon on Monday, July 15th.

——— The Parish Council of Hapton (Lancs.) require tenders for the electric lighting of the village from September 1st next to April 30, 1896. Tenders must be sent in to the Chairman of the Council before the 15th instant.

Tenders Accepted.—In our last issue particulars were given of the acceptance of the tender of Messrs. Clay Brothers and Co. for the electric lighting of Messrs. Hancock's brewery at Cardiff. The following is the complete list of tenders:—

	£	s.	d.
Clarke, Chapman and Co. (Gateshead-on-Tyne)	£1,705	0	0
Barclay and Son (London)	1,640	0	0
Easton, Anderson and Goolden (London)	1,579	15	0
Wilson (G.) and Co. (Aberdare)	1,578	19	0
Laing, Wharton and Down (London)	1,572	10	0
Lewis and Fletcher (Cardiff)	1,477	0	0
Knapman, Hodder and Co. (Cardiff)	1,420	6	0
Saunders and Co. (Cardiff)	1,420	0	0
Strode and Co. (London)	1,387	0	0
Clay Brothers and Co. (Cardiff (accepted)	1,337	17	0
Fergus and Co. (Cardiff)	1,245	0	0

——— The following tenders have been received for the electric lighting of the Presbyterian Church of England, Newcastle-on-Tyne:—

	£	s.	d.
S. Bury	£63	0	0
R. J. Charleton and Co. (accepted)	80	0	0
Wynne and Barnard	82	10	0
Reid (F.), Ferens and Co.	95	0	0
Rowland Barnett and Co.	110	16	7
Ernest Scott and Mountain	118	0	0
Bland Brothers	168	10	0

[All of Newcastle-on-Tyne.]

——— The Electric Light Committee of the Belfast Corporation have accepted the tender of Messrs. S. Z. de Ferranti (Limited) for the supply of meters.

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Tenders Accepted.—The contract for the equipment of the Manhattan elevated railway in New York for electric traction, at an estimated cost of over a million pounds sterling, has, it is stated, been secured by the Westinghouse Company.

——— *Correction.*—It our issue of June 14th it was stated that the tender of Messrs. Knapman, Hodder and Co., of Cardiff, being the lowest, had been accepted for the lighting of the Cardiff Free Library. We are asked by Messrs. Strode and Co. to state that this is an error, Messrs. Strode's tender having been accepted.

——— On the recommendation of the Watch Committee the Birkenhead Town Council have accepted the tender of Messrs. W. A. Shaw and Co., of Stockport, for the erection and establishment of a fire-alarm system for the town for the sum of £835.

Tenders Received.—The Electric Lighting Committee of the Wolverhampton Town Council have decided to recommend the acceptance of the following tenders for plant for the electric lighting extensions :—

Thomas Parker (Limited) (dynamos, &c.)	£2,232
Marshall, Sons and Co. (steam engine)	845
Callender Company (extension of mains, &c.)	536

Business for Sale.—As will be seen from our advertisement columns, Mr. J. M. Macleod (liquidator under the sequestration of the estate of Mr. J. Scott, trading as D. and G. Graham) has for sale the business of electrical engineers, bell-hangers, &c., hitherto carried on by Mr. Scott, at 134 to 140, Douglas-street, and of wholesale and furnishing ironmongers at 201, Byars-road, Glasgow, together with the stock in trade, plant, machinery, and book debts. The business has been established over 50 years. The stock, plant and machinery may be seen on application to Mr. J. Macleod, 101, St. Vincent-street, Glasgow, who will give facilities for inspecting the works.

Appointment Vacant.—The Bradford Corporation are prepared to receive applications for the appointment of engineer to take charge of their electricity works at a commencing salary of £300 per annum. Applications must be sent in to Mr. W. T. McGowen, Town Clerk, Town Hall, Bradford, by the 17th inst. Some further particulars are given in our advertisement columns.

——— The Governors of the Northern Polytechnic invite applications for the post of principal. After the 25th March next the stipend will be at the rate of £500 per annum, and from September 29th next to March 25th at the rate of £300 per annum. Applications must be sent in to Mr. E. Griffiths, secretary, St. Mary's Vestry Hall, Islington, N., before July 15th.

——— The Birmingham Corporation requires an engineer, competent to take entire charge of the electric light and power installation in the new Municipal Technical School. Salary £2. 10s. per week. Applications, stating full particulars, must reach the Secretary (Mr. Geo. Mellor), Paradise-street, Birmingham, by the 13th inst. Some additional information is given in our advertisement columns.

——— The Governing Body under the Swansea Intermediate and Technical Education Scheme require a head master. A minimum salary of £600 per annum is guaranteed. Applications are to be sent in by Monday, the 15th inst., to the Chairman of the Governing Body, Guildhall, Swansea.

Appointment.—Mr. A. G. Ashcroft, formerly assistant to Prof. Kennedy, at present assistant in the laboratory of Prof. Baird, of University College, London, and lecturer on engineering at the People's Palace, London, E., has been appointed Principal of the Woolwich Polytechnic in place of Mr. Garrett, resigned. The commencing salary is £350 per annum.

——— Mr. Sydney W. Baynes, at present electrical engineer to the Bradford Corporation, has been appointed chief electrical engineer to the St. Pancras Vestry. The salary attached to the office is £600 per annum.

New Address.—The Nalder and Harrison Construction Syndicate (Limited) have now removed to their new address at Bow Common-lane, London, E. Telegrams: *Lucimeters London.* Telephone No. *5064.*

Liquidations.—At a meeting of the shareholders in Galloways (Limited), boiler makers, Manchester, a resolution was passed on June 10th last to the effect that it was desirable, for the purposes of reconstruction, that the Company be voluntarily wound up. This resolution was confirmed on June 25th, and Mr. J. W. Pollitt, of Marsden-street, Manchester, was appointed liquidator, with power to consent to the registration of a new company with the same title.

——— A resolution was passed on May 8th last, and confirmed on June 6th, that it was desirable to reconstruct the Otis Steel Company (Limited), and that the Company be wound up. Mr. A. Young, of Coleman-street, London, E.C., was appointed liquidator. On the 29th ult a petition for the winding-up of the Company was adjourned till Wednesday next.

——— In connection with the winding-up of the Agence Dalziel (Limited) the Official Receiver has issued the usual summary, and in his observations thereupon calls attention to the peculiar methods adopted in order to find capital for the flotation of the concern, the failure of which is by Mr. Dalziel attributed to the expenditure having exceeded the income owing to excessive competition, to the attacks of the Paris Press, and other similar causes.

Personal.—Mr. Reginald J. Wallis Jones, A.M.I.C.E., M.I.E.E., has been appointed engineer and manager of the Electric Welding Company (Limited).

Agency.—Messrs. George Piggott and Co., of Cannon-street, E.C., inform us that they have been appointed sole London agents for Messrs. C. E. Collins and Co., electric light fittings manufacturers, of Birmingham. Messrs. Piggott are also agents for Mr. F. M. Newton.

Aberystwyth.—Mr. A. H. Preece has presented a lengthy report on the electric lighting of the streets by the local electric light company. Mr. Preece expresses satisfaction with the result of his inspection, and recommends that the Council procure a photometer for the purpose of recording the power of the light.

Blackpool.—At their last meeting the Town Council considered the Electric Lighting Committee's report, which recommended that a Sub-Committee be appointed to consider Mr. Hammond's report on the present position of the electricity works, and that until a further extension of the electricity works be made no further applications for electric current be entertained. Councillor Pearson, in moving the adoption of the report, said that the present plant at their station was taxed to its fullest capacity, and the Committee would ask at an early date for power to largely extend the works. So far the electric light had proved an unqualified success, and the balance-sheet for the past year showed that they had made a gross profit of £1,604. Their total expenditure during the year was £3,877, while the receipts were £5,481; £1,409 was set aside for depreciation and interest, and £600 for sinking fund, thus showing a net loss of £278.

Bolton.—The Gas and Electricity Committee of the Town Council have instructed their electrical engineer (Mr. J. H. Rider) to prepare a scheme for furnishing a continuous supply of electricity throughout the borough. At present the current is switched off at midnight. A sub-committee has been appointed to consult with the Streets Committee on the question of electric traction on the Corporation's tramways.

Church Lighting.—St. Margaret's Church, Prince's-road, Liverpool, is now lighted throughout by electricity.——The United Methodist Free Church at Burnley has been fitted throughout for the electric light.

City of London.—At the meeting of the Court of Common Council last week a report was presented from the City Lands Committee asking authority to appoint Mr. A. A. Voysey as consulting electrical engineer to the Corporation at an honorarium of £50 per annum, subject to annual election by the Committee. The proposal met with considerable opposition, and ultimately the report was negatived. In the course of the discussion it was stated that the cost of electric current supplied to the London Corporation in 1893 was £387, and in 1894 £513; gas in 1893 £1,312, and in 1894 £882.

Cork.—The Cork Electric Light and Power Company (Limited) have notified the Corporation of their intention to apply for a Provisional Order enabling them to supply the city with electric current for public and private lighting.

Country House Lighting.—Mr. A. H. Browne, M.P., has instructed Messrs. Drake and Gorham to instal the electric light throughout Broome Hall, Holmwood.

Decimal System.—The Select Committee of the House of Commons on Weights and Measures has recommended that the metrical system should be legalised experimentally for two years, and should thereafter become compulsory.——An instructive Paper was read by Mr. J. L. Wilkinson on "The Decimal System" before the members of the International Railway Congress now sitting at the Imperial Institute. Mr. Wilkinson pointed out that the whole of the civilised countries of the world, except Great Britain and some of its important colonies and dependencies, had introduced the decimal system in some shape or form.

Eastbourne.—In deference to a request from the Town Council, the local electric light company have decided to make a reduction of 1d. per unit in the price of current supplied to the Town Hall and band stand from the 30th ult.

Eccles.—The minutes of the Watch Committee, presented to the Town Council on Monday, stated that Mr. S. V. Clirehugh, the Council's consulting electrical engineer, had prepared a report on the proposed electric lighting scheme, in which provision had been made for lighting the whole of the area covered by the Council's electric lighting Order, together with such private lighting as the Committee considered it was reasonable to anticipate. It was estimated that a capital outlay would be involved of £18,971, but

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that no charge upon the rates would be necessitated, as the income, after allowing for expenditure, was estimated to leave a small surplus in favour of the scheme. If the public lighting of the district only were undertaken, it was calculated there would still be a balance in favour of the electric light of about £130, as the capital outlay figures would be reduced to about £15,000, and the annual upkeep, &c., to £1,560, against £1,690 now paid for gas. The Committee, after carefully considering this report, had decided to adopt it, and to recommend that application be made to the Local Government Board for powers to borrow £19,000 to carry out the scheme. It was pointed out by Mr. Alderman Kendall that the Board of Trade, having been informed of the proposed action of the Corporation, had deferred considering the question of the revocation of the Order until June 9, 1896, when, if some scheme was not in process of being carried out, the Order could be revoked, and it was more than likely that a private company would step in. After some discussion the Committee's minutes were approved, and application is to be made to the Local Government Board as above-mentioned. Plans and specifications are being prepared, and are to be considered at an early meeting of the Council.

Edinburgh.—At a meeting of the Electric Light Sub-Committee of the Town Council on Tuesday last, it was unanimously resolved to recommend that, in view of the various extra duties undertaken by Mr. Monkhouse (borough electrical engineer), and which were not included in the terms of his appointment, and having regard to the large salaries paid to similar officers in other cities, his salary be increased from £300 to £400 per annum. The Sub-Committee gave further consideration to the scheme authorised by the Town Council for the extension of the high-tension mains to the south side of the city, and every effort is to be made to expedite the works so as to ensure the supply of current by the beginning of the winter.

Electric Calls.—Several of the principal clubs and hotels in London are provided with a useful electrical device for cab-calling. In lieu of the discordant whistle formerly used, two lamps are suspended outside the building, one coloured red and the other green, and by pressing a knob in the entrance hall the hotel attendant shows one colour or the other. If a red light is shown cabmen are made aware that a four-wheeler is required, and if a green light that a hansom is wanted.

Electric Welding.—The Electric Welding Company (Limited), of Hindon-street, Pimlico, S.W. (owners in this country of the Thomson patents), exhibited at the *conversazione* held at the University College, Gower-street, W.C., on the 27th ult., an automatic wire-welding plant. It is stated that the use of wire-welding plants in America is almost universal, and the Company is making considerable progress in the introduction of these machines amongst wire and cable manufacturers in Great Britain.

Expansion of Telegrams.—It will be remembered that some weeks back *The Times* took strong exception to the course adopted by the Central News Agency in dealing with telegrams received in connection with the war between Japan and China. The *Daily Chronicle* understands that the conductors of *The Times* have decided to take legal proceedings against the Central News Company "for alleged breach of contract in connection with the 'expansion' of telegrams from the far East during the late war." If this course is adopted the case is likely to prove of great public interest.

Hull.—At a meeting of the Electric Light Committee of the Corporation, held last week, a report was read from the deputation, consisting of representatives from Hull, Blackpool, Bradford, Brighton, Lancaster, Wolverhampton, Glasgow, &c., which waited upon Major Cardew a few days back to place before him the views of the various Corporations on the revised Board of Trade regulations. The report states that Major Cardew gave general sympathetic consideration to the views expressed by the deputation, and promised, if it was found necessary, that the Board of Trade would later on convene a meeting of the Corporations and others interested in the supply of electric current for the purpose of obtaining a full discussion of the proposed regulations before they became law. It was pointed out that the regulations respecting voltage, if insisted upon, would seriously affect the Hull station.

International Railway Congress.—At a meeting of the delegates at this Congress on Tuesday a Paper was submitted by MM. Scolari and Rocca, officials of the Mediterranean Railways of Italy, on the subject of the 24-hours day, strongly recommending the railway authorities to adopt this system, which, the writers urged, would bring about genuine advantages, especially in the telegraph and railway services. By its adoption in the telegraph service mistakes that now easily occurred would be avoided, and there would be a saving in transmitting unnecessary signs. The writers estimated that in the system of the Western Union Telegraph Company a saving of the transmission of 150,000,000 letters annually would be effected out of the 44,000,000 messages a-year transmitted by that Company.

Limavady (Ireland).—At the last meeting of the Board of Guardians notice was received from Mr. J. E. Ritter, J.P., of his intention to apply for a Provisional Order to light by electricity a district of the Limavady Union. Mr. Hopkins thought that the shareholders in the Limavady Gas Company would not like to hear of this. Mr. Given said the shareholders in the Company did not care. Sir Thomas Leckey said that Mr. Ritter was to be congratulated on introducing the electric light into the Union. The notice was ordered to be put on the minutes.

Liverpool.—At the last meeting of the Special Lighting Committee it was stated that there was a good prospect of the Bill for the acquisition of the local electric supply company's undertaking being passed through Parliament this year. The Committee intend to apply for a Provisional Order to enable them to supply electric current to the whole of the city.

Nottingham.—Messrs. Calvert and Co., of Exchange-buildings, Manchester, have obtained a contract for lighting electrically Colwick Hall and Grounds, Nottingham. The installation, which is for 24 2,000 c.p. arcs, is to be completed by the 1st prox. Messrs. Calvert and Co., although a comparatively new firm in this country, notify that they are very busy in the contract department.

Omnibus Lighting.—Many attempts have been made, with more or less success, to light the omnibuses of the London General Omnibus Company and the London Road Car Company, but recently these attempts have been abandoned. A trial has, however, for the past two or three weeks been made on some of the 'buses of the London General running between Broad-street station and Westminster, and the lighting has so far proved satisfactory, the conductors affirming that no trouble has been experienced during the experiment, which is at present only on a small scale.

The Pacific Cable.—This week's bulletin is to the effect that the Vice-President of the San Francisco Chamber of Commerce, from thorough inquiries made, is convinced that a Pacific cable will shortly be laid by a group of British capitalists. The route chosen is from Auckland to Vancouver, by way of Norfolk Island, Fiji and Fanning Island. This very important information comes through Reuter's Agency.

Peterborough.—At the last meeting of the City Council the salary of Mr. J. C. Gill, the city engineer, was raised from £275 to £375 per annum, in consideration of his performing the additional duties of electrical engineer.

Provisional Orders.—The Carlisle Electric Lighting Provisional Order has been passed by both Houses of Parliament.

Redcar.—At the last meeting of the District Council a letter was read from Messrs. Stacey and Bennett stating that the cost of introducing the electric light for the public lighting of the district exceeded their unaided capabilities, and asking the Council's support in forming a company. It was agreed to appoint a committee to meet Messrs. Stacey and Bennett to consider the question.

Shanghai.—The Municipal Council have received plans for the construction of about 25 miles of tramway on the overhead electric system.

Snaefell.—The electric railway is rapidly approaching completion, and will, it is expected, be ready for opening in a few weeks. The railway opens out magnificent mountain scenery, and goes to the summit of Snaefell, the highest mountain in the Isle of Man.

Society of Engineers.—On Wednesday last the members of this Society visited the central station of the Dover Electricity Supply Company (Limited).

Stretford.—At the last meeting of the District Council a letter was read from the Manchester Suburban Electric Supply Company (Limited) intimating their intention of applying in the next Session of Parliament for a Provisional Order to enable them to supply the district with electric current, and asking for the sanction of the Council to the application. After some discussion the communication was referred to the Highways Committee for consideration and report.

Telephone Trunk Lines.—Interesting and successful experiments with the trunk telephone wires between the Exchange Post Office, Liverpool and the General Post Office, London, took place on Monday last before the Lord Mayor, the President of the Liverpool Chamber of Commerce, and representatives of the chief shipping firms. The object of the experiments was to test the utility of these wires, with which it is intended ultimately to connect the chief towns of the kingdom. Conversations were carried on between Mr. Spencer Walpole, the secretary of the Post Office, and several other leading officials, as well as with Glasgow and Leeds. Similar trials of the trunk lines took place at Bristol on the same day, the results proving highly satisfactory.

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UP-RIVER STEAMERS.—The service of steamers on the river Thames, especially those for the beautiful up-river points, has hitherto, by universal consent, been most unsatisfactory. A new departure has now been made, and yesterday (Thursday) a large party of press representatives and others, under unfavourable weather conditions, proceeded from London to Hampton Court on the "Queen Elizabeth," a vessel drawing only 15 inches of water, and so constructed as to comfortably pass through all the locks up to Hampton Court. The builders, Messrs. Edwards and Co., of Millwall, are to be congratulated upon the handsome appearance of the boat, which has a promenade deck the entire length of the vessel (165 feet), and is installed with the electric light, fancy fittings being let into the panels of the saloons. A complete electric lighting plant has been supplied by Mr. W. Mackie, of Turnmill-street, London, E.C. The owner and manager, Mr. Edgar Shand, has exceptional experience of Thames river traffic, and it is to be hoped that his spirited endeavour to provide suitable craft for passenger and pleasure traffic may meet with such success as to warrant a speedy increase in the fleet of which the "Queen Elizabeth" is a promising example. Even in wet weather the "Queen Elizabeth" is a very comfortable boat.

WELLINGBOROUGH.—The installation of the electric light in the extensive sidings of the Midland Railway Company at Wellingborough, where the marshalling of all the coal traffic for London and the South is carried out, has now been completed. By means of the electric light work can now be performed with the same facility by night as in daylight, and with much less danger to the men employed.

WELLS.—Some time back an offer was made by Mr. A. Dixon Browne to light the public streets of Wells for a sum of £350 per annum for a period of three years. This proposal was approved by the Town Council, and a contract prepared for Mr. Browne's signature. There appears to be some hitch in the arrangements, and in a letter read at the last meeting of the Council it was suggested that, in order that the scheme of lighting the district electrically might be carried through, the appointment of another electrician might become necessary.

WEST COWES.—The District Council have received Mr. Medhurst's report on the proposed electric lighting of the district, and is to be considered at the next meeting.

WOLVERHAMPTON.—The report of the Lighting Committee, which is to be presented at the meeting of the Town Council on Monday next, states that the generating plant at the central station is now taxed to almost its utmost capacity, and, as the Council wish to make certain extensions, the Committee recommends that additional machinery be put down, and that application be made to the Local Government Board for sanction to borrow a further sum of £5,000 for this purpose.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

June 19, 1895.

11,944. C. RALEIGH. London. Improvements in the electrolytic deposition of metals and in means applicable therefor.

11,951. S. BERDITSCHEWSKY (called APOSTOLOFF). London. Improved system of telephonic exchange.

June 20, 1895.

11,973. C. B. CRAWSHAW and R. KENNEDY. Bradford. Improvements in lights and reflectors for photography by electric and other lamps.

11,976. H. W. HEADLAND. London. Improvements in electric safety lamps for use in mines and other places.

11,982. S. F. WALKER. Cardiff. Improvements in electromagnetic devices for automatically breaking the connections with the source of supply of electric light and power cables.

12,030. W. J. DAVY. London. Improvements in electric arc lamps.

12,035. T. J. PHIPPS. London. Mechanism for cutting off gas or electric current at any desired time.

12,042. W. JANDUS. London. Improvements in globes for arc lights for other lights of great intensity.

June 22, 1895.

12,157. J. L. BERNERS and F. GRIFFIN. London. Improvements in electric lighting, specially applicable for lighting vehicles.

12,161. A. J. MOULART. London. Improvements in apparatus for automatically indicating the fracture of electric conductors.*

June 24, 1895.

12,187. H. C. L. HOLDEN. Woolwich. Improvements in telephonic apparatus.

12,229. H. J. F. VOIGT and J. A. HAEFFNER. Liverpool. Improvements in electric resistance and in the manufacture thereof.*

12,232. J. B. ATHERTON and G. H. NISBETT. Liverpool. Improvements in or appertaining to the manufacture of electric cables and of materials therefor.

12,244. J. C. GRAHAM. London. Improvements in electro-deposition.

June 25, 1895.

12,233. A. J. BOULT. London. Improvements in devices for attaching electric conductors to their supports. (L. N. Kugler, Germany.)

12,307. L. B. ATKINSON. London. Improvements in dynamos, motors, and alternators.

12,311. SIEMENS BROS. AND CO. (LIMITED). London. Improvements in contact or collector bars for the overhead conductors of electrical railways and tramways. (Messrs. Siemens and Halske, Germany).

12,329. A. MERREL and A. DUFFEK. London. Improvements in and relating to telegraphic systems and instruments therefor.

June 26, 1895.

12,374. R. HOCKING and G. BRAND. London. Improved means for indicating and controlling the supply of electricity to portable and other electric lamps and apparatus.

12,394. E. KOSANKE, C. FUHR, and B. KRAUSSE. London. A new or improved apparatus for indicating the time and number of telephonic communications.

12,404. G. HOOKHAM. London. Improvements in electricity meters.

June 27, 1895.

12.412. A. L. TAYLOR. Liverpool. A combined heat radiator and electric lamp shade.

12,414. J. T. NIBLETT. London. Improvements in apparatus for electrically lighting vehicles.

12,417. C. H. WEISE. Manchester. Improvements in the manufacture of positive plates for secondary electrical batteries.*

12,420. C. H. WEISE. Manchester. Improvements in the manufacture of plates for secondary electrical batteries.*

12,438. W. WEAVER. London. Ventilators for culverts, tubes, pipes, boxes, and chambers laid or fixed in roads and footpaths in connection with the distribution of electricity.

12,468. A. MÜLLER. London. Improvements relating to the current supply of electric railways by an auxiliary accumulator battery.*

12,470. A. MÜLLER. London. Improvements relating to electric railway vehicles.*

June 28, 1895.

12,477. K. J. TARRANT and C. R. G. SMYTHE. London. Improvements in and connected with the insulation of storage cells, batteries, &c.

12,498. M. MEIROWSKY. London. An improved compound for electrical insulating purposes*.

12,499. E. A. BROWNING. Edinburgh. Improvements in holders for electric lamps.

12,521. J. B. TORRES. London. Improvements in and connected with the electrolysis of oxides, salts, and other compounds.

12,533. H. H. LAKE. London. Improvements in electrical alarm devices for steam and other gauges. (W. H. Bradt and M. Marble, United States*).

12,545. A. MOULART. London. An electrically-protected locking or fastening device for doors or the like.*

12,546. CHAMBERLAIN AND HOOKHAM (LIMITED) and S. H. HOLDEN. London. Improvements in electricity meters.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

11,241. BOARDMAN. Electric lamp.

11,559. LÜDEKE and OTHERS. Magneto-electric motors.

12,304. FRENAY-OLYFF. Electric telephone systems.

12,476. RAWORTH. Electric switching and regulating apparatus.

12,082. SHORE. Erecting telephonic, &c., wires.

13,728. DICKINSON. Supporting overhead wires or cables.

14,847. LIARDET. Electric batteries.

14,987. WISE (Solvay and Co.). Electrolysis of alkaline salts.

17,379. WILLCOX (Eisenwerk vormals Nagel and Kaemp Actien-Gesellschaft). Electric elevators or cranes.

20,807. TAYLOR. Telegraph transmitters.

24,613. HALL. Electric signalling system.

1895.

5,747. PERKINS. Dynamometers.

7,086. RUSSELL and OFFICER. Electric switch.

7,649. CROSBY and SHAW. Arc lamps.

7,668. DEVONSHIRE (Rice). Electric distribution.

7,673. FRIEDLÄNDER and MÜLLER. Incandescent lamps.

8,873. LINDNER and VAN SWEEVELT. Electric traction.

9,010. BAIRD. Electric railways.

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COMPANIES' MEETINGS AND REPORTS.

Electric and General Investment Company (Limited).

The sixth ordinary general meeting of the shareholders of this Company was held on Tuesday at Winchester House, under the presidency of Mr. George Herring.

The SECRETARY (Mr. J. Cecil Bull) read the notice calling the meeting.

The report having been taken as read, the CHAIRMAN said: The empty chairs tell me pretty plainly that the absent shareholders are perfectly satisfied with the report, and I have no intention of detaining those gentlemen who are present with a long speech. I will therefore at once proceed to the balance sheet. The first line on the left hand is the capital, and, as I have before explained, the smallness of the capital you have paid up is the cause of your large dividend. The reserve fund in connection with the Founders' shares I will speak of when I come to deal with the other side of the account. The reserve fund of the Ordinary shareholders still remains as before; and the item of "Provision for contingencies" we have left, for reasons we consider quite satisfactory, at £8,000. The loan account is increased to £26,790, and perhaps you will notice the reason for that by the footnote to the balance sheet. Last year there was a liability of £35,431, which is now reduced to £8,516. That partly accounts for the increased loan. The item of sundry creditors stands at £1,431. The balance of profit and loss account is £5,330, of which I will speak presently. On the other side of the balance sheet the entry "By investments at cost" is one upon which you naturally depend. I may say that the investments are stated at cost, not because we have not carefully gone over them and seen the valuations, but because we have determined not to be continually altering them according to the valuations, although we keep that point in our mind. I can tell you, however, that the £69,821. 8s. 2d. is absolutely good at the present moment. The sundry debtors are quite good; in fact, many of them have since paid. The item of cash in hand speaks for itself. The Founders' reserve fund is smaller by the amount of money on the other side—that is, by the dividends received and investments sold by trustees—£1,584. I shall have again to say a few words regarding the Founders' reserve fund, and therefore I will at this moment merely call attention to this alteration, and proceed to the profit and loss account. The first item there to which I will call your attention is the general charges, and, as I have before said, they increase with your profits, and you must grumble if you see the charges decrease, because that will mean that your profits are less. An interim dividend was paid to you last December at the rate of 10 per cent. per annum for the six months ended 30th November, and there is now a balance of £5,330, which we propose to divide in the manner stated in the report. We propose to pay to the Ordinary shareholders a dividend at the rate of 30 per cent. per annum for the past six months, and a dividend on the Founders' shares of £20 per share for the year. This will leave a balance of £330. 13s., which will be apportioned equally to the reserve funds of the Ordinary and Founders' shares. Now, with regard to the Founders' reserve fund I will say a few words. We invested it originally for the Founders, and in doing so we invested it, as we thought, in a proper and advantageous manner. Fortunately it has turned out to be even better invested than we had hoped for at the time, and therefore the Board and the Trustees thought that it was only a proper thing that some small part of the securities should be sold and be divided amongst the holders of the Founders' shares. Absent shareholders, as well as those present, must understand distinctly that all the stock of the Founders' reserve could have been sold if the Trustees had liked, but they only sold this portion in order to keep up the rate of dividend. I have no wish to discount or to prophesy regarding the future, but I think it only fair to tell you what the worth of your shares is at the present moment, and I can do that in a few words, so that you may see at once how you stand. Taking our word that the investments at cost price are worth the money, we find that we have the capital which you have paid intact, which we will call £1; the reserve fund, which we call another 10s.; and the provision for contingencies, which you may reckon as being about £5,000 for the Ordinary shareholders' reserve and £3,000 for the Founders' reserve, would give another 5s. a share, and in addition there is the present dividend of 3s. per share, so that altogether you have your Ordinary shares at this moment worth £1. 18s., *plus* the goodwill of the business, and it is for you to reckon what that is worth. We believe that the reserve fund, if cut up, would produce £140 to each of the holders of the Founders' shares. Their £5 of capital is intact; and taking at £30 a share their portion of the provision for contingencies we have £175 a share, in addition to the £35 16s. to be paid now. The Founders' shares are at this moment, therefore, worth absolutely £210 each, *plus* the goodwill of the business. I make these remarks because our shares are not dealt in on the Stock Exchange in the free manner that, for instance, Turkish stocks are dealt in, and therefore there is a general feeling—What is the worth of the shares? I have now told you what their value is at the present moment, irrespective of what the goodwill of the business may be worth. I do not know that I need detain you any further, but I shall be glad to answer any questions. I now propose—

"*That the report of the Directors and the statement of the accounts to May 31, 1895, with the appropriation of the surplus profits as proposed, be and the same are hereby received and adopted.*"

Mr. J. B. BRAITHWAITE, Junr., briefly expressed his pleasure in seconding the motion.

The resolution was carried unanimously.

The CHAIRMAN: I have now to propose—

"*That a dividend at the rate of 30 per cent. per annum for the half-year ended May 31, 1895—making, with the interim dividend at the rate of 10 per cent. per annum paid for the six months ended November 30, 1894, 20 per cent. for the year—be and is hereby declared on the capital paid up on the Ordinary shares, that a dividend of £20 per share be and is hereby declared on each Founder's share, and that the respective dividends be paid on July 3, 1895.*"

Mr. B. H. VAN TROMP seconded the motion, which was carried unanimously.

The CHAIRMAN: The Directors who retire are Lord Cloncurry and Mr. Braithwaite. Lord Cloncurry has found it necessary to remain in Ireland for the greater part of the year, and therefore wishes to retire. We have accepted his resignation with great regret, but we were compelled to do so. Mr. Braithwaite, the other retiring Director, offers himself for re-election. His abilities and devotion to your interests are so well known that it is not necessary for me to say anything further, and I therefore formally propose that he be re-elected.

The MANAGING DIRECTOR (Mr. Emile Garcke) seconded the resolution, which was unanimously agreed to.

On the motion of Mr. SYDNEY MORSE, Mr. George T. Rait was re-elected as auditor for the year ending May 31, 1896.

A cordial vote of thanks to the Chairman and Directors brought the meeting to a close.

India Rubber, Gutta Percha, and Telegraph Works Company (Limited).

A half-yearly general meeting of this Company was held on Thursday at Cannon-street Hotel, Mr. S. W. Silver presiding.

The SECRETARY (Mr. W. J. Tyler) read the notice calling the meeting.

The CHAIRMAN said: The occasion of calling you together to confirm the proposal just referred to in the notice calling the meeting affords an opportunity of reminding you that when we last met discouraging prospects of the trade of the country generally prevailed, and allusion was made to the caution necessary in opening accounts in order to avoid losses. This coupled with such keen competition as prevails on all sides, called for extra care and great efforts on the part of the staff and every one engaged, in order that the volume of business of this large and varied concern might not be diminished. Speaking generally, I may say the works, which are in first-rate order, at Silvertown and Persan, have been fairly well employed, with the exception of the submarine telegraph departments, in which we have no contract of importance to report. You doubtless are aware that our books are not made up until the end of the year. As a matter of prudence and precaution it is, in the judgment of the Directors, not judicious to pay a higher interim dividend than 2½ per cent. on the present occasion. With these few remarks I beg to move

"*That an interim dividend of 2½ per cent., or 5s. per share, free of income tax, payable on the 5th inst., be now declared.*"

Mr. ABRAHAM SCOTT seconded the resolution.

Mr. ROBERTSON asked if the shareholders might have a little further information with regard to the serious drop in the interim dividend from 10s. to 5s. per share. He thought that, at least, attention ought to have been called in the circular sent out to the reduction, instead of it being altogether ignored. The Board would probably have observed that some of the shareholders had been frightened by the announcement, and had been hurt in their interest. If anything of the sort should occur again he hoped the Board would give some explanation in the circular issued to the shareholders.

Capt. GRANT inquired if the Directors had any information to impart with reference to the Pacific cable.

Mr. WATSON wished to know if the reserve fund still stood at £450,000.

The CHAIRMAN, in reply, said: With regard to the circular issued to the shareholders calling this meeting, I may say that it has been in the same form from the commencement, and I do not think we shall alter it. (Mr. Robertson: "I hope you will.") The Pacific cable question remains unaltered. Yesterday's *Times*, I think, has a reference to it, but that is only a repetition of what we heard six months ago. It is in the hands of the Home and Colonial Governments. The reserve fund remains as it was.

The resolution was then agreed to unanimously.

Mr. TREBLE proposed a vote of thanks to the Chairman, which was carried.

The proceedings then terminated.

United River Plate Telephone Company (Limited).

The following report of the Directors of this Company for the year ended March 31st last will be presented at the ninth ordinary general meeting, to be held at Winchester House, Old Broad-street, E.C., on Tuesday next, at 12 o'clock:—

At par of exchange the Company's gross receipts for the year were £149,262. 2s. 9d., the working expenses in the River Plate £71,449. 9s. 3d., and the loss on exchange £58,693. 2s. 7d., leaving a profit, after the deduction of all charges, of £9,901. 15s., to which is added £6,417. 17s. 4d. brought forward, making a total of £16,319. 12s. 4d. The Directors propose to transfer to depreciation and renewal fund £3,000, and recommend that a dividend of 3 per cent. (free of income tax) be paid upon the

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Ordinary share capital of the Company, and that the balance of £4,619. 12s. 4d. be carried forward.

The capital outlay for the year was £2,661. 16s., against £3,038. 5s. 8d. for the previous year. The plant has been maintained in good and efficient condition at the cost of revenue. There has been a continuous increase in the business of the Company, and the Directors trust that this improvement will be maintained in the future.

Mr. Frank W. Jones and Mr. Alfred Le Rossignol offer themselves for re-election as Directors, as do the auditors, Messrs. Cooper Brothers and Co.

NEW COMPANIES, STATUTORY RETURNS, &c.

CAPITAL AND COUNTIES ELECTRICITY SUPPLY COMPANY (LIMITED).—This Company was registered on June 28th, with a capital of £5,000, in £5 shares, to carry on the business of electric light contractors and makers and dealers in electrical plant and apparatus. The subscribers, with one share each, are: Edward Mann, electrician; F. Wright, C. E. Masterman, Percy Greville, electrician; A. Branch, electrician; W. E. Hanshaw, and Geoffrey New.

LIVERPOOL DISTRICT LIGHTING COMPANY (LIMITED).—This Company was registered on June 29th, with a capital of £2,000, in £5 shares, to carry on at Liverpool and its neighbourhood the business of an electric supply company in all its branches, electricians, mechanical and electrical engineers, suppliers of electricity for the purposes of light, heat and motive power, and manufacturers of and dealers in electrical apparatus and materials; to construct, lay down, establish, fix, and carry out all necessary cables wires, lines, accumulators, and works, and to carry on the business of a gasworks company. The subscribers, with one share each, are: J. Entwistle, H. J. Hale, W. Bartington, A. W. Cockeram, J. Cox, G. Hall, and J. Griffiths.

NEWMARKET ELECTRIC LIGHT COMPANY (LIMITED).—This Company was registered on June 27th, with a capital of £30,000, in £10 shares, to carry on at Newmarket, Suffolk, and neighbourhood, the business of electrical engineers, electricians, engineers and contractors, suppliers of electrical power, light and heat, manufacturers of and dealers in electrical and scientific apparatus, chemical engineers, and the general business of an electric light, heat and power supplying company. The subscribers, with one share each, are: T. Jennings, J. V. Lawrance, W. B. Sheppard, G. J. Jennings, B. Cuennell, A. Hughes, and E. H. Leach, all of Newmarket.

PINTSCH'S PATENT LIGHTING COMPANY (LIMITED).—This Company was registered on June 27th, with a capital of £60,000, in £5 shares, to carry on the business of lighting railway carriages, buoys, &c., with gas or other illuminating agency.

STANDARD ELECTRO-GALVANISING COMPANY (LIMITED).—This Company was registered on June 27th, with a capital of £4,000, in 3,500 Ordinary and 500 Deferred shares of £1 each, to purchase and work certain patents, &c., and to carry on the business of manufacturers and galvanisers of iron, steel, and other metals.

TOWN AND VILLAGE ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—This Company was registered on June 25th, with a capital of £100,000, in 19,800 Ordinary shares of £5 each and 1,000 Founders' shares of £1 each, to acquire and take over as a going concern the business of supplying electric light, heat and power, carried on by the Western Counties Electric Light and Power Syndicate (Limited), at Kingswood, Gloucestershire, and at Keynsham, Somersetshire, and carry into effect agreements made between George J. T. J. Parfitt and Edward B. A. James (acting for the Company), and between Harry Seymour Foster and the Company, and to carry on the business of undertaking the supply of electricity for light, heat, power and other purposes, electrical and mechanical engineers, electricians, and manufacturers of and dealers in all apparatus required for the generation, distribution, supply, accumulation and employment of electricity. The subscribers, with one share each, are: H. A. Tobias, H. E. Bailey, C. A. Mocatta, T. J. Woodrow, I. du Mont, C. F. Ince and L. H. Lemon. The first Directors are: F. B. Bond, W. Clifton, E. B. James and E. Casper.

ALTERNATE-CURRENT ELECTRO-MOTOR SYNDICATE (LIMITED).—An agreement, dated April 8th, made between Walter Langdon-Davies, engineer (the vendor), and George W. de Tunzelmann, electrical engineer (acting as trustee for the Company), provides for the sale to and purchase by the Company of the rights of the vendor as the inventor of certain improvements in electro-motors and similar electromagnetic apparatus having for their object the production of an approximately uniform rotating magnetic field suitable for working non-synchronous alternating-current motors, for which he has filed provisional specification and acquired provisional patent rights No. 19,364 of 1894. The consideration for the sale has been fixed at £2,500, payable £500 in cash and £2,000 by the allotment as fully paid of 2,000 shares of £1 each. The vendor has agreed to serve the Company at a salary of £400 per annum.

ANDREWS' FOREIGN SYNDICATE (LIMITED).—The statutory return, made up to May 6th, has been filed. The nominal capital is £4,000, in £1 shares. Of these 3,710 have been taken up, and 3,318 issued as fully paid to Joseph D. F. Andrews, electrical engineer, and John C. B. Andrews. The full amount has been called on the remaining 392 shares.

CITY NOTES.

CENTRAL LONDON RAILWAY.—Letters of allotment in the recent issue of the capital of this Company have been posted.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LIMITED).—This Corporation makes payment of the half-yearly interest on the Five per Cent. Mortgage Debentures, due 1st inst., on and after that date.

CHELSEA ELECTRICITY SUPPLY COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend on the Six per Cent. Preference shares of the Company for the half-year ended June 30th. The dividend is payable July 18th.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended June 30th were £780, as against £1,020 in the corresponding week of 1894, being a decrease of £240. The total receipts for the half-year amount to £23,873, against £23,638 for the corresponding period of 1894, an increase of £235.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The warrants for interest due July 1st on this Company's Five per Cent. Debenture Stock have been posted.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—Mr. C. L. W. Fitzgerald presided yesterday (Thursday) over an extraordinary general meeting of the shareholders of this Company, when the resolutions relative to the modifications of and additions to the Articles of Association passed at the extraordinary general meeting of the Company held on June 6th last, were unanimously confirmed.

COVENTRY ELECTRICAL ENGINEERING COMPANY (LIMITED).—This Company has issued a prospectus inviting applications for 3,234 £1 shares. The Company was registered on September 11th last with an authorised capital of £5,000 in £1 shares, and carries on a general electrical engineering business. The lists opened on Monday last and closed yesterday (Thursday).

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of June, 1895, amounted to £1,884, as against £1,617 in the corresponding period of last year.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of June amounted to £58,500, and to £53,752 in the corresponding period of 1894, being on increase of £4,748.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of June, 1895, amounted to £36,679, and to £44,244 in the corresponding period of last year.

ELECTRIC AND GENERAL INVESTMENT COMPANY (LIMITED).—The warrants for the dividends, &c., recently declared by this Company, have been duly posted.

ELECTRICAL COMPANY (LIMITED).—We are asked to state that at the general meeting of this Company, on June 25th, Mr. F. T. Eggers was elected as Director. A resolution was passed by the Board appointing Mr. Eggers Managing Director. It was also decided that an important increase of capital will take place at the fall of the year.

INDIA-RUBBER, GUTTA-PERCHA AND TELEGRAPH WORKS COMPANY (LIMITED).—On the announcement of the greatly reduced interim dividend on the Ordinary shares of this Company, a fall in the shares from 21½—22½ to 17—19 took place. The *Financial News* is responsible for the following explanation:—"The reduction in the interim dividend of the India-Rubber and Gutta-Percha Company from 5 to 2½ per cent., which caused such a heavy fall in the shares last week, is not, we believe, due to any falling off in the Company's general business, but to a special reason. Tenders were invited some time ago for the new Pacific cable, and although nothing has yet been finally decided, the tender of the India-Rubber Company was the lowest, and has every prospect of being accepted. It is probably in order to retain as much cash in hand as possible, in case they get the contract for laying the cable, that the Directors have reduced the usual interim distribution; and, if this be so, shareholders need have no anxiety for the future." The closing price of the shares on Wednesday was 20—22.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 30th ult. amounted to £1,193. The amount for the corresponding week last year was £894; increase, £299.

NATIONAL TELEPHONE COMPANY (LIMITED).—The Directors of this Company, at their meeting yesterday (Thursday), resolved, subject to final audit, to recommend at the forthcoming general meeting of shareholders the following dividends (less income tax) for the half-year ended June 30th last:—At the rate of 6 per cent. per annum on the amounts paid up on the First and Second Preference shares, 5 per cent. per annum on the amounts paid up on the Third Preference shares, and 5 per cent. per annum on amounts paid up on the Ordinary shares, carrying £35,000 to reserve and about £3,000 forward. The transfer books of the Company will be closed from the 13th to the 26th inst. inclusive, and the dividend warrants will be posted on the latter date.

WEST AFRICAN TELEGRAPH COMPANY (LIMITED).—This Company gives notice of the annual drawing of Five per Cent. Mortgage Debentures, which will be paid off at par on September 2nd next at the National Bank of Scotland (Limited), Nicholas-lane, Lombard-street, E.C.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended June 28th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,552.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the half month ended June 30th were £1,854, as compared with £2,301 for the corresponding period of last year.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, June 26.		Price Wednesday, July 3.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending July 3. Highest	Lowest
			TELEGRAPHS								
£1,012,880	Stock	10/0	Anglo-American	47	49	47	49	4 1 8	Jan., Apr., July, Oct.	47	..
£2,993,560	Stock	20 0	Do. Preferred	88½	89½	88	89	4 9 11	" "	89	88
£2,993,560	Stock	5/0	Do. Deferred	8½	9	8¼	8¾	..	..	..	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer) xd	103	106	101	104	3 16 11	January and July	..	..
130,000	£10	3/0	Brazilian Submarine xd	13	13½	13	13½	4 16 4	Mar., June, Oct., Dec.	13½	13
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906) xd	111	115	110	114	4 7 9	June and December	111	..
10,000,000	$100	1¾%	Commercial Cable Capital Stock xd	165	170	165	170	4 2 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	13½	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	21	..
12,931	5	2/0	Direct Spanish (fully paid)	3½	4½	3½	4½	4 8 11	April and October	..	–
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10¼	9¾	10¼	4 7 7	" "	9⅞	–
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each xd	105%	108%	103%	106%	4 4 11	..	..	–
60,710	20	2/0	Direct United States Cable, 1877	9½	9¾	9½	9¾	4 0 5	Jan., Apr., July, Oct.	9½	..
400,000	10	2/6	Eastern	16¼	16½	16⅜	16⅝	3 18 1	" "	16⅝	16⅜
70,000	10	6%	Do. 6 per Cent. Preference	17¼	17¾	17¼	17¾	3 7 7	" "	17 9/16	–
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	123	126	123	126	3 3 6	May and November	125½	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	109	106	109	4 13 6	February & August	..	..
250,000	10	6/6	Eastern Extension	17	17½	17	17½	4 1 2	Jan., Apr., July, Oct.	17½	17¼
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	124	127	124	127	3 3 0	February & August	125½	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900 xd	104	108	102	106	4 14 4	January and July ..	104½	125
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900 xd	104	108	102	106	4 14 4	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	107	110	107	110	3 13 11	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	111%	114%	111%	114%	3 10 6	May and November	112	–
180,227	10	2/3	Globe Telegraph and Trust	9⅞	10⅛	10	10¼	4 8 11	Jan., Apr., July, Oct.	10⅛	9⅞
180,042	10	6%	Do. 6 per Cent. Preference xd	16½	17	16¾	17	3 10 7	" "	16¾	16⅝
150,000	10	5/0	Great Northern	22	22½	21½	22½	3 16 3	Jan., April, and July	21⅞	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	..	..
17,000	25	37/6	Indo-European	47	50	49	52	4 16 2	May and November	50¾	49⅝
37,548	10	2/6	London Platino-Brazilian	5	7	5	7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	106	110	106	110	5 11 1	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942 xd	107	110	105	108	3 14 1	..	..	..
11,839	8	4/0	Reuter's	3½	4½	3½	4½	..	April and October	..	..
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	124	129	124	129	4 13 0	" "	125	..
15,609	10	5/0	West African Telegraph	4½	5½	4½	5½	..	January and July ..	..	–
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	102	106	102	105	4 16 7	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902 xd	100	105	98	103	7 15 4	June and December	100	..
88,321	10	6d.	West India and Panama	¾	1	¾	1	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	9¾	10¼	9¾	10¼	5 6 8	May and November	10 3/16	10
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9	8½	9½	6 13 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.) xd	110	113	109	112	4 9 3	June and December	..	..
64,242	15	6/0	Western and Brazilian	10½	11	10½	11	4 1 11	May and November	10¾	10½
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6½	6¾	..	–	6⅝	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4¼	4¾	4½	4¾	..	..	4 9/16	4⅜
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	103	107	103	107	5 14 10	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	103	107	103	107	5 14 10	" "	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	5 19 8	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 17 8	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	–	..	3½	..
224,850	10/0	1¼d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	–	May and November	..	–
171,504	£1	8·215d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	..	..
484,597	5	2/6	National	5½	5¾	5⅝	5⅞	4 5 1	June and December	5 13/16	5 11/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15½	16½	15½	16½	3 12 9	" "	16¼	16
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½	15½	14½	15½	3 17 5	" "	15	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅞	6⅛	5⅞	6⅛	4 1 8	–	6	..
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.) xd	104	106	105	107	3 5 5	January and July ..	106	101⅞
58,000	5	1/0	United River Plate	1½	2½	2	3	..	" "	2	..
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.) xd	87	92	92	97	5 3 1	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	14½	15½	14½	15½	1 2 3	–	15	15
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15¾	16¼	16	16½	3 13 10	–	16½	16 3/16
£100,000	Stock	5%	Do. 5% Debenture Stock (red.) xd	130	135	131	134	3 12 9	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	–	15⅝	15½
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	..	..
8,322	£5	..	House-to-House Electric	–		–		..	–	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	–		–		..	–	–	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July ..	–	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7¾	7⅞	7¾	7⅞	..	–	..	..
111,000	5	..	London Electric Supply	..		..		..	–	..	–
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	10¼	10¾	10½	11	2 14 7	..	10⅝	..
£150,000	Stock	4½%	* Do. 4½% Debs. xd	115	117	115	117	3 16 11	June and December	117	..
6,452	£10	2/0	Notting Hill Electric	8	8½	8	8½	..	–	..	–
19,980	£5	4/6	St. James and Pall Mall	8¼	8¾	8¼	8¾	..	–	..	–
20,000	£5	7%	Do. 7 per Cent. Preference	9	9½	9	9½	3 13 8	–	9¼	9½
59,900	5	5%	Westminster Electric Supply (fully paid)	7¾	8¼	7¾	8	3 2 6	–	..	–
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	8	1/6	Brush Electrical Engineering	2¼	2½	2¼	2½	6 0 1	–	2⅜	–
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	–	..	–
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	112	115	112	115	3 19 4	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2	2½	2	2½	..	January and July ..	..	–
12,139	5	..	Edison and Swan United	1¾	2¼	1¾	2¼		..	..	–
£100,000	Stock	4½%	Do. 4% Mortgage Debenture Stock xd	–		104	107	4 4 1	..	104	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		–		..	..	–	..
120,000	2	..	Electric Construction	⅝	⅞	¾	1	..	..	⅞	–
12,845	2	2/9½	Do. 7 per Cent. Cumulative Pref.	1¾	2¼	1¾	2¼	..	..	1 15/16	1¾
91,195	2	10/0	Elmore's Patent Copper Depositing	1	1½	1	1½	..	..	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	¼	¾	1¼	1½	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	17	19	20	22	4 11 11	February & August	21¾	17
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 7 7	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..	–	..	..
16,000	£10	..	Do. 8 per Cent. Preference	..		–		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)		⅛		⅛	..	..	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	43	45	43	45	5 6 8	March and July...	43⅝	43
£150,000	100	5%	Do. 5 per Cent. Bonds xd	106	109	104	107	4 13 6	January and July	..	..
37,514	£5	–	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,870	10	12/0	W. T. Henley's Telegraph Works Ordinary	10½	11½	10½	11½	5 4 4	..	11	..
£30,000	10	7%	Do. 7 per Cent. Preference	14	15	14	15	4 13 4	..	14¾	14½
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock	..		104	107	4 4 1	..	106	..
			RAILWAYS AND TRAMWAYS.								
£330,000	Stock	1¼%	City and South London Railway	42	44	42	44	2 16 10	May and November	..	–
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	..	–
£67,130	Stock	4%	Do. 4% Perpetual Debenture	132	134	132	134	2 19 9	May and November	..	..
37,500	£10	2%	Liverpool Overhead Railway	9⅞	10	9 15/16	10 1/16	1 19 10	–	..	..
6,295	10	5%	Do. 5% Preference	14¾	15¼	14¾	15¼	3 5 7	..	..	–
125,000	Stock	4%	Do. 4% Debenture xd	109	111	110	112	3 11 5	January and July	..	–

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 895. [No. 11. Vol. XXXV.] FRIDAY, JULY 12, 1895. PRICE SIXPENCE.

NOTES.

In another column will be found a brief description of a large isolated plant recently laid down at Reading, the chief point of interest of which lies in the use, sanctioned by the Phœnix Fire Office, of iron piping. Instead of being run in the orthodox wood casing, the conductors from the main switchboard to the ceiling roses are encased in iron pipes.

The employment for a new purpose of what in the quaint language of the Patent Office would be termed an old "instrumentality" is always to be preferred to the adoption of any brand-new device answering the same end, provided, of course, the old instrumentality answers the purpose economically, mechanically and electrically at least equally well. The right place for the insulation of a house wire is on the wire itself, not on its protecting shield, the sole object of which should be to afford protection from mechanical injury, wet, fire, and the depredations of rodents. However, almost any form of conduit is better than wood casing, and it is therefore satisfactory to learn that the wiring of the new buildings now being erected on the grounds of the North-Western Hospital, Haverstock Hill, is also to be carried out on some conduit system. The tenders for this job have to be sent in by Thursday next, but, so far, the response to the advertisements has been meagre in the extreme. If, of course, one particular type of conduit had been specified, this result would have been expected. But as the contractor is left free to adopt any pattern within wide limits, it looks as if wood casing had more adherents than is warranted by the reason of things.

It is becoming increasingly difficult to vindicate any line of research from the charge of futility unless one can specify exactly in what its utility consists. The plea of the general utility of an extension of knowledge no longer avails. It is not enough to discover a way of attaining a certain end; the advantage—scientific or industrial—of reaching that end must be made plain. Tried by this standard, low temperature research is amply justified. In an address delivered some time ago before the Royal Institution, and reprinted in our present issue, Prof. Dewar marshals in formidable array the scientific fruit gathered by him when investigating the properties of bodies at the temperature of liquid atmospheric air, or thereabouts (−190°C.). Liquid oxygen is found to be very transparent to heat rays; the electrical conductivity of metals and alloys becomes exceedingly high; the optical properties of bodies are greatly modified; the elastic constants of metals are profoundly altered, there being for the most part a large increase in tenacity, although bismuth maintains its reputation for eccentricity, its breaking stress being reduced by 50 per cent. between 15°C. and −182°C. And now Prof. Dewar, in conjunction with Prof. Fleming, publishes a preliminary account of some low-temperature investigations on the thermo-electric properties of various pure metals and alloys. The experimenters propose to discuss their results in a further Paper, and we will therefore confine ourselves to pointing out the anomalous behaviour of our eccentric friend bismuth: at about −80°C. the thermo-electric curves of both pure and impure bismuth become discontinuous, bismuth behaving in regard to thermo-electric property at low temperatures in much the same way as does iron in regard to magnetic property at high temperatures. The final justification of low-temperature research, its industrial application, will no doubt come in due time; meanwhile this demonstration of its scientific utility will suffice for most of us.

A number of interesting experiments on the phenomena of electrostatic discharge have recently been undertaken by Mr. G. T. Hanchett, and are described by him in an article in the *Electrical World* of New York. Mr. Hanchett has found that when a uni-directional spark is passed between two tinfoil electrodes there is no appreciable loss of weight of the electrodes, even when weighed with a balance turning with 0·01 milligramme, although finely divided dust of tin was deposited symmetrically around the electrodes and in the spark gap. The dust must have been of an extremely finely divided nature in order to be apparent over so large an area, and yet to possess negligible weight. It is to be regretted that Mr. Hanchett does not appear to have employed any optical or other method of determining the thickness of the film. We would suggest also that oxidation of portions of the electrodes may possibly compensate to some extent for loss of weight, and thus make the latter seem negligible. The discharge exhibits two marked characteristics—a fine blue line and a hazy red line; but when only feeble discharges are passed the red line is not present. Increase of electrostatic capacity in the circuit has the effect of giving greater prominence to the blue line, and it gives a yellower tint to the red one. The author regards this as being in

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curious disagreement with MAXWELL's formula, since the increased capacity of the circuit apparently produces a discharge of shorter luminous wave-length. This, however, is rather an unwarranted interpretation of MAXWELL's formula, which is intended to give, not the frequency of the spark light, but the frequency of the electrical oscillations.

PASSING an open street box in the City recently, we observed a couple of men engaged in removing a quantity of what appeared to be wood-paving blocks. The blocks had been placed inside the box in order to fill up space which might otherwise be occupied by an explosive mixture of gas; and they were apparently being removed in order that a joint might be made. The use of bulky solids in this way is an excellent expedient under the circumstances. Various materials have been proposed, from bags of sand to blocks of timber; but the use of all of them entails considerable increase in the labour and time of opening up a street box. Bulk, not weight, is the chief desideratum. Timber blocks no doubt answer the purpose sufficiently well, the only conceivable objection to them being the possibility of their becoming ignited in the remote event of a gas explosion. But it would seem advisable to string the blocks together, so that they may easily be drawn out, rather than to have them separate, as is now the case. Metal, were it not so heavy, would be the best thing to use, as its high thermal conductivity would prolong an explosion into a safe and mild temporary combustion.

IT is well known that in the case of some substances which are poisonous in small quantities, a very much larger dose will prove its own antidote; but it has been left to a Belgian Viscount to apply this principle to secondary batteries. In the old days the great drawback to pasted plates was the liability of the peroxide to flake off and form a connection between the two plates, with consequent detriment to the cell; and much trouble and ingenuity have been expended to render short-circuiting from this cause well-nigh impossible. In Belgium, however, they are about to order things differently; that is, if the Viscount can have his way. He has discovered that oxides in general, and peroxide of lead in particular, have no specific conductivity, and that if they conduct the current when used in a cell, it is only due to the liquid in which they are immersed. Utilising this discovery, he reduces the internal resistance to a minimum by placing the negative electrodes in direct contact with the peroxide without the interposition of any insulator whatever. The inventor states that the only care which need be taken in the setting up of this exceedingly simple and compact cell is to avoid any purely metallic connection between the positive and negative electrodes. There is a delightful simplicity about the construction of this cell which, we make no doubt, will be as much appreciated by our readers as by ourselves.

Cable Interruptions.—There are no cable interruptions to report this week.

Budapest Tramway Company.—The Municipal Committee of Budapest has renewed the contract with the Tramway Company for 50 years, on the condition that by 1898 all the lines are electrically equipped.

Copper Market.—According to Messrs. Merton and Co.'s statistics the visible supply of copper on June 30th was 58,182 tons, as against 50,072 tons on June 30, 1894, and 49,955 tons on June 30, 1893.

Central London Railway.—The Directors of the Central London Railway have instructed their engineers (Sir John Fowler, Sir Benjamin Baker, and Mr. Greathead) to proceed at once with the work.

Telephonic Communication in Java.—A company has just been formed in Batavia with a capital of 33,000fl., to be known as the Telefoon Maatschappij Buitenzorg, to establish and operate a telephone exchange at Buitenzorg.

Municipal Telephony in Amsterdam.—In view of the fact that the concession granted to the Bell Company for the operation of the telephone exchange in Amsterdam shortly expires, the municipal authorities have lately decided to carry on the same as a municipal undertaking.

"The Engineer" Road Carriage Competition.—Our esteemed contemporary the *Engineer* is offering a prize of one thousand guineas, in two or more prizes, for a public competition upon one of the main roads of the kingdom, of mechanically propelled vehicles. Further particulars are promised later.

The Lagrange-Hoho Process.—A practical demonstration of the Lagrange-Hoho process for the electrical treatment of metals was lately given at the central electric lighting station in Fribourg. A company is, it is stated, being formed to acquire and exploit the Swiss patents of the process.

Relative Merits of Cable and Electric Traction.—In speaking of the relative economy of cable and electric traction, Mr. McCulloch, general manager of the National Railway of St. Louis, is of the opinion that where a line earns only £10 a day per mile of single track, it is more economical to operate by electricity, but at £20 per day per mile the cable is the cheaper.

Drilling a Gas Well by Electric Motor.—The Westinghouse Electric Company will begin this week the drilling of a well for natural gas on the land in front of its new works at East Pittsburg, and the novel experiment of using electricity for power will be made. An ordinary 25 H.P. motor, such as is used in a traction car, will be placed in the engine house instead of a steam engine, and the electricity will be supplied from the works.

Electric Traction on Branch Railways in America.—According to *Engineering* the Pennsylvania Railroad Company, finding some of their branch lines financial failures, have introduced electric traction to try and render them remunerative. The first of these branches to be so worked is the Mount Holly line, which is about seven miles in length. In some preliminary experiments a speed of 42 miles per hour was obtained with a trolley car on this line, and with two standard cars attached a speed of 30 miles per hour was reached.

Accumulators at the Paris Central Telegraph Office.—Up to 1892 the work of the Paris central telegraph office required no less than 10,000 large Callaud cells. In that year, however, more than 3,000 of these cells were replaced by two batteries of accumulators. These accumulators have given such satisfaction that it is now proposed to suppress primary batteries altogether, and to instal a further batch of accumulators. The accumulators at present in use consist of a 50 cell battery of 60 ampere-hour Laurent-Cely cells, and a 60-cell battery of 72 ampere-hour Tudor cells.

Damage by Lightning.—On Tuesday last week a ploughman was driving from Lochearn Head Station, when he was struck by lightning and killed. The horse was also thrown down, but recovered.—At Wednesbury, on Saturday last, a young lad, aged 16, was killed by lightning while running across a field.—During a thunderstorm in Southern Sweden on Monday last week a shed, in which nine men and five women had taken shelter, was struck by lightning. Eight of the men were killed on the spot, while the shed was destroyed by fire. Those not killed were seriously injured.

Curious Accident in a Canadian Power House.—According to the *Canadian Electrical News*, an unfortunate accident occurred at the power house of the Toronto Railway Company some short time ago. The electrician in charge of the new Siemens-

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Halske generator undertook to scrape the machine with a knife. The result was that the knife was drawn in and the armature short-circuited; the machine was badly damaged and severely burned the attendant. The accident threw on to the generator of the Canadian General Electric Company so great a strain that it broke down. Traffic on the street railway was for a short time stopped, and during repairs there was some restriction in the number of cars running. The Siemens-Halske machine had not passed out of the hands of the electrician of the firm, who was making the usual tests, when the accident occurred.

Report of the Select Committee on the Telephone Service.—The following is the text of the report of the Select Committee appointed to consider and report whether the provision now made for the telephone service in local areas is adequate; and whether it is expedient to supplement or improve this provision either by the granting of licences to Local Authorities or otherwise:—"Your Committee have examined numerous witnesses upon the matter referred to them, and have completed their evidence, but have not, in view of the approaching dissolution of Parliament, had sufficient time to consider their report. They have therefore agreed to report the evidence they have taken to the House, and to recommend that a Committee on the same subject be appointed in the next Session of Parliament, to consider and report upon the evidence already taken, and, if necessary, to take further evidence.—June 25, 1895."

Obituary.—The death is announced of Mr. J. B. Stearns, who died at Camden, Maine, U.S.A., on the 5th inst., aged 65 years. Mr. Stearns will be chiefly remembered in connection with the practical application of the duplex system of signalling. He showed how capacity could be added to the artificial circuit by means of condensers in such a way as to successfully balance the static capacity of the line. This made the duplex system practical and workable. He visited this country in the early seventies, and the result was the adoption by the Post Office in 1873 of his system of balancing. By means of this system the Department was enabled to work long circuits as duplex circuits, whereas before it had only been possible to apply duplex working to short lines having small capacity.——Rear Admiral Arthur Cecil Curtis, who suddenly expired at Spithead on Wednesday in a boat when returning from a visit to some of the vessels of the Italian fleet, was senior lieutenant of H.M.S. "Terrible," when that vessel took part in the Atlantic cable expedition of 1866, and he was promoted to the post of commander for his services in this connection.

Magnetic Observations.—In the report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, which was read at the annual visitation, it is stated that the variations of magnetic declination, horizontal force and vertical force, and of earth currents have been registered photographically, and accompanying eye observations of absolute declination, horizontal force, and dip, have been made as in former years. Increased magnetic activity was shown in the year 1894, and great disturbances occurred on July 20th and August 20th; the spot of light of the vertical force magnet on the former date, and the spots of light of the horizontal force and vertical force magnets on the latter, having passed beyond the range of the registering sheets for some hours. In July and August the disturbances in the earth-current registers caused by the South London Electric Railway showed a great increase, which is presumably due to the experiments then being made in the use of motors on the carriages of the railway instead of separate locomotives. In the year 1894 there were 10 days of great magnetic disturbance and 13 other days of lesser disturbance. Tracings of the photographic curves for all of these days are being made, and will be published in the annual volume according to the arrangements made with M. Mascart.

Electric Traction for Milan.—As we announced in our issue of June 21st, the Town Council of Milan has entered into a contract with the Italian Edison Company by which the entire tramway service will be transferred to that Company on January 1, 1897. According to the *Frankfurter Zeitung*, this Company a short time ago received a concession from the Italian Government which enables it to employ water of the Adda—the outflow of Lake Como—to the extent of 24,000 H.P. This power the Company intends to transmit to Milan, a distance of about 22 miles, and several adjacent towns for lighting and power purposes. The conditions of the tramway contract are as follow:—The town undertakes to build and equip the lines and purchases all the materials and plant at its own expense, for which purpose a loan of 3,000,000 lire (£120,000) will be taken up. The town pay the Company for the working of the line 0·287 lire per car kilometre about 4½d. per car mile. The cars are to run 18 hours per day, from 6 a.m. till midnight. The town is to take 55 per cent. of the gross receipts and the Company 45 per cent. The system employed to be that of overhead conductors, as already put down by the Edison Company on a trial line 1·5 mile long.

The Electric Supply of the Dresden Railway Stations.—The novel feature of this plant is the up and down transformation of the "drehstrom" current, which is generated at 150 volts, transformed up to 3,100 volts, transmitted to the various railway stations and repairing shops, and transformed down again for lighting and power purposes. The plant consists of four 200-kilowatt Siemens "drehstrom" machines, coupled direct to horizontal tandem and compound engines running at 100 revolutions. The alternators have 60 poles and, therefore, a periodicity of 100 per second. The alternators feed on to three omnibus bars. For parallel running, electrical devices are provided on the governors of the steam engines which enable the speed to be regulated. A small motor moves the balance weight of the governor, and a switch on the main switchboard controls the action of this motor, and so allows the speed of the engine to be altered at will. In this way, two machines can be put in parallel without the assistance of resistances or an artificial load by simply influencing the governors of the two engines. The main current is taken from the omnibus bars to the transformer room, which comprises at present nine 100-kilowatt "drehstrom" step-up transformers, whence it is taken away by underground triplex cables. From a tower about 50 yards away run bare overhead conductors, which are then employed throughout the whole system.

Spherical Reflecting Globes for Arc Lights.—In a recent number of *L'Electricien* M. Albert Nodon relates a curious episode which occurred at Havre in connection with two Brianne arc lamps, which lighted a jeweller's shop front. These lamps were variable focus lamps, and were run two in parallel off the secondary of a transformer giving 60 volts, impedance coils being placed in series with each lamp. The carbons were placed inside a large glass globe, the hemisphere which faced the street being silvered inside and frosted out, so as to keep the light from the eyes of the passers by and reflect it back into the shop windows. As soon as the lamps were started running it was noticed that they went out regularly at intervals of about half an hour for an instant or so. On investigating the matter several small pieces of carbon about 4cm. long, cratered at one end and pointed at the other, were found at the bottom of the globe, and on further examination afforded an explanation of the extinction of the lights. The arc, in fact, when struck usually occupied a point somewhat above the horizontal diameter of the globe. A conjugate focus was formed at the corresponding distance below the horizontal diameter, with the result that the greater portion of the luminous and heat rays from the arc were concentrated upon the lower carbon, which soon became red hot at that point and then began to burn away, a process which was hastened by the increased heating effect of the current due to the increased resistance of the carbon at this point. The carbon was soon eaten away, and fell to the bottom of the globe; the mechanism of the lamp then brought the upper carbon into contact with the lower; the arc was struck below the horizontal diameter of the globe, and a conjugate focus of the arc was formed at a corresponding point above, with the result that the upper carbon was then eaten away in a similar manner, and so on. The difficulty was got over by doing away with the spherical globes, and replacing them by cylindrical reflectors of parabolic shape.

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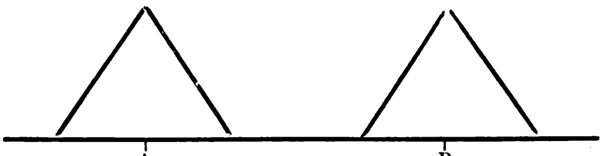
ELECTROMAGNETIC THEORY.—LXXI.*

BY OLIVER HEAVISIDE.

(*Continued from page 253.*)

§ 276. Imagine any wave form to be transmitted at a constant speed undeformed, as, for instance, a hump running along a flexible cord. Let it be as in the figure, namely, a triangular hump whose position at the moment of time $t=0$ is A, and at some later time t is B. It is to be imagined to travel at uniform speed v from left to right, so that the distance AB is vt, increasing uniformly with the time. If the base line is the axis of x, the travelling form is our "function of x," its value being the ordinate of the wave form.



Let $f(x)$ represent the function when at A, and let it become $F(x)$ at B. They only differ in the change of origin. Their relation to one another is

$$F(x)=f(x-vt); \tag{77}$$

that is, the value of F at x at the moment t is, by definition, the same as the value of f at a distance vt to the left. Equation (77) expresses the characteristic property of an undistorted and unattenuated wave when the speed is constant. It is a positive wave. When it goes the other way, it is a negative wave, and the *minus* sign must be changed to *plus*.

Differentiate equation (77) with respect to x and t separately and compare them. We see that

$$\frac{dF}{dx}=-\frac{1}{v}\frac{dF}{dt}. \tag{78}$$

This is the characteristic partial differential equation of a solitary undistorted wave. It is easily understood by watching the transit of a particular part of the wave past a fixed point, and considering how the speed v of transit combined with the slope determines the time rate of increase of F at the fixed spot. Equations (78) and (77) have practically the same meaning. Thus, given (78), its solution is (77), understanding that f expresses an arbitrary function of x.

Now write (78) in the form

$$\frac{dF}{dt}=-v\Delta F, \tag{79}$$

where Δ stands for d/dx, and solve it as an ordinary linear equation. This makes

$$F=\epsilon^{-vt\Delta}f, \tag{80}$$

where f is a constant with respect to t. In our present case it is any function of x. That (80) is the solution is verifiable by its satisfying (79). What f is may be seen by putting $t=0$. Then $F=f$. So f is the initial state of F, and is therefore the same as the former f. Comparing (80) with (77), we see that the operator $\epsilon^{-vt\Delta}$ is the translation operator, so that

$$\epsilon^{-vt\Delta}f(x)=f(x-vt). \tag{81}$$

This is the universal property of the operator $\epsilon^{h\Delta}$ when h is a constant. What it does, when applied to a function of x, is to translate it bodily through the distance h to the left.

Applying (81) to the result (76) which gave rise to these remarks about uniform motion of a function, we found that a certain F series, when considered to exist only on the positive side of the origin, was identical with

$$(1-x/l)2(+\epsilon^{-2l\Delta}+\epsilon^{-4l\Delta}+\epsilon^{-6l\Delta}+\ldots)1, \tag{82}$$

where the operand 1 is only positively existent. Denoting this operand by $f(x)$, the auxiliary terms in (82) are equivalent to

$$2f(x-2l)+2f(x-4l)+2f(x-6l)+\ldots \tag{83}$$

The value of every one of these functions is 2 when it exists. But the first one only begins to exist when x reaches $2l$, the next when x reaches $4l$, and so on. The result is that the constant 2 is added on every time the variable x passes the points $x=2l$, $4l$, $6l$, &c. The function $(1-x/l)$ therefore, which falls down to -1 when $x=2l$, and which would by itself go on decreasing to $-\infty$, is lifted up by the first auxiliary to its starting value $+1$. The same series of values are then repeated between $x=2l$ and $4l$. Then the second auxiliary begins and lifts up the function to its initial value for another repetition. The F. series therefore represents $(1-x/l)$ between 0 and $2l$, followed by unending repetitions of the same series of values of the function.

If we allow the F series to exist on the negative side also, it is sufficient to note that it is an odd function of x, to see its nature there. The negative side may be done operationally by itself by ignoring the part already done, and reckoning x positively the other way; but this is quite unnecessary, since the work has been already done equivalently on the positive side.

Equation (81), or, which is the same,

$$\epsilon^{h\Delta}f(x)=f(x+h), \tag{84}$$

is the well-known so-called "symbolical" form of Taylor's theorem. For it is merely the condensation of the form obtained by expanding the exponential, viz.:

$$\left\{1+h\Delta+\frac{(h\Delta)^2}{\underline{|2}}+\frac{(h\Delta)^3}{\underline{|3}}+\ldots\right\}f(x)=f(x+h). \tag{85}$$

The form (84) is much more convenient. It is the form that always occurs naturally in operational mathematics. That is, we get solutions of the form $\epsilon^{h\Delta}$ acting upon something or other, and the meaning is simply a bodily translation performed upon it.

The way followed above is not the usual way of leading to Taylor's theorem, for which see works on the Calculus. It is a quasi-physical way, by which its truth becomes obvious in a general sense. It only involves the idea of translation of a form so far as the essential part goes. But now comes the question of failures. In fact, the proofs of Taylor's theorem are largely devoted to the discussion of modified forms with remainders occurring when there is some discontinuity, involving an infinite differential coefficient. When mathematicians come to an infinity they are nonplussed, and hedge round it. They would, for example, stick at the three sharp corners in the function above used, which involve discontinuity in the slope, or infinite curvature.

But there is no difficulty of the kind in the physical way of looking at the matter, so far as the act of bodily translation is concerned. One shape of the function is just as easily conceived as another, and we are not limited to the angelically perfect function which is finite and continuous itself, and has all its derivatives finite and continuous. It was long ago remarked by Sir G. Stokes that it is important for physical mathematicians to conceive of functions wholly apart from their possible symbolical expression. The remark is particularly important in the discussion of waves and their propagation, when discontinuous functions have frequently to be dealt with.

Now (77) is unexceptionable, and requires no special interpretation involving infinities. If $f(x)$ makes a jump suddenly at any place, so does $F(x)$ precisely at a corresponding place. But (78), which is taken to be equivalent to (77), inasmuch as it utilises differential coefficients, may require interpretation. We should not say that the whole thing breaks down if the slope is infinite, because (78) becomes meaningless. It requires interpretation, but is not uninterpretable. The variations in dF/dx and those in dF/dt keep pace together precisely, and this tie does not break when they are momentarily infinite.

Although, of course, in a popular sense, infinities are immeasurable, they are not necessarily unmeasurable. A suitable standard is required to measure an infinity. Consider, for example, the case of electrification. Starting with a finite volume density, if we imagine it condensed on a surface, we have infinite volume density. But that causes no trouble. It is now to be measured by its surface density. Again, imagine it condensed from finite surface electrification to linear elec-

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trification. This means infinite surface density, and therefore doubly infinite volume density. But we now have a finite linear density, so there is no difficulty in measurement, or at any rate in the conception of the suitable way of measuring. Again, the notion of impulses in dynamics is exceedingly useful, though it involves the idea of an infinite force. We must not be afraid of infinity. If suitably measured, it may be no bigger than zero, or else quite small.

Now I think that similar ideas may with advantage be introduced into pure mathematics, to enlarge the scope of the mathematicians' investigations, and enable them to tackle infinities, instead of evading them. However, we are not concerned with the real or supposed failures in Taylor's theorem, perhaps rather to be considered failures in the mathematical machinery. In the operational mathematics $\epsilon^{h\Delta}$ is the translational operator, no matter how many discontinuities may be in the way. We do not have to consider the infinite values, but just jump over.

In physical applications, say to waves, the subject of operation is real and single valued, though it need not be finite and continuous. But I do not see any reason why the translational idea should not be carried further. Let it be applied to any definite series of values, or of multiple values, or perhaps to the case of a multiple pole, involving a collection of infinities.

§ 277. Since the investigation in § 275 shows one the working of the inner mechanism of a Fourier series in an interesting way, it will be worth while to consider another example of the same sort. We may put it thus :—

$$\coth l\Delta \,.\, f(x) = (1 + 2\epsilon^{-2l\Delta} + 2\epsilon^{-4l\Delta} + \dots)f(x) \qquad (86)$$

$$= \left\{\frac{1}{l\Delta} + \sum_1^\infty \frac{2/l\Delta}{1+(n\pi/l\Delta)^2}\right\}f(x); \qquad (87)$$

and if we like to confine ourselves to the region 0 to $2l$, we may omit the translational auxiliaries, and write

$$f(x) = \left\{\frac{1}{l\Delta} + \sum_1^\infty \frac{2/l\Delta}{1+(n\pi/l\Delta)^2}\right\}f(x). \qquad (88)$$

Take $f(x) = 1$ to make up the expansion of $1 - x/l$ considered in § 275.

Next take $f(x) = x$. Then (88) becomes

$$x = \frac{x^2}{2l} + \sum_1^\infty \frac{2l/(l\Delta)^2}{1+(n\pi/l\Delta)^2}, \qquad (89)$$

since $x = \Delta^{-1}1$, $\frac{1}{2}x^2 = \Delta^{-2}1$. Continuing the algebrisation we obtain

$$x = \frac{x^2}{2l} + \sum_1^\infty \frac{2}{n^2\pi^2}\left(1 - \cos\frac{n\pi x}{l}\right); \qquad (90)$$

or, which is the same,

$$x = \frac{x^2}{2l} + \frac{1}{3} - \sum_1^\infty \frac{2}{n^2\pi^2}\cos\frac{n\pi x}{l}. \qquad (91)$$

This is true between $x = 0$ and $2l$.

But the full meaning, according to (86), (87), including the auxiliaries, is

$$\sum_1^\infty \frac{2}{n^2\pi^2}\cos\frac{n\pi x}{l} = \left(\frac{x^2}{2l^2} - \frac{x}{l} + \frac{1}{3}\right) - \frac{2}{l}[x - 2l] - \frac{2}{l}[x - 4l] - \dots, \qquad (92)$$

where the terms with square brackets are the auxiliaries. They are to be understood in this way. In (86), $f(x)$ is to be x, so the auxiliary functions (not doubled) are $f(x - 2l)$, $f(x - 4l)$, &c., and these are the same as $x - 2l$, $x - 4l$, &c., when they exist. Now $f(x)$ is born when $x = 0$, and is positively existent. So $f(x - 2l)$ is born when $x = 2l$, and so on. The final result is simple enough, namely, that in (92), with a particular value of x, just as many of the auxiliaries exist as have positive values. The rest are not yet born ; they are zero.

In the region $x = 0$ to $2l$ we have the curve

$$y = \frac{x^2}{2l^2} - \frac{x}{l} + \frac{1}{3}. \qquad (93)$$

The ordinate y is $\frac{1}{3}$ at $x = 0$ and $2l$, and has its minimum, namely $-\frac{1}{6}$, midway between. After $x = 2l$, it would rise up to infinity by itself, but the first auxiliary is now existent. Adding it on, we get

$$y = \frac{x^2}{2l^2} - \frac{3x}{l} + \frac{13}{3}. \qquad (94)$$

This is the same as

$$y = \frac{(x-2l)^2}{2l^2} - \frac{(x-2l)}{l} + \frac{1}{3}. \qquad (95)$$

Comparing the last with (93), we see that they have the same form, only x in (93) becomes $x - 2l$ in (95). So the values of y between $x = 0$ and $2l$ repeat themselves between $x = 2l$ and $x = 4l$. Then the second auxiliary comes into play, and causes another repetition of the same series of values of y. And so on to infinity.

The above refers to the positive side of the x axis. On the negative side we see the meaning of the Fourier series by observing that it is an even function of x.

The reader who is curious in this matter will find it useful to treat various simple Fourier series in the manner of § 275, to discover their meaning. Thus, given

$$f(x) = A_0 + \sum_1^\infty A_n \cos\frac{n\pi x}{l} + \sum_1^\infty B_n \sin\frac{n\pi x}{l}. \qquad (96)$$

This may be converted at sight to

$$f(x) = A_0 + \sum_1^\infty \frac{A_n}{1 + (n\pi/l\Delta)^2} + \sum_1^\infty \frac{B_n(n\pi/l\Delta)}{1 + (n\pi/l\Delta)^2} \qquad (97)$$

by the use of (73) and its cosine companion formula. Now sum up the partial fractions, if you can. The coefficients are supposed to be known functions of n. The summations may be effected by the formulæ for the expansion of $\coth l\Delta$, $(\text{shin}\, l\Delta)^{-1}$, &c., in partial fractions, or by formulæ derivable from them. When this is done, comes another important step. The trigonometrical functions of $l\Delta$ may be expressed in series exponentially (*e.g.*, like $\epsilon^{-2l\Delta}$, &c.), and then Taylor's theorem, in its general translational sense, comes into play, and the full meaning of the F. series becomes evident. We determine it to represent a certain function between certain limits, and endless repetitions of the same values caused by the existence of the auxiliary terms involving the translational operators. The example in § 275 is fully descriptive in a general way, combined with the explanation in § 276, and the application may be made to a variety of formulæ. But the method is not meant for general use, because the summation of the partial fractions may be a troublesome matter.

The question arises whether a Fourier series with its constants given numerically can be done in the same way. Probably it can, or by some extension of the process. But it may be necessary to discover first the law followed by the coefficients, so that they may be regarded as functions of n.

§ 278. By equation (86), we see that the operator $\coth l\Delta$, applied to a positively existent function of x, turns it into the sum of $f(x)$ and of twice the sum of its values at the points $x - 2l$, $x - 4l$, &c.

From this, we conclude that if $f(x)$ exists only between 0 and $2l$, meaning thereby that it is zero outside those limits, the series $\coth l\Delta \,.\, f(x)$, as in (86), represents $f(x)$ first, in its proper place, and then an infinite series of repetitions of the values of the same function doubled. For example, if $f(x)$ is x^2, we get first x^2, next $2(x - 2l)^2$, then $2(x - 4l)^2$, and so on, in regions of length $2l$, every one by itself.

Therefore

$$(\tfrac{1}{2} + \tfrac{1}{2}\coth l\Delta)\mathrm{I}f(x) \qquad (98)$$

represents $f(x)$ and periodic repetitions of the same (not doubled), from $x = 0$ to ∞, still understanding that $f(x)$ is zero except between 0 and $2l$.

And by a slight extension we see that if

$$\mathrm{F}(x) = (1 + \epsilon^{-2l\Delta} + \epsilon^{-4l\Delta} + \dots + \epsilon^{2l\Delta} + \epsilon^{4l\Delta} + \dots)f(x), \qquad (99)$$

then $\mathrm{F}(x)$ represents $f(x)$ and periodic repetitions to right and left through the whole range of x from negative to positive infinity. Only one term exists (or is finite) at a time. But if $f(x)$ be so chosen that its initial and final values do not agree, there is a jump in the manner before alluded to. The periodic property $\mathrm{F}(x + 2l) = \mathrm{F}(x)$ is momentarily violated, unless we represent the vertical part of the curve by the mean value.

Now, the reader may amuse himself by considering the exponential expansions of other trigonometrical functions of a differentiator, as than $l\Delta$, and the reciprocals of shin $l\Delta$ and

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cosh $l\Delta$, and their powers as operators on a function. It will be sufficient here to derive Fourier's theorem in its general form from the above.

Go back to (99). By construction the series $F(x)$ has the same meaning as Fourier's

$$F(x)=\int_0^{2l} uF(y)dy, \qquad (100)$$

where

$$u=\frac{1}{2l}\left(1+2\Sigma_1^\infty \cos\frac{n\pi(y-x)}{l}\right). \qquad (101)$$

Here u is expressive of a unit impulse at the points $x\pm 2nl$, as before explained, and (100) shows how a single value of the function is isolated.

Now $\Delta 1$ is a unit impulse at the origin of the variable. Let the variable be $y-x$. Then $\Delta 1$ signifies a unit impulse at point $y=x$, and nothing anywhere else. So, by (99), we have

$$u=(1+\epsilon^{-2l\Delta}+\epsilon^{-4l\Delta}+\ldots+\epsilon^{2l\Delta}+\epsilon^{4l\Delta}+\ldots)\Delta 1. \qquad (102)$$

Since, by construction, this u represents the periodic unit impulse, like (101), we see that (102) must be the operational form of (101) itself.

But to algebrise (102) it is convenient to consider the positive and negative regions separately. Split u into halves, thus :—

$$u_1=\tfrac{1}{2}(1+2\epsilon^{-2l\Delta}+2\epsilon^{-4l\Delta}+\ldots), \qquad (103)$$

$$u_2=\tfrac{1}{2}(1+2\epsilon^{2l\Delta}+2\epsilon^{4l\Delta}+\ldots), \qquad (104)$$

Here u_1 is for the positive side, and u_2 for the negative, u_1 meaning half a unit impulse at the origin $y=x$, and whole ones at $y=x+2l$, $x+4l$, &c.; whilst u_2 means half a unit impulse at $y=x$, and whole ones at $x-2l$, $x-4l$, &c.

Now (103) is equivalent to

$$u_1=\frac{1}{2l}\coth l\Delta \,.\, l\Delta. \qquad (105)$$

This is equivalent in partial fractions to

$$u_1=\frac{1}{2l}\left\{1+\frac{2}{1+(\pi/l\Delta)^2}+\frac{2}{1+(2\pi/l\Delta)^2}+\ldots\right\}. \qquad (106)$$

Finally, the algebrisation is immediate, making

$$u_1=\frac{1}{2l}\left\{1+2\cos\frac{\pi}{l}(y-x)+2\cos\frac{2\pi}{l}(y-x)+\ldots\right\}. \qquad (107)$$

This result shows the same expression identically as Fourier's u in (101). But it has not the same meaning. Remember the reservation that $y-x$ ranges from 0 to ∞ only in connection with u_1. In (105), (106) the positively existent unit operand is understood. So (107) is limited to the positive side.

Similarly, from the symmetry of the complete u in (102) with respect to the origin $y=x$, or by reckoning $y-x$ positively the other way, so that u_2 is represented formally by u_1, we find that u_2 is given by the same expression (107) as u_1. Only in this case y has to be not greater than x.

So, removing the restriction, we see that the sum of u_1 and u_2 has the same expression as either. No change is needed in the trigonometrical formula because it is an even function of $y-x$. In its use to represent u_1 or u_2 alone, we merely restrict the range of its application. When unrestricted, we find that the u of (101) means the same as that in (102), the impulse periodic both ways.

It seems somewhat unnatural to consider the right and left halves separately. And yet it is necessary. This becomes evident at a discontinuity. Suppose $f(y)$ is zero on the left side of $y=x$, and finite instantly on the right side. Evidently u_2 is inoperative, and u_1 alone works. It gives only $\frac{1}{2}f(x)$, that is $\frac{1}{2}$ the value on the right side.

Again, if at $y=x$, the function is A on the left and B on the right side, u_1 will give $\frac{1}{2}$B, and u_2 will give $\frac{1}{2}$A. The complete u will therefore spot the mean value.

Poisson's demonstration is interesting in this connection. Instead of u he used the function

$$v=\frac{1}{2l}\left\{1+2\Sigma_1^\infty h^n \cos\frac{n\pi(y-x)}{l}\right\}. \qquad (99)$$

It becomes the same as u when $h=1$. Now when h is <1, this v function is continuous. Its total between 0 and $2l$ is 1, and it has a hump at the point $y=x$. The closer h is made to approach to unity, the more the v function is heaped up at and close round the point $y=x$. In the limit it is all there, like u. Now the curve of v is symmetrical with respect to $y=x$; half its area is on one side, and half on the other. So, if h is very close to 1, and we use v in the formula (91) instead of u_1, we shall obtain $\frac{1}{2}$(A+B) approximately, and the more closely we make h approach unity the closer the approximation. I know no reason why a failure should occur just as perfection is reached.

(To be continued.)

NOTES ON SOME EXPERIMENTS WITH ELECTRO-MAGNETIC MECHANISM.

BY P. V. McMAHON.

(Continued from page 293.)

The next group of experiments was made with the same coil, and under similar conditions with cores Nos. 2, 3, 4 and 5, each core being 15·5in. long, $\frac{2}{3}\frac{2}{2}$in. diameter. No. 2 had both ends cylindrical, No. 3 had the top end tapered for a distance of 2in., No. 4 the top end tapered 6in., and No. 5 both top and bottom ends tapered 6in. (*see* Fig. 3). A set of observations was obtained for each core (*see* Figs. 5, 6 and 7), with different weights attached, and the travel and variation of ampere turns plotted as before. It is noticeable from these curves that their general shape is very similar, but the travel is shorter as the weight is increased for the same variation of ampere turns. Thus, with the cylindrical-ended core light the travel for 5,000 ampere turns variation is 2·3in.; with 35oz. weight attached the travel is 1·9in. for the same variation of exciting power; increasing the weight to 52oz. the travel is further reduced to 1·5in. for 5,000 ampere turns variation. The same reduction of travel is obtained with the other three cores for an increase of weight, except in the case of the double-tapered core without a weight; here the travel is 2·25in. for a variation of 5,000 ampere turns. With 35oz. added to core the travel is 3·2in. for same exciting power; increasing the weight to 52oz. the travel is reduced to 2·55in. for 5,000 ampere turns variation. This difference in behaviour is probably due to the core being so much lighter, on account of the bottom end being tapered, that it was drawn into the coil much more than in the other cases with the lowest excitation. In fact, comparing it with the core tapered 6in. at the top end, we can plainly see from the curves that the latter core point was 0·5in. below and inside the top flange of the coil, with an excitation of 3,500 ampere turns, while the double taper core point was 1·4in. above and outside the top flange of coil; thus the effect of tapering the bottom and top ends of the core, as compared with the top end only, raises the core 1·9in. in coil for same minimum excitation. This difference disappears as the cores are weighted, but the double taper core seems to rise much quicker in the beginning than the single taper core, and then bends over rather quickly at the end of its range.

For greater convenience in comparing the different cores, the results are arranged in sets, first taking the four different cores under the following conditions, viz.:—Core only, core plus 35oz. attached, core plus 52oz. These results plotted give the curves Figs. 5, 6 and 7 respectively. Secondly, on each sheet of curves a section of the top of the coil is given full size, the zero line of travel corresponds with the outside top edge of the coil, and the first point in the curves gives the various positions of the core with minimum excitation (or the least number of ampere turns that will sustain the core). In this set the position of each individual core and the amount of excitation with different weights is given; and, lastly, the effect of using the coil iron clad is given for cores Nos. 3 and 4. The latter core was tried with a weight of 100oz. attached.

It may be here mentioned that the weights used were made of lead, to avoid any disturbance of the lines of force; this also accounts for the odd weights 35oz., 52oz., and 100oz, instead

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of 25oz., 50oz., and 100oz., say, or the succeeding weights being some multiple of the first weight.

Table II. gives the result of the 12 experiments with these four cores, under the condition of—core only, core plus 35oz., and core plus 52oz. For the sake of comparison, columns 4 and 5 give the travel of each core under the conditions above mentioned for a variation of 5,000 ampere turns excitation.

In the first set, 2 to 2*c*, with core only, the 6in. taper gives a travel of 4in., and movement of the core is more nearly proportional to the increase of excitation than the others. Next in merit comes the 2in. taper core, which has a travel of 2·9in. The square-ended and double taper cores are almost equal as regards the travel; but the former gives best movement. By best movement I mean a motion of the core proportional to the increase of excitation and the whole arrangement sensitive to the changes in the amount of excitation.

The next set, 3 to 3*c*, the core had a weight of 35oz. attached (or total weight about double that in 2 to 2*c*). Here the double taper core gave the largest travel, 3·2in. Next

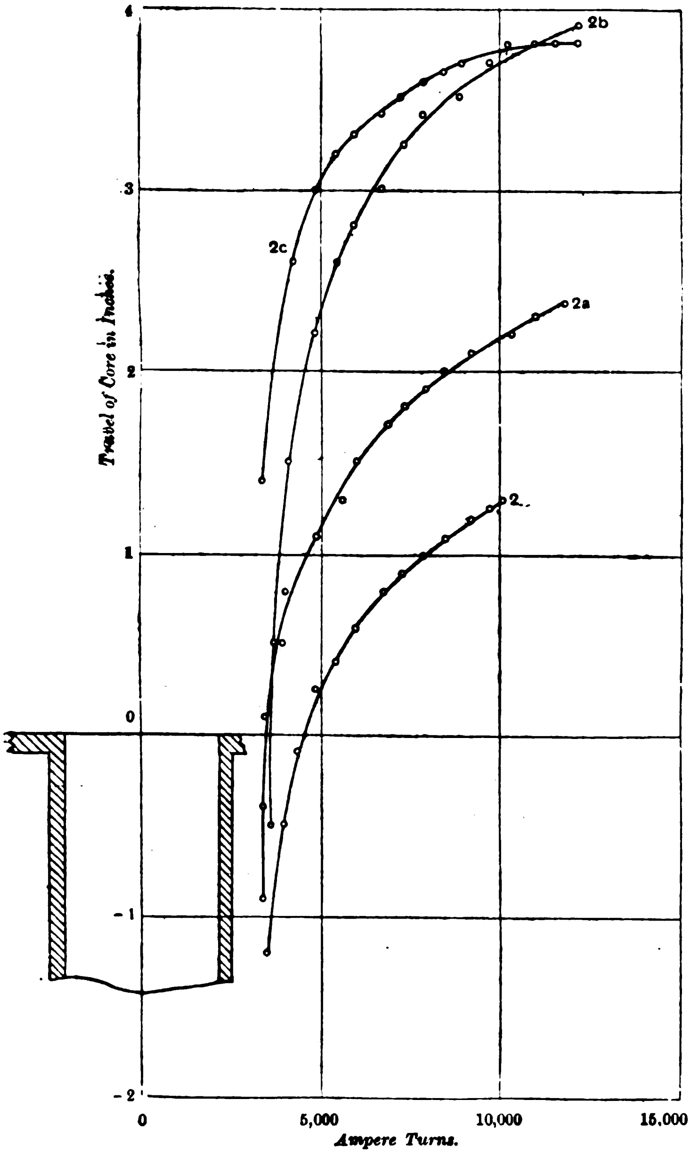

Fig. 5.—Core only.

comes the 6in. taper core (3*c*), with a travel of 2·7in.; the 2in. taper (3*a*) and square ends (3) come next, with travels of 2·15in. and 1·9in. respectively. Although in this set, from the point of view of maximum travel, 3*c*, or double-taper core, is the best, yet upon examining the curves we can find that 3*b*, or 6in. taper, is more suitable for the purpose aimed at, as this curve may be said to be straighter than any of the other of the same set.

Coming to set 4 to 4*c*, the core had a weight of 52oz. attached (or total weight nearly treble that in 2 to 2*c*). Here again

Table II.

—	Max. travel.	Max. S *i* variation	S *i* variation.	Travel for 5,000 S *i* variation.	—	
2	2·6in.	6,600	5,000	2·3in.	Square ends	core only
2*a*	3·25in.	8,100	5,000	2·9in.	Taper 2in. one end	
2*b*	4·4in.	8,800	5,000	4·0in.	Taper 6in. one end	
2*c*	2·4in.	8,800	5,000	2·25in.	Taper 6in. both ends	
3	2·0in.	6,100	5,000	1·9in.	Square ends	core +35 oz.
3*a*	2·25in.	5,750	5,000	2·15in.	Taper 2in. one end	
3*b*	3·0in.	6,100	5,000	2·7in.	Taper 6in. one end	
3*c*	3·3in.	6,100	5,000	3·2in.	Taper 6in. both ends	
4	1·4in.	4,000	5,000	1·5in.	Square ends	core +52 oz.
4*a*	1·9in.	4,700	5,000	1·9in.	Taper 2in. one end	
4*b*	2·8in.	6,500	5,000	2·45in.	Taper 6in. one end	
4*c*	2·7in.	5,400	5,000	2·55in.	Taper 6in. both ends	

the double core has the maximum travel, 2·55in., not very much more than 4*b* or 6in. taper, which has a travel of 2·45in.; 4*a*, or

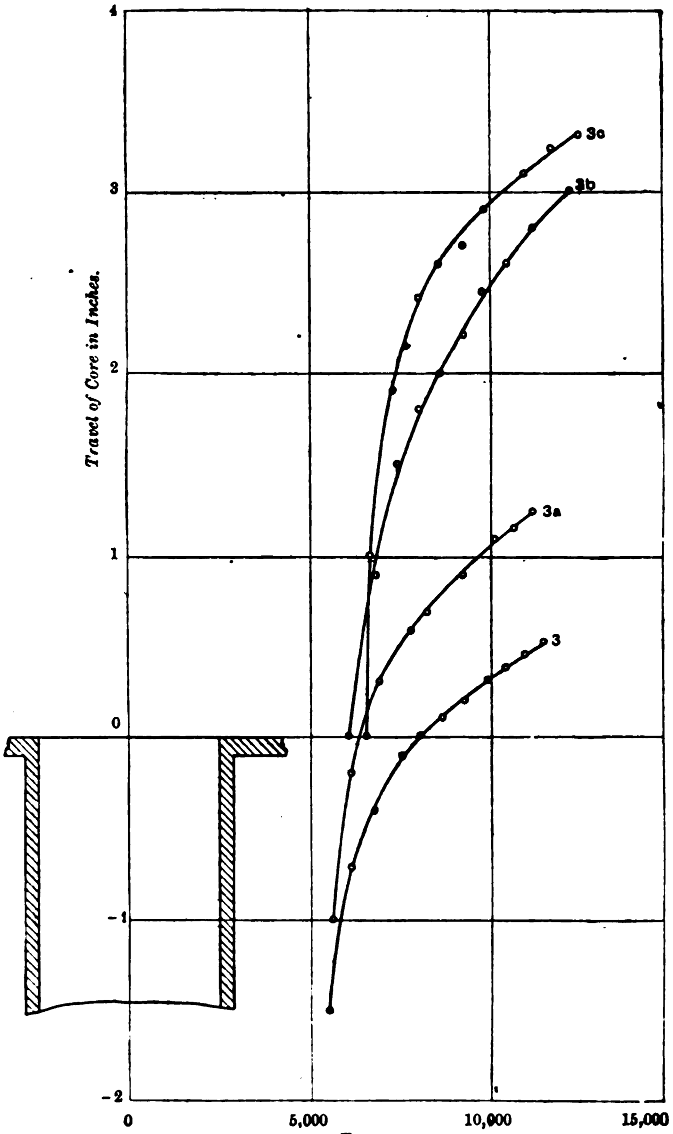

Fig. 6.—Core + 35oz.

the 2in. taper core, has a travel of 1·9, and 4, or cylindrical-ended core, travel 1·5in. In this set, as in the last, the 6in. taper core gives the best result, as an inspection of the curve will show; here the distance travelled is almost proportional to the increase of excitation.

Bearing in mind the object of these experiments, *i.e.*, maximum strength, range, sensitiveness, and equal increments of travel for equal increments of excitation, it seems as if 4*b*, or the 6in. taper core, weighted to 52oz., is the best; next comes 4*c*, or the double taper core.

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It is interesting to examine the different positions taken up by the point of the core with the least excitation, *i.e.*, the smallest number of ampere turns that will sustain the different cores under different conditions. Take the cylindrical-ended core: with the core only, smallest excitation is 3,500 ampere turns, and the point of the core 1·2in. inside and below the top flange of the coil. With 35oz. attached to the core, least excitation is 5,500 ampere turns, and point of core 1·5in. inside and below top of coil. Increasing the weight to 52oz., the minimum excitation is 7,000 ampere turns, and point of core is 1·2in. inside and below top of coil, or exactly the same position as when the core had no weight attached and the excitation was half the present amount.

Next take the core No. 3, tapered 2in. from the top, with core only; the minimum excitation was 3,500 ampere turns, point of core 0·9in. inside and below the top of coil. When the 35oz. were attached to the core the point was 1in. inside and below the top of the coil, and minimum excitation was

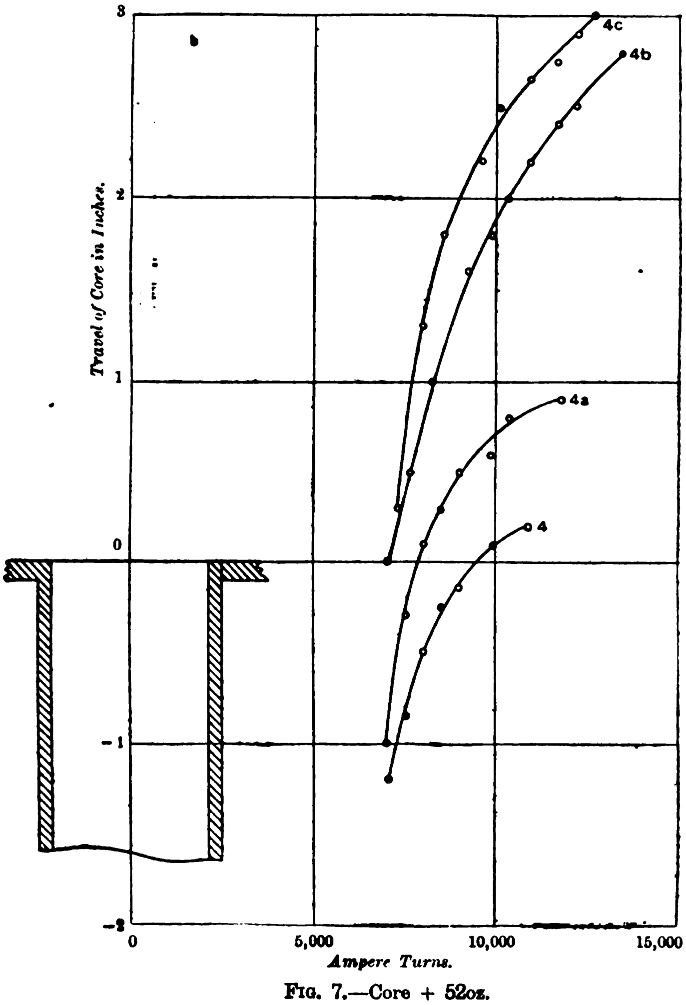

Fig. 7.—Core + 52oz.

5,500 ampere turns. With weight increased to 52oz. the minimum excitation was 7,000 ampere turns, and point of core was 1in. inside and below top of coil, or same position as with 35oz. attached, but 55,000 ampere turns.

Now take No. 4 core, tapered 6in. from point downwards, with core alone; minimum excitation was 3,500 ampere turns, and point of core took up a position 0·5in. inside and below top of coil; attaching 35oz. to the core, the excitation was 6,000 ampere turns, and point of core just flush with top of coil; when the weight was increased to 52oz. the figures were 7,000 ampere turns and point of core just flush with top of coil.

Lastly, using core No. 5, tapered for 6in. top and bottom, with core only, the minimum excitation was 3,500 ampere turns, and point of core was 1·4in. outside and above top of coil; when the 35oz. weight was attached to core, the excitation was 6,500 ampere turns, and point of core was flush with top of coil; the same position as No. 4 with same weight, but requiring 500 ampere turns more; and finally, attaching the 52oz. to core, excitation and position was 7,380 ampere turns, and point of core 0·3in. outside and above top of coil.

Summing up with respect to minimum excitation and position of core, the excitation seems to remain constant for the different kinds of core under the same condition with regard to the weight, and the position of point seems to vary without regularity.

The effect of using the iron jacket was next tried, but cores Nos. 3 and 4 only were used. Referring to the results obtained in the first set of experiments with the coil iron clad, it would seem as if the action was no longer that due to a core and solenoid pure and simple, but depended upon the variation of the air gap to move the core. The square-ended core was not used in this experiment, as once the circuit was closed the point of the core would immediately fly to the top of the coil, and the air gap remaining constant, no movement of the core would take place by varying the excitation.

For an almost similar reason the double-tapered core was discarded. This core, being tapered in opposite directions for 12in. of its length, only leaves 3·5in. of the core parallel. Now, the coil being 7in. long, it can be seen that by the time the top of the core was flush with the outside of the iron jacket the other taper in a reverse direction comes into action at the bottom of the core; thus the result would be a sort of differential action—that is to say, when the air gap at the top of the coil was tending to decrease by reason of the upward movement of the core, the air gap at the bottom would commence to increase, and a large range was not to be expected; in addition, the weight supported would in all probability be small. Returning to the cores actually tried, we see from the curves plotted the vast difference made in the shape of the curve by increasing the length of the taper.

With No. 3 core (2in. taper) the curve rises quickly at first and then bends sharply, giving a very small travel. This happens with 35oz. and 52oz. attached; the travel is slightly reduced by the latter weight. Compare this result with that obtained with No. 4 core under similar conditions. Here we get a curve fairly straight, and a range more than twice as great for the same variation of excitation.

Referring to columns 4 and 5, Table III., which gives the travel of the two cores under the condition mentioned, and taking 5,000 ampere turns variation as a standard for comparison, with No. 3 core loaded with 35oz., the travel is 1·2in., while, increasing the weight to 52oz., the travel is 1·1in., and the curve is even more regular, although both are entirely unsuitable for their purpose (*see* curves, Fig. 8).

Table III.

—	Max. travel.	Max. S*i* variation	Trav'l for 5,000 S*i* variation	—	—	
3a¹	1·7in.	9,250	1·2in.	5,000	Core + 35oz.	2in. taper.
3b¹	1·4in.	9,000	1·1in.	5,000	„ + 52oz.	
4a¹	3·7in.	7,250	3·15in.	5,000	Core + 35oz.	6in. taper.
4b¹	3·6in.	6,500	3·05in.	5,000	„ + 52oz.	
4c¹	2·3in.	3,750	3·1in.	5,000*	„ + 100oz.	

Using core No. 4 (6in. taper), with 35oz. attached, the travel for 5,000 amperes variation is 3·15in.; increasing the weight to 52oz., the travel is 3·05in., or only 0·1in. less. With this core the weight was further increased to 100oz., and the curve is almost a straight line. In this case the excitation was only varied through 8,750 ampere turns, the minimum being 9,200 and maximum 12,500 ampere turns; for the variation the travel is 2·3in., producing the curve through a range corresponding to a variation of 5,000 ampere turns, shown by the dotted part of the curve; the range is 3·1, or practically the same as with 35oz. and 52oz. attached, but the curve is straighter, although the weight is nearly treble that first used. From these results it would seem, by properly proportioning the length of taper and weight supported by the core, that the curve connecting travel and excitation may be made absolutely a straight line.

* Assumed.

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Undoubtedly No. 4 core with iron-clad coil gives the best result, but it lacks the sensitiveness obtained when the coil is used without the iron jacket. This sluggishness might, I think, be overcome to a great extent by very carefully centring the coil with respect to the iron jacket, and ensuring that the core is a good fit in the coil.

In experimenting with some smaller coils and taper cores I found it a very good arrangement to have the core tube slightly

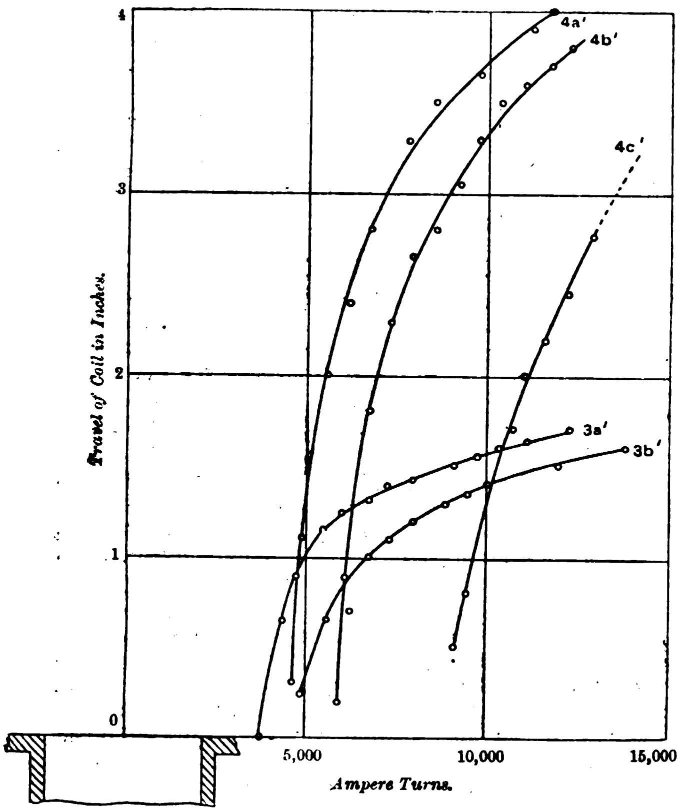

Fig. 8.—Iron-clad.

larger in diameter than the core, say $\frac{1}{16}$th of an inch, and to secure the core in a very thin brass tube, making the latter a good yet easy fit in the former (Fig. 9).

The want of sensitiveness due to the use of the iron jacket appears from the experiments to be due to the air gap between the core and iron jacket not being exactly the same width all round the core. The smallest amount out of line between the coil and jacket axis makes an incredible difference, so much so

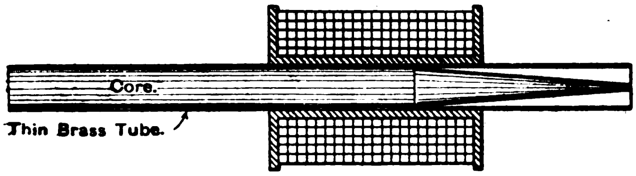

Fig. 9.

that, comparing two curves obtained with same core, one carefully centred with respect to the holes in the iron jacket and the other slightly out of truth, the former give a series of points perfectly regular and sensitive, while the latter gives the points of the curve so much out of line that it requires a stretch of imagination to draw the curve between the points instead of from point to point, and the core keeps sticking, and would take up several different positions for the same number of ampere turns.

At first it seemed as if this sluggishness was due to the better magnetic circuit, but the result of the experiments seems to point to the reason given above. No doubt the better magnetic circuit may have a little effect upon the sensitiveness, but want of proper adjustment seems to be the principal cause.

Before leaving this part of our subject, it may be instructive to compare the effect of the iron jacket upon the position taken up by the point of the core with minimum excitation; with that obtained with the same core and weight without this jacket. Taking No. 3 core first, we find that, weighted with 35oz., minimum excitation was 5,500 ampere turns and point of core 1in. inside coil; with iron jacket minimum ampere turn was 3,700, and point of core was flush with top of coil. Increasing weight to 52oz., minimum ampere turns were 7,000, and point of core was 1in. inside coil; using iron jacket the ampere turns and position of core were respectively 5,000, and point of core 0·2in. outside of coil, or 0·2in. inside iron jacket. Turning to No. 4 core, weighted with 35oz., the minimum excitation was 6,000 ampere turns and point of core flush with top of coil; using the iron jacket the above numbers became 4,600 ampere turns and point of core 0·3in. outside top of coil and 0·3in. inside iron jacket. When the 52oz. weight was attached the minimum ampere turns were 7,000 and point of core was flush with top of coil; the effect of the iron jacket was to make minimum excitation 6,000 ampere turns and point of core 0·2in. inside iron. Thus in all cases the iron-clad coil supported the core and weight with less ampere turns, and drew the core further in than when the coil was used alone.

(To be continued.)

THE TELEPHONE SYSTEMS OF THE CONTINENT.

BY G. L. ADDENBROOKE.

Mr. A. R. Bennett during last year spent some months in making a tour of the Continent with the object of inquiring into and noting the position and progress of the telephone in each country. The results of his experiences are now embodied in a book with the above title which has lately been published by Messrs. Macmillan and Co.

The first effect of this work is rather confusing, because it commences by a long introduction of 30 pages, in which the matter which follows is employed in an attempt to demonstrate how badly the public have been served by the holders of the existing telephone monopoly, and to show how much rates might be reduced and the utility of the telephone extended if municipalities, companies, or co-operative societies were allowed a free hand to erect and work exchanges for their mutual benefit. Thus the reader is plunged at once into the middle of a controversy and confronted by statements for which as yet he has received no warranty.

The idea is thus conveyed that the book is technical and out of the province of general readers and telephone users, who, on the other hand, are the people for whose benefit the book is presumably written.

If, however, readers will skip the introduction, and read first the data and descriptions which Mr. Bennett gives, the mind will be carried comfortably along, and the result is that one is led on to comprehend of the subject after a fair amount of easy reading, diversified by a good sprinkling of valuable illustrations and with an occasional semi-humorous touch, such as the description of the method of settling disputes between subscribers and operators in Paris. Having thus gone through the book it is easy to turn back and read the *introduction* effectively and follow Mr. Bennett's arguments. Logically, this introduction should have been the *conclusion*, and come at the end of the book with a separate title-page.

The descriptions of the results attained abroad would then have gained in prominence, the appearance of bias would have been removed, and the authority of the book and its influence on the public and on the Committee of the House of Commons which has recently been dealing with the question would have been enhanced. So much for general criticism.

Seeing that, apart from the manner of the book, the matter raised grave issues, the writer thought it would be worth while calling on the National Telephone Company and at the Post Office to find out in what light they viewed Mr. Bennett's efforts. At the Telephone Company's office, after sending in his name and object, the general manager returned a message to the effect that he had read the book, and did not think it of much account, but that the Company would be pleased to show him

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(the writer) their exchanges, and explain what they were now doing. At the Post Office the authorities are not pleased with Mr. Bennett's references to them, which we think he would have been wiser to omit, as there is another version which quite simply explains the apparent discourtesy noticed in Mr. Bennett's introduction. This is not, however, the place to discuss the attitude and position of the Post Office authorities towards the telephone; but of the policy and actions of their technical advisers it is impossible to speak without high praise. The writer has a pretty adequate knowledge of the comparative attention which has been bestowed on the scientific study of the telephone both in the Post Office and the National Company, and while the investigations which have been made by the Post Office, and which have just resulted in the splendid trunk lines to Glasgow and Dublin, must command the admiration of any impartial observer, on the other hand the short-sighted repression of all scientific work, which was the keynote of the late United Telephone Company's policy, and the luke-warm support of it by their successors, is very unfortunate when one thinks of what might be done for the public good and convenience if a really enlightened policy were adopted, instead of an unwilling and ungracious acquiescence in improvements which have been forced by public opinion from outside instead of arising from increasing knowledge and experience within. The administration of the Company has certainly improved recently, but had they from the first adopted a more enlightened attitude technically towards the nation they would have been saved many of their difficulties, and would have secured better treatment from the Post Office, which is really the guardian and mouthpiece of the national will in this question.

Mr. Bennett's statistics and arguments must be left to speak for themselves, and we hope later on that the author will see his way to condense them and eliminate the less important, so that the gist of the work could be presented to the general reader and telephone user in a small volume at a price which a non-technical reader would be likely to pay. As it stands, while the work is valuable to practical telephonists, the majority of telephone users can hardly be expected to buy it.

THE BRUSSELS ELECTRIC TRAMWAY.

There are two lines of electric tramway at Brussels. The one runs from the Midi to the Nord railway stations, following a semi-circular route through the main boulevards of the town, and is three miles long; the other runs from a point in the south-east of the town to a suburb, Uccle, and is 2·7 miles long. The generating station is about a quarter of a mile distant from the Midi end of the Midi-Nord line. The Uccle line branches from the other at about two miles from the Midi station.

The whole plant and equipment was ordered by the Brussels Municipality from the Union Elektricitäts Gesellschaft, of Berlin. It was completed in June, 1894, the Union Company undertaking to work it for the Municipality for two years at a guaranteed maximum expenditure per kilowatt-hour. As, however, the expense of working has been considerably under that guaranteed, the municipality are satisfied, and will take over the line this month.

The tramway is an excellent example of international practice. It is in a thickly-populated district, which has waived its objection to overhead wires, and where coal is cheap and the horses are overworked. The boilers are English, the engines German, the motors American, the contractors' chief engineer (M. Pedriali, who kindly showed our correspondent round the generating station) Italian, and, doubtless, some of the polite gentlemen in the general office are French.

In the boiler house are three Babcock-Wilcox boilers. The boiler pressure is 118lb. per sq. in. The feed water is pumped from the town main by Worthington pumps through a Dervaux purifier, a Schmidt meter, and the feed-heater, where it is heated by the exhaust steam (the engines being non-condensing). A small quantity of lime and carbonate of soda is used to soften the feed water. Native coal, of a poor quality, is used, and the stoking is done by hand.

The engine house adjoins the boiler house, and the steam main is duplicated. There are five tandem engines, built by Ludwig Loewe and Co., of Berlin, each giving 180 I.H.P. The valve gear is Mackintosh-Seymour, and the governor works direct on the throttle-valve. The five dynamos, each 100 kilowatt, are belt-driven. They are of the Thomson-Houston type, but manufactured by the Union Elektricitäts Gesellschaft; they are four-pole and slightly over-compounded. The engines run at 235 and the dynamos at 625 revolutions per minute. The mean electrical pressure at the station is 520 volts. The average maximum current leaving the station during the day is 500 amperes. The daily output from the station is from 2,000 to 2,200 kilowatt-hours. The brushes of the dynamos, as well as of the motors, are of carbon. As an average, 6·6lb. of coal are consumed per kilowatt-hour supplied at the dynamo terminals.

The switchboard is of slate, there being one panel for each machine. The connections are all made behind the board, the back of which forms, as it were, the wall of a narrow corridor with a door at each end, so that the connections can be got at without any difficulty. The switching arrangements are very simple. There are no fuses on the switchboard, but there is a 250-ampere fuse on each terminal of the dynamos themselves.

The cars and line are on the usual Thomson-Houston single-trolley system. The greater part of the line is two-track, both tracks being on the same side of the road. The trolley-wires are in most places suspended from ornamental steel poles placed at the edge of the pavement, and this arrangement is by no means unsightly. Span wires are only used in a few places where there is no room for poles. On part of the suburban line wooden poles are used. The trolley wire is of Felten and Guilleaume's phosphor-bronze, and is 0·322in. diameter. The wire is divided into sections of 550 yards length, insulated from one another. One distribution cable is used, there being no feeders. The cable is from Siemens and Halske, and is insulated with jute and compound, lead-covered and steel-armoured. Both the T and straight-through joints are made in Siemens' cast-iron junction boxes of the well-known pattern. The rails form the return circuit, without a supplementary cable or feeders. The "channel-pin" bond is used to connect them.

There are 22 cars running during the day, each consisting of a motor car and trailer, each car being designed for 35 persons. The cars, when empty, weigh 6½ and 2½ tons respectively. The steepest grade is 6·8 per cent. The motor cars are each fitted with two Thomson-Houston single-reduction 15 H.P. motors of the W.P. 30 pattern. The motors are series-wound, and can be switched by the driver either in series through a resistance, in parallel with a rheostat in series, or each singly on to the line in series with the rheostat. The maximum speed of the cars in the town is about 12 miles an hour; outside the town, 15 miles an hour.

THE MEXICAN GOVERNMENT TELEGRAPH SERVICE.

Within the past ten years the telegraph service in Mexico has undergone a complete transformation under the able and energetic management of Saturnino Islas, who was singled out for the task by President Diaz when carrying out those great reforms in the civil service which are associated with his name. Previous to 1885 the telegraphs in Mexico were almost a bye-word on the American continent. The operators were political nominees, who seem to have drawn their salaries, like their patrons, for party services, and not for the work they were supposed to perform. The lines were in a deplorable condition, and had obtained such an evil reputation that travelling by night was rendered dangerous through the prevalence of broken or derelict wires on the roadways. Contractors who had charge of the maintenance neglected their obligations, though drawing their payments punctually. If the accounts recently published by the *Electrical Engineer* of New York are correct, half the messages entrusted to the Mexican authorities never reached their destination; and, as a natural result, the service was comparatively little used, whilst

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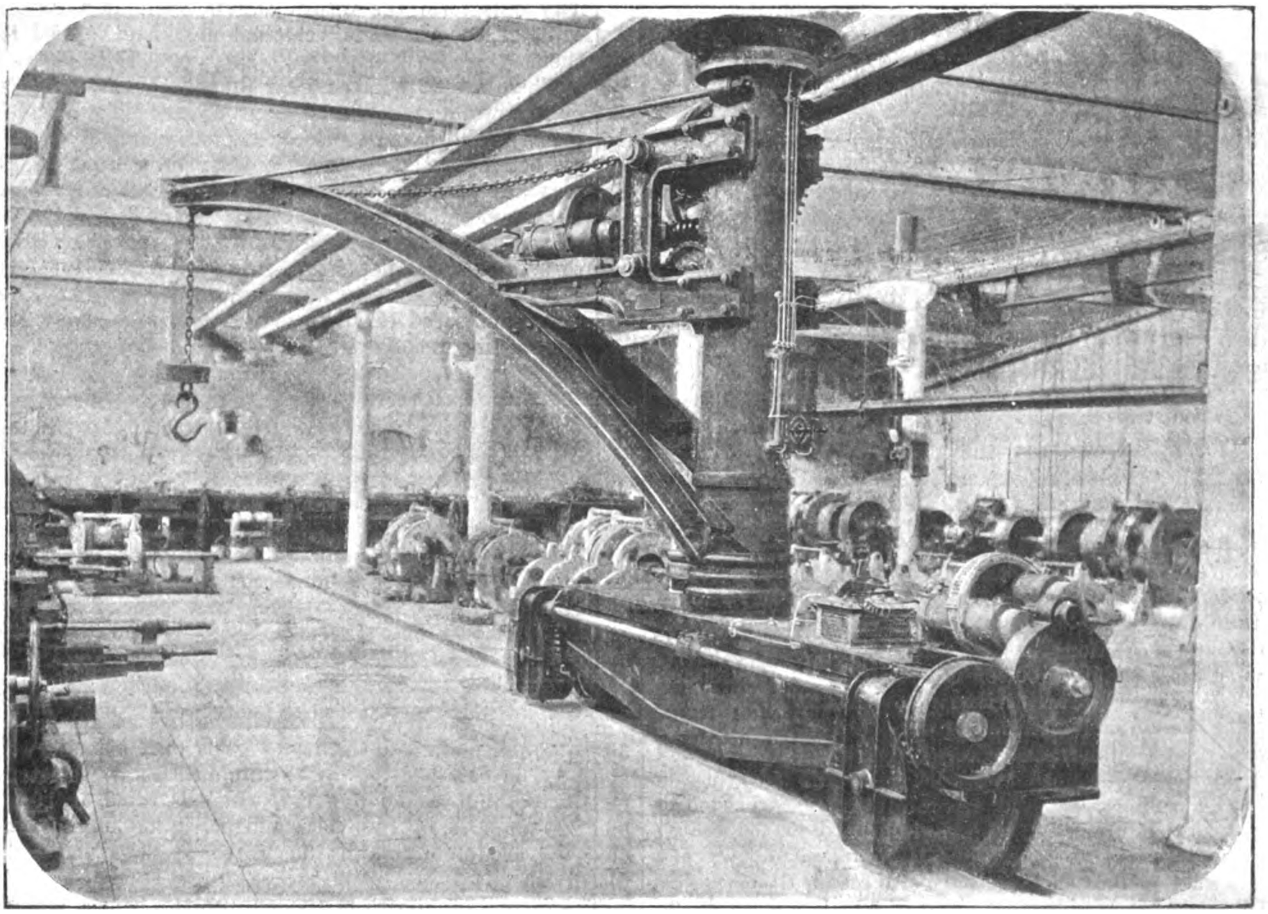
the expenditure was far in excess of the revenue. Saturnino Islas has now changed all this, and the financial position of the Mexican telegraph system now compares favourably with that of any other department of the Mexican Republic, which has made such rapid strides of late that its revenue is more than double what it was some 20 years ago. Having studied modern telegraphy in the United States, and applied his knowledge practically on the Vera Cruz Railway, Saturnino Islas went to work in reorganising the department over which he speedily acquired sole control. By first changing the *personnel* of the service and then setting to work on the repairs of the lines, he soon made it evident that traffic would not be slow to follow restored confidence. Competent operators took the place of the old ornamental employés; the lines were got into working order, and useful extensions carried out on an efficient and rational scale, so that at this moment there are 26,000 miles of wire and 806 stations directly under Government control. The central office in the capital is handsomely appointed and thoroughly well manned; whilst the country is carefully divided under the direction of able superintendents, who are held responsible for the maintenance of their several sections.

It should be noted that the Government telegraphs in Mexico are primarily for State purposes—that is to say, for the service of the army, a very important function in countries like the South American States, where the population is always turbulent, and more or less given to revolutions. Consequently we do not look for an ideal tariff in those regions suited for popular use such as we consider essential on the European continent. But we should have expected from Saturnino Islas, who in other respects has shown many qualities of independence and originality, something better than the "zone" system of charges—a system which is neither sound in theory nor good in practice. The tariff, as designed by him, ranges from 20 cents to 2 dollars for a message of 10 words, the rates varying by 20 cents for every 120 miles (180 kilometres) or fraction of the same—that is to say, every office is treated each as the centre of a number of circles that distance apart, the charges therefore varying according to the zone in which the place is situated to which the telegram is going. Approximately this is charging by distance, but the approximation is so wide that the difference of cost must appear very arbitrary in the case of places situated near the zone boundaries but on different sides of them. It is claimed for this system that the official can see at a glance what the charge must be when he has found the place on the plotted map; but it leaves out of account the customers' ignorance as to a detail of that sort. Nobody knows what he may have to pay beforehand; and this circumstance deprives the system of all title to being a popular one. Experience has proved that a charge based strictly upon distance is not theoretically defensible, seeing that the expense, after first cost, does not vary by distance. But a tariff framed on approximate distances is altogether indefensible. Mexico is settling down into habits of peace and civilisation; it is perhaps not too much to hope from it that a tariff more in accordance with the experience of older countries abroad may soon find favour in that country. It is interesting to note that all the cables used in Mexico are manufactured in England.

A WORKSHOP ELECTRIC CRANE.

The accompanying illustration has been reproduced from a photograph sent us by M. Fabius Henrion, of Nancy. It



represents a 6-ton electric crane. As the rail upon which the crane runs extends the whole length of the shop (80 metres), and as the jib has a radius of action of 5 metres, the crane is able to serve an area of 80 by 10 metres. The crane picks up the castings as they arrive, takes them to the various tools, thence to the erecting shop, thence

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to the testing shop, and afterwards to the spot where the machines are painted, packed, and put on the trucks. At the bottom the crane runs on a single Brunel rail; at the top it is guided by two iron girders between which runs a roller. Along these two girders run two wires, from which the current is collected by two brushes. The movement of translation is effected by the motor mounted on the carriage, the motor being caused to drive the crane ahead or astern, slowly or quickly, by means of a lever turned more or less to the right or left. The reversal of the motor is effected by reversing the current in the field. Carbon brushes in fixed positions are used. The motor which is seen on the platform between the pillar and jib effects the lifting motions, and is governed by the regulator fixed to the pillar. When the load is being lowered it cannot descend too quickly, for if the speed increases beyond a certain point the motor becomes a generator and a brake is thus automatically put on.

AN EXAMPLE OF INTERIOR CONDUIT WIRING.

BY ALBION T. SNELL.

Some interest now attaches to the use of interior conduits for electric wiring, and perhaps a brief description of a lighting plant which I have recently designed for Messrs. Heelas, Sons and Co., of Reading, may on this account prove of interest.

Messrs. Heelas have one of the largest drapery and furniture houses in the South of England, and their premises extend over a ground plan of more than an acre. The buildings vary from two to five stories at the front and back of the block,

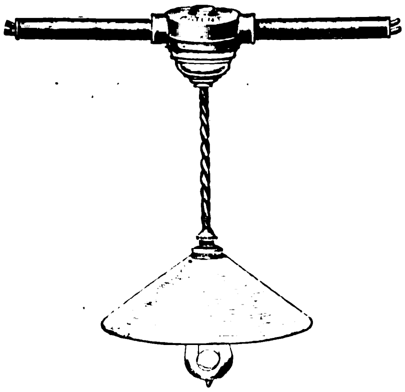

Fig. 1.

while in the centre portion they are generally of one storey with a lofty skylight. Consequently the levels of the ceilings differ in all the departments. Owing to the peculiar arrangement and construction of the interior of the buildings it was felt that wood casing was unsuitable. It was not strong enough to be carried in air from point to point as was absolutely necessary, and, moreover, it would be unsightly in many places, even assuming it could be economically and securely erected. Accordingly it was decided to use iron pipes throughout, running the conductors in pairs in one pipe.

To facilitate the distribution and balance the fall of pressure the area is divided up into sections, and each is served by a feeder from the engine house. In some cases sub-feeders are carried from the section boxes to smaller distributing boxes, but in most cases the distribution is effected from the section boxes. The sub-circuits are divided into circuits of five amperes each. The section and distributing boxes are all made of cast iron, with glazed iron-framed doors. The iron pipes to and from the boxes are tapped into sockets in the sides of the boxes. The ceiling roses and separate switches are fixed in iron bases, so that from the main switchboard to the ceiling roses the conductors are encased in iron pipes, and are free from the least chance of an electric fire, and they are also practically safe from mechanical injury. The lamps are chiefly suspended by strong flexible cord (Fig. 1), but a few are fitted as shown in Fig. 2.

The generating plant is situated in a separate brick building with the accumulator house alongside. The plant comprises a Crossley Otto 14 nom. H.P. gas engine of the new scavengering type, which indicated 43 H.P. on testing when first erected (*see* Figs. 3 and 4. It has the usual heavy flywheels and electric-light governor, and ordinarily runs at from 204 to 200 revolutions per minute. Since the initial pressure of the exploding gas, with this type of engine, is about 250lb. to the square inch, and the exhaust is made at from 40lb. to 30lb., some difficulty

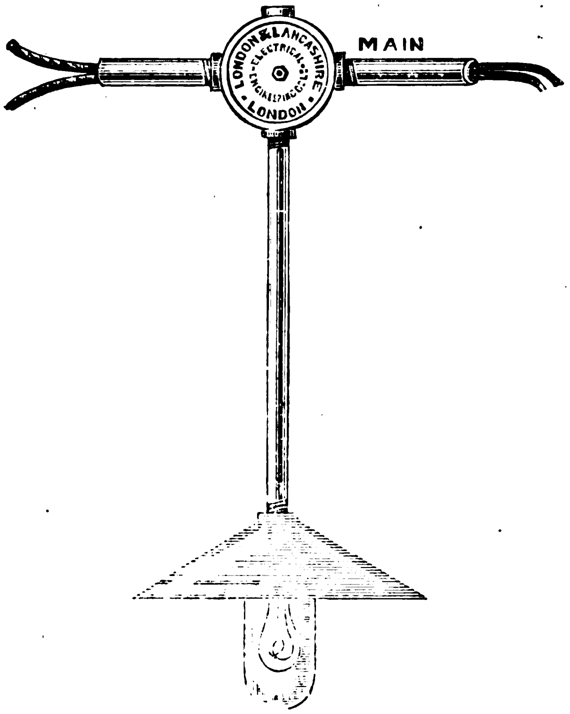

Fig. 2.

was experienced at first with the noise. Ultimately it was overcome, and the engine now makes little, if any more, noise than one of the same power of the ordinary type. There is a 4-in. cast iron exhaust pipe about 58ft. long leading into the top of a "hangdown" silencer with an open bottom, fixed into a brick chamber laid in cement and built into the ground.

Fig. 3.—Indicator Diagram of 14 N.H.P. Crossley Gas Engine of "Scavenger" type. Full Load. 200 revs. and 100 explosions per minute. 43 I.H.P.

The uptake for carrying off the fumes has an area of about 36 square inches, and the discharge is made almost without noise. The engine drives by belting an Electric Construction Company shunt-wound dynamo, which is rated at 105 volts and 220 amperes, or 140 volts and corresponding current for charging accumulators. It has three bearings and a heavy disc flywheel.

The main switchboard is divided into two panels, one for the positive connections and one for the negative, in the usual manner. The feeders are all brought to omnibus bars, and have

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a switch and fuse to each main. Ammeters are provided for reading both the current from the dynamo and that given to or from the cells, and a voltmeter with two-way switch enables the dynamo and feeder pressures to be read as desired. There is also a magnetic cut-out in the charging circuit which cuts in the cells when the dynamo pressure is high enough for charging, and cuts them out in the event of the pressure falling. The storage battery consists of 55 R5 Epstein cells, which have a capacity of about 200 ampere-hours at 50 amperes discharge. They act as a regulator during the hours of lighting, and as a storage reservoir for the light load by day and the night load after the shops are closed.

There are six arc lamps each of 2,000 c.p. nominal, and the equivalent of 850 incandescent lamps of 8 c.p. each, the actual number of lamps being about 528. Great care has been taken in the arrangement of the lamps to secure the best illuminating effect, and economy of power has been specially studied on account of the short hours of full-load working. All the incandescent lamps are of 3-watt efficiency.

The chief point of interest to users of gas-engine plant is the consumption of gas in the engine per B.T.U. This has been ascertained with considerable accuracy, as the gas is supplied through a separate meter. Reading gas costs 2s. 9d. per 1,000 cubic feet. From the mean of tests taken at different times and by different observers it appears that the cost of gas, at a maximum output of six arc lamps and about 450 incandescent lamps of various powers, is a little less than 1·25d. per B.T.U., and at a minimum output is 1·75d. These figures have never been beaten, I believe, for a plant of the same size.

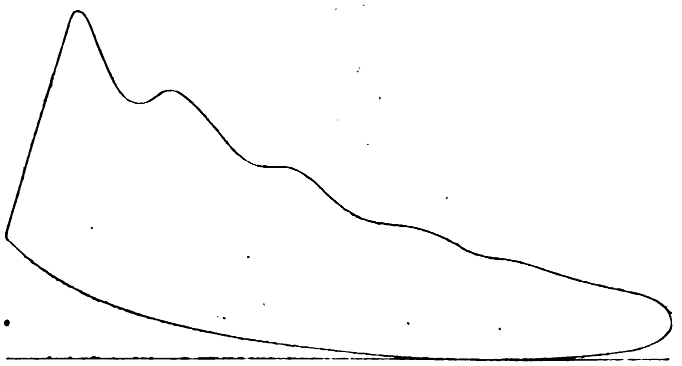

Fig. 4.—Indicator Diagram of 14 N.H.P. Crossley Gas Engine of "Scavenger" type Running Light. 200 revs. and 21 explosions per minute.

The cells are charged, when necessary, in the mornings from 9 o'clock until about midday, it being found that this is sufficient in a general way. During charging, a few lamps are run in the basements through a suitable switch arrangement. The cells supply the lamp current until it reaches 50 amperes, when the engine is started and kept running until the demand falls again to 50 amperes. In the winter time the engine runs for the lighting service from about 4 o'clock until half-past 7 or 8. The house has about 70 incandescent lamps installed in the service rooms, sitting rooms, dining rooms, and bed rooms, the current for which is supplied from the battery when the engine is shut down.

Mr. Musgrave Heaphy made an inspection of the plant, and expressed himself as being highly pleased with the use of iron piping and iron distributing boards, and the general method upon which the wiring was planned. The whole of the work was carried out by the London and Lancashire Electric and General Engineering Company to the plans and specifications of the writer.

Magnetic Observatory for Greenwich.—Provision has been made in the Navy estimates for the erection in Greenwich Park of a magnetic pavilion for absolute determinations of the magnetic elements, and the plans are now being prepared in the Director of Works' department. It is proposed to establish this station in the immediate neighbourhood of the Observatory, and at such a distance that there would be no suspicion of disturbance from the iron in the buildings.

THE BRUSSELS CENTRAL ELECTRIC LIGHT STATION.

By the courtesy of Mr. Pullar-Phibbs, electrical engineer to the Brussels municipality, an occasional correspondent of this journal was recently able to view the Brussels central lighting station. Our correspondent's impressions are given below. He gives several items of information not to be found in the description of the station which appeared in our issue of March 30, 1894.

The chief part of the load at Brussels is spread over a rectangle whose sides are about 1 mile and $\frac{2}{3}$ mile long. The station is at the Place St. Catherine, at one of the corners of this rectangle. At present there are 30,000 lamps of 8 c.p. (or the equivalent) connected to the mains. The three-wire system with accumulators is used, the pressure between the outer mains being 220 volts and the middle wire not being earthed. The distribution network is fed at 11 points, and it is intended shortly to increase this number to 24. At every feeding-point there are feeders to all three mains.

The boilers are by Babcock and Wilcox, and are similar to those at the tramway generating station. They are fitted with "smoke preventers" on the Orvis system, but these are not used, as coke is burnt. This system consists of leading a mixture of steam and air to the top of the fire, each furnace being provided with four of these inlets. The feed water, which is obtained from the Willbroeck canal, is softened with lime and carbonate of soda, and a purifier by Dervaux of Lille is used, as at the tramway station.

There are eventually to be six engines, each of 650 H.P., though only three have been put down at present, one alone being now sufficient to take the maximum load with the help of the battery. They are horizontal compound engines, built by Carels Frères, of Ghent, and are fitted with Sulzer valve gear and jet condensers, which latter produce a vacuum of 25·6in. Each engine rope drives two dynamos through rope driving. The engines run at 60, the dynamos at 300 revolutions per minute. The latter are separately-excited four-pole machines with drum armatures, built by La Société Anonyme Electricité et Hydraulique (formerly Julien Dulait) of Charleroi. Each machine is designed to give a maximum current of 1,200 amperes at 130 volts. The field magnets are excited by the batteries, and are connected two in parallel, two in series. Thus connected their resistance is $5\frac{3}{4}$ ohms, and they require a current from 10 amperes at light loads to 18 or 19 amperes at full load.

The battery consists of 140 Julien cells. The boxes are of lead; they contain 41 plates $101\frac{1}{2} \times 101\frac{1}{2}$in., and their capacity is 3,500 ampere-hours. The normal maximum rate of discharge is 350 amperes, but they are guaranteed to give 1,400 amperes for half an hour without damage to the plates.

The switchboard is on a gallery, as at some of the London stations, and does not present any novel features. All the feeders are brought to the switchboard, and each is connected to the omnibus bar through a rheostat, there being a voltmeter for each feeding point. The accumulator regulating switch is of the usual vertical type, there being 25 regulating cells. There is an automatic switch between the dynamo omnibus bar and the battery, which breaks contact when the current falls to a certain value. To give a rough indication of the condition of the insulation of the mains, a high-resistance voltmeter is inserted in turn between each outer main and earth once a day. If the two readings differ a little, but not too much, the mains are considered to be in a good condition; if the two readings are exactly equal the middle wire falls under suspicion. There are also recording ammeters to record the current leaving the accumulator terminals. The instruments are all of Hartmann and Braun's manufacture. The board is of black marble, and all the connections are at the back, where they are only with difficulty accessible.

The testing room, which is honoured with the title of "Chambre de Vérification," is on the first floor. There is a complete cable-testing set of the same design as that in the India-rubber Company's testing rooms at Silvertown. It includes a four-coil Kelvin mirror galvanometer, a four-dial Wheatstone's bridge, Rymer-Jones keys, &c., all of the Silver-

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town manufacture. The galvanometer is suspended on four india-rubber tubes, but there is no arrangement for supporting the instrument when dusting it. There is, in addition, a Crompton's potentiometer, with an Ayrton-Mather l'Arsonval galvanometer, for checking and calibrating the station instruments. There is also a spare Carpentier-d'Arsonval galvanometer.

The mains have all been supplied by the India-rubber, Gutta-percha and Telegraph Company. They are of vulcanised india-rubber, and are drawn into cast-iron pipes, there being a separate pipe for each of the three mains. The testing wires for all three mains are in the same pipe as the neutral wire. The section of the neutral cable is, on an average, about half that of the other cables. All the drawing-in, junction and distribution boxes are built of brick. Only a few of them are drained, and there is no system of ventilation. The ends of the pipes in the boxes are not blocked. The house service cables are T'd from the distributing mains by solid joints, which are insulated with india-rubber, and mostly not vulcanised. The insulation of the complete network is 350 to 400 ohms; this is high, considering that the minimum insulation of the house installations is fixed at 2 megohms per lamp.

The Silvertown Company were the contractors for the whole of the plant under the stipulation that as much as possible of it should be of Belgian manufacture. The contractors' guarantee expires next November. The price charged per unit is 80 centimes (7·6d.). Two supplementary stations are being built—one at the Hotel des Chemins-de-Fer, which is also at the edge of the district of greatest load. This station is to be driven by five gas engines of 120 H.P., the gas being obtained from the town mains. The other supplementary station is being built in the Avenue Louise, and will be chiefly for the lighting of the Ministerial Offices, where 4,000 8 c.p. lamps are being installed. This station will not be connected to the network. It will also have gas engines as prime motors, four 60 H.P. engines having been ordered for it.

THE METROPOLITAN WEST SIDE ELEVATED RAILROAD OF CHICAGO.

This line, of which our New York correspondence gave a short description in *The Electrician* of May 10th, resembles in many ways the Liverpool Overhead Railway, and a few of the more important details, as given by the *Street Railway Review*, may be of interest.

The road, says our contemporary, was built for a steam road, and all the plans were drawn for locomotive traction. The credit for inducing the owners of the road to adopt electricity is probably due more to the present general superintendent, W. E. Baker, than to any other man. As general manager of the Intramural Railway at the World's Fair he secured possession of facts and figures which were convincing as to the economy of electricity as a motive power. The structure is the heaviest elevated road structure yet built in America. It was designed to carry safely in service 30-ton locomotives, followed by double-deck cars. The minimum height of the structure above the street is 14ft., the usual height being 15ft. The track is 4ft. 9in. above the bottom of the supporting girders. The supporting pillars are 14½ft. to 18½ft. high. The standard foundation is 7ft. deep and 8ft. square. The girders are 4ft. deep. Distance between pillars is 39ft. to 50ft. The lateral bracing is equivalent to 450lb. per lineal foot of track. The rail is 90lb. T, with four-bolt fish-plates.

The most notable of the structures is the rolling lift or jack knife bridge across the Chicago River. The bridge spans 174ft. from pier to pier. It is really two distinct bridges, each bridge having two tracks. The two parts are raised and lowered separately. The west halves are operated from an elevated tower between the tracks, and the east halves from the switch and signal tower south of the tracks. The motors, controllers, and air brakes for raising and lowering the bridges are practically identical with the motor car equipments.

The greater part of the structure had been built and many of the rails had been laid before the use of electricity was fully decided on. The laying of the third conductor rail was not, however, attended with much difficulty, except at the complicated switches on some parts of the four-track structure. The trolley contact rail is 45-lb. T, and is run at one side of each track about 7in. above the track rails. It is supported on blocks of wood boiled in paraffin. These blocks are 6in. square, and are mounted on iron brackets about 1in. high. The contact rail is fastened down to these insulating blocks with wood screws and clips. Contact shoes are put on each of the four corners of a motor car, and at switches the third rail on one side is discontinued as on the Liverpool line, and a rail is placed where the shoes on the other side of the car will make contact until the switch is passed. Where the third rail ends at switches, V-shaped frogs, lower at the head than at the point, are provided, so that the trolley shoe will not catch in passing on to a rail. To hold the ends of the trolley rail in alignment, light two-bolt fish-plates are used. The bonds are put under the rail base, and consist of heavy flexible copper strips about $\frac{3}{16}$in. thick, and as wide as the base of the rail. These strips have two rivets in each end, which are riveted up through the base of the rail, one each side of the web. Forty-five pound T rail is also used for feeders. These feed rails are run between tracks, and are boxed over for protection and so as not to interfere with workmen walking along the structure. At switching points and at some stations where there is not room on the structure for the feed rails, copper wire hung under the structure is substituted.

The contact rail is sectioned, each section being controlled by a feeder panel, with circuit breaker at the power house. From the power house, which is only 1¼ miles from the down-town terminus, 18 feed rails go west. The contact rails are sufficient to feed the down-town end. Contact rails are cross bonded, and connected to feed rails about every 300ft., though at switching points and curves this distance is lessened. For a return circuit the track rails are used; these are not bonded at the joints, but are connected at the middle of each rail to the structure. At all connections where copper wire is connected to iron rails, a cast brass rivet is sweated to the end of the wire and riveted to the rail.

At the Chicago River, where the continuity of circuits is broken by the rolling lift bridge, four Simplex rubber and lead-covered armoured submarine cables were laid on the river bottom. A shallow trench was dredged in the mud of the river bottom before they were laid.

The four-track structure necessitates the use of a much more elaborate system of switches and signals than have yet been put on any elevated road. There are three notable pieces of special work. At Marshfield-avenue, where three double-track lines converge to the four-track main line, elaborate special work is put in, which allows the sending of trains in any direction. On the viaduct just east of the Canal-street station is another complicated piece of special work to facilitate terminal switching. At the east side of the river is still another system of interlocking switches for use at the Franklin-street terminus. The system of interlocking switches is similar to that used on steam roads, but has the added complication of the third contact rail, which in some places has to be shifted along with the switches. This problem has never before been faced either by builders of special work or interlocking switches. The tower at Marshfield-avenue has 13 levers for 24 switches, and four movable point frogs; 11 levers for 28 facing point locks, 23 levers for 23 signals, and six levers for working 10 contact rails. There are seven spare spaces for levers, there being a provision for 60 levers on the frame.

The road has at present an equipment of 55 motor cars and 100 trailers. For the first few years trains of one motor and two trailers will be run. The present motor cars have two motors. When the traffic increases enough to justify longer trains, two more motors will be put on each motor car and six car trains can be run. The new cars are 47ft. 2⅞in. over all, and 40ft. over the sills. The width at the sills is 8ft. 7in., and at the eaves 8ft. 11in. The roof is 12ft. 10in. from the rail. These motor cars are intended as smokers, and have none but side seats. The motorman's cab occupies two corners, half of each cab being in the car and the other half occupying half of the platform. To give the car strength to act as an electric locomotive a very substantial steel sub-frame was put on, and in order to have sufficient traction, no attempt was made to lighten anything about the motor cars. The weight of the car, exclusive of the motor, is about 18 tons. They are finished in quartered oak, and have rattan covered side seats. The motor car trucks consist of very heavy steel frames, with central cross beams hung on elliptic springs. One end of each of the motors is suspended from the centre beam. The dimensions of the trail cars correspond approximately with those of the motor cars, and their seating capacity is 48.

This is the first elevated road to adopt an automatic coupler, the Van Dorn coupler being selected. For brake equipment the straight air brake was adopted, as it was thought that the driver has a much more accurate control of his train in making stops with a straight air brake than with an "automatic" brake in which he has not direct control of the valve supplying the brake cylinders. This brake has the disadvantage, of course, that if the train pipe parts the brakes are useless, but in such an event the motors can be reversed and put in parallel with the circuit breaker open. For six-car trains it is hardly practicable to carry an air-storage cylinder large enough to brake a train making frequent stops, although with

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the present three-car trains the motor car storage is ample. To provide for the future, storage tanks have been put on all the trail cars and are to be connected to the motor car by a separate hose. This arrangement is simply for air storage and is entirely independent of the train pipe supplying air to the brake cylinders.

The electrical arrangements in the driver's cab are very complete. In the right-hand front corner is the air-brake valve. Just left of this is the series-parallel controller. On the wall of the cab, at the left of the motorman, is a circuit breaker. A fuse is also placed in the cab, but it is very heavy, and it is not intended that it shall melt except in extreme cases. The circuit breaker is intended to take care of all ordinary overloads. In one cab is the air pump operated by an electric motor. This motor is automatically cut in and out of action by the air pressure in the main reservoir. This automatic regulator is put on the left wall of the cab, below the circuit breaker. The cab which does not have the air pump in has a small rheostat controller for the air-pump motor. In front of the driver is an air-pressure gauge with two different coloured pointers. One pointer indicates the pressure in the main reservoir and the other the pressure in the train pipe and brake cylinders. To avoid any annoyance from having circuit breakers on both ends of a car, they are connected in parallel, and the driver throws out the one at the rear when he leaves it to change ends.

The series-parallel controller is an imposing structure compared with those used on street cars, providing as it does for four motors and such a heavy current. The arrangement is such that it can be used as a series-parallel controller or as a plain multiple controller. The reason for this is that sometimes, when starting with a heavy load with the motors in series, one pair of wheels will slip and the counter electromotive force of the slipping motor reduces the current flowing through the others, so that the power of starting is still further reduced. With the motors in multiple the slipping of one does not affect the other. The arrangement of the controller is very peculiar. When the controller is off, the handle is always at the left, and when it is at the left the controller is always off. To make a start with the motors in series the driver turns the handle in a direction contrary to the hands of a watch. When he has gone a half a revolution the motors are in series with all the resistance out. To put the motors in multiple he continues turning a full revolution. During the revolution and a half necessary to make the ordinary start the steps have been as follows: During the first half revolution the motors are in series and the resistance is gradually cut out. During the second half revolution the process is reversed, so that at the end of the first revolution the motors are entirely cut out as they were before starting. When, however, the handle begins on the second revolution, the motors are in multiple with the resistance all in circuit. When a revolution and a half has been covered the motors are in multiple with no resistance in. To shut off current and bring controller back to zero, the motorman continues another half revolution. To start with the motors in multiple the handle is turned a half revolution in the direction of the hands of a watch. Indicators on top of the controller plainly show the driver what he is doing. In ordinary service a man need only turn the handle one way, a revolution and a-half to start and a half revolution more to shut off current. The magnetic blow-out is, of course, used on this controller. In the cab near the brake valve is a small handle for turning on the sand. The sand will be blown by compressed air.

The motors are of the General Electric type, weighing about 13 tons each. The armatures are barrel-wound, and the insulation of the motors is asbestos, so that they are believed to be fireproof. Doors are provided both above and below the commutator, and the brush holders can be put either above or below, so that they can be looked after from the car or from the pit. Another feature peculiar to this motor is that there is a cap to slip over the end of the brush, so that a side contact is not depended upon. The suspension of the motor is by a link from the centre cross beam of the truck. The only spring in the suspension is that afforded by the springs in the truck.

All cars are heated with electric heaters, made by the Central Electric Heating Company, of New York, 12 to each car. They are arranged in series of four. When all are in circuit, the current taken is 14 amperes at 500 volts (7 kilowatts). The driver's cab also has a small heater. Every motor car has electric headlights and "markers," or designation lights. The electric headlight is put over the centre of the hood, and the two markers are put on each side of it. The head-light markers and lights in driver's cab, a series of five at each end of a motor car, are on an independent circuit, which is turned on and off as the motorman changes ends.

The contact shoes, of which there are four to each motor car, are supported on wood beams projecting out from the motor truck frames. There is a chilled cast-iron shoe hanging loosely by links slotted at one end. There are no springs about it. A flexible copper wire connects to the middle of the shoe to make electrical connection. The angles of the links by which it is hung are such that it is perfectly rigid in the direction in which the ordinary strain comes, while it will give way to unusual obstructions.

The power plant is at present of about 6,000 H.P. nominal capacity, but could be increased to 12,000 H.P. The distance to the river is about one mile, and provision has been made for running the station condensing. There are four Reynolds-Corliss vertical cross-compound condensing engines, of which two are direct connected to General Electric 1,500-kilowatt generators, and are guaranteed to work satisfactorily with a load of 3,100 H.P. The two small engines are direct connected to 800-kilowatt generators, and are guaranteed to a load of 1,500 H.P. The engines are fitted with a special Reynolds-Corliss valve gear, which allows cutting off steam at any point from zero to ¾ stroke. The cut-off of both cylinders is controlled by a heavy fly-ball governor. The valve gear is also so arranged that if desired the low-pressure cut-off may be set by hand instead of being controlled by the governor. Each engine is provided with a separate governor, which controls a butterfly valve in the main steam pipe. This governor is set so that if anything should happen to the governor which controls the speed of the engine, causing it to run away, the auxiliary governor would close the butterfly valve and shut off steam entirely from the engine before the speed could increase to a dangerous point. The connecting rods for the two sides of the engine are connected to overhung cranks on the ends of the shaft, and the fly-wheel and armature are keyed on to the shaft between the two main frames of the engine. The engines are very heavy and massive, and are spread out wide in all directions on top of the foundations so as to prevent vibration. The principal dimensions of the two large engines are as follows:—Stroke, 48in.; diameter high-pressure cylinder, 36in.; low-pressure cylinder, 72in.; diameter main shaft, 24in.; length, 22ft.; flywheel, 24ft. 4in. in diameter; weight, 150,000lb.; revolutions per minute, 75. With each of these large engines is a Reynolds independent vertical air pump and condenser, with air pump 36in. in diameter by 16in. stroke, driven by a Corliss steam cylinder 16in. in diameter. The two small engines are of exactly similar proportions as the large. The initial steam pressure is 125lb. Each engine has a Stratton separator. A travelling crane runs the length of the engine room, and is operated by electricity.

The boiler room contains 12 300 H.P. Babcock and Wilcox boilers, in batteries of two each. The most interesting thing about this boiler room is the arrangement for handling and burning coal. Coal is thrown directly into storage bins in front of the boilers by being dumped down through doors in the roof from cars on a siding of the elevated structure which passes directly overhead, or it can be hauled by teams to the alley in front of the boiler room and thrown in through the windows. Shoots take the coal from the bins to the hoppers of the mechanical stokers. The grate of this stoker consists simply of an endless chain running over sprockets at the front and rear. The coal from the hopper feeds on to this chain and motion is supplied the chain by a stoker engine furnishing this power for several batteries of boilers. If the right speed is given to the grate, the fresh coal will take fire before it has travelled many inches of the grate, and will be practically consumed by the time it reaches the back of the grate. The motion of the grate over the sprockets at the back throws the ashes down into the pit. The speed of each grate is regulated independently of the main driving shaft by changing the length of the crank working the rachet which drives the grate. This stoker has the advantage over others that it gives a perfectly even and level grate surface, and the grate does not move relative to the coal. This allows the burning of fine cheap fuel, and ensures an evenly distributed admission of air to the fire. Another advantage of this stoker is the fact that at a moment's notice the whole thing can be pulled out from under the boiler, as it is mounted on wheels and runs on a track.

A steel stack 150ft. high and 12½ft. inside diameter lined with brick furnishes the draft. This can be supplemented by two Sturtevant blowers which can deliver air to the ashpits.

A Notable Chemical Action on Aluminium Alloy.—An experiment of M. le Chatelier was described in a recent communication to the Académie des Sciences, which may have an important bearing. Equal parts of aluminium and copper were fused together in a crucible. The resulting ingot was then placed for 24 hours in a solution of common salt and lead chloride, with a view to dissolving out the uncombined aluminium. No apparent change could, at the end of this time, be observed in the ingot. It was accordingly removed from the saline bath, washed, and dried. At the end of 12 hours the whole mass was found to be reduced to the state of powder from the spontaneous oxidation of the alloy. A similar ingot, not immersed in the solution of sodium and lead chlorides, was unchanged at the end of a month.

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The Electrician.

The Oldest Electrical Journal, 1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

All Editorial letters to be addressed to the Editor.

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as evidence of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices.*

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A PLEA FOR THE ORGANISATION OF INVENTION.

Between the adoration of the inventor; as practised in America, and the distinct discouragement of him which is fashionable in England, there is a happy mean preferable to either extreme. The widely different attitude adopted towards men of many inventions on this side and on the other side of the Atlantic has its origin in the widely different circumstances and characteristics of the two peoples. The groove which our forbears have been good enough to cut for us is so broad, and has led us for so long in the right direction, that it seems to most Englishmen to smack of rank heresy, not to say gross disrespect, to suggest that the groove is also a deep one, and as difficult as it is desirable to get out of. This sleepy self-satisfaction results in a certain irritating obtuseness to new ideas, and, indeed, to novelty of any kind, which, although of no small utility in the painless repression of fads and faddists of all sorts and conditions, forms an atmosphere which is not exactly suited to the delicate constitution of the inventor. Even in those countries in which the inventor is encouraged by legislation and public opinion, and where invention is more or less organised and directed to definite ends, the principle of encouraging originality, admitted in theory, is with difficulty actually practised; the effort to grasp new conceptions, the discomfort of getting out of an old rut into a new one, is too severe for most of us to take to it kindly. In a country, then, in which there is not overmuch legislative encouragement of the inventor, and no general public encouragement whatever, the passive and active hindrances to invention become highly effective. Again, the typical inventor of the story-book and after-dinner speech, an individual who, it must be candidly confessed, has a real corporeal existence, is not calculated to win respect in any country where the narrow business spirit predominates. To begin with, the typical inventor is usually suffering from a very severe attack of enthusiasm; a grave disadvantage

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where business bargains and the financial support of business men are the matters in hand. Furthermore he is, as often as not, completely ignorant of the industry which he has honoured with his attentions; nevertheless, he is almost fanatical in his faith in the efficacy of and necessity for his particular device, and as a fanatic is quite unable in the nature of things to give reasons for the faith that is in him, he fares badly in the hands of anyone wanting to know why it is absolutely necessary to adopt this or that improvement, and how long it will be before the returns come in. For the typical inventor, so called, it is impossible, indeed, to do more than obtain good-natured toleration. Many things, from the Salvation Army to German bands, are good-humouredly suffered by the great British Public, and the typical inventor would only be one more small addition to the very long list of irritants modern man is expected to endure without loss of temper. Typical inventors are certainly very trying, but then there is always about one chance in ten thousand that you may be contemptuously tolerating a Schwarz or a Gutenberg, which adds all the flavour of a mild Stock Exchange speculation to your magnanimous condescension.

It is not, however, the technically ignorant or wildly enthusiastic inventor that our good friends the Americans publicly worship. A dash of enthusiasm is indeed no disadvantage, nor for matter of that a little technical ignorance; an overtrained mind is not likely to possess the freshness requisite for genuine invention. Graham Bell, Elihu Thomson, Nikola Tesla—none of whom, by the way, are American born—are typical of the character, bent of mind, and genesis of the transatlantic inventor. An inventor is as much a part of the bag and baggage of a big American manufacturing or engineering company as a works manager, head draughtsman or chief estimating clerk. They do not use steam-hammers to crack nuts with out there, and inventive geniuses are not expected to waste the greater portion of their time in deadening routine work. Not only are the pecuniary rewards large, but inventions are not, as with us, usually labelled with the name of the reigning Sovereign, or any other pointless appellation, rather than endanger the inventor's peace of mind—and his fidelity to his employers—by connecting his name with the mechanism he has devised. Economically this severe suppression of the individual would seem somewhat short-sighted, since many would be content to take some of their reward in fame, which costs nothing. Of course, the ostentatious encouragement of invention which is so much *à la mode* in America has its reverse side. The legal facilities and forms ostensibly intended to stimulate and protect invention can be and have been made to serve quite other purposes. The much talked of poor inventor, unless he has, to use the phraseology of Emerson, "hitched his waggon to a star"—that is to say, to a big manufacturing concern or a millionaire speculator—fares but little better across the Atlantic than in this country, although, indeed, his fellow countrymen are considerably more predisposed in his favour. Concerns which enjoy a monopoly, whether in the United States or in the United Kingdom, do not, of course, encourage invention. They have, as a rule, paid huge sums for the patents which confer the monopoly, and their natural instinct is to sit quietly at the receipt of custom during the fourteen or seventeen protected years and trust that their long possession of the field will enable them to hold their own for many a year after the inventor is let loose upon them. But even in the case of monopolistic concerns, placing a straight waistcoat upon the inventive minds of the staff and a muzzle on their mouths defeats its own object in all but a very few exceptional cases. A monopoly with long-sighted men at its head might, by the judicious encouragement, and above all by the proper organisation, of the inventive spirits that are sure to be found amongst its employés, build up a new network of patents as fast as the old one wore out and thus perpetuate itself *ad infinitum*, and if it were to perpetuate itself in this manner its perpetuation would not be the unmixed evil it otherwise would certainly prove to be. Useful even as a means of maintaining a monopoly the organization of invention is invaluable as a weapon in competitive warfare. Concerns engaged in an industry where competition is keen do not indeed disdain the aid of the inventor, although with us he is not in most instances regarded as a separate organism, but is expected to work out his ideas in his leisure hours—if he has any—in much the same hap-hazard manner that a writer of Society verses dashes off his rhymes on the back of an envelope after dinner. This method, or rather lack of method, without doubt achieves one end. The percentage of unqualified failures is extremely small. It cannot, however, be considered conducive to epoch-making inventions, and it is to be questioned whether our present plan of graciously permitting foreigners to invent what we condescend to subsequently apply and improve is one which will lend itself indefinitely to the preservation of our industrial supremacy.

NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(Continued from page 327.)

§ 47. **Capacity Tests** (*continued*)—With further reference to the "earthing period," previously mentioned, the Saunders key can be used in a manner to make this period anything desired, although provided as described with the arrangement to make the period as small as possible. The earthing period is, of course, the time elapsing between raising the charge key and putting down the discharge key. Mr. Arthur Dearlove's above-mentioned article, which will repay careful study, shows that the earthing period had an important influence on the accuracy of the correction: if insufficient time was allowed the cable was not properly discharged, and the correction became too large, making the apparent capacity too high. The tests were taken on laid cables of 1,331 and 100 knots respectively, and the true capacity per knot was taken as that determined on two-knot lengths at the factory, at a temperature of 75°F. The cables were each balanced against condensers of 20 and 60 microfarads capacity. On the large cable the mean of the tests gave an excess of only four-fifths of one per cent. over the true capacity as measured in factory lengths. This on a cable of 472 microfarads must be admitted to be a very good proof of the usefulness of the Muirhead correction. The earthing period allowed was three seconds, and it was found that a less period complicated matters, as the absorption discharge was then first in one direction and then in the other. In such cases the *difference* only was taken as the correction to apply, but the author of the Paper points out that this effect may be used as a means of finding the right time necessary for the "earthing period" for any length of cable. For the purpose of verifying the accurateness of the correction, the periods of "charge" were varied from 5 to 60 seconds, and it was found that the correction became somewhat too powerful with periods exceeding 30 seconds. The normal period of charge need not, in the ordinary course, exceed about 5 seconds on the longest cables, but it is gratifying to know that this time may be extended to 30 seconds without lessening the accuracy of the correction, as it allows more time to balance the slides.

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One cannot fail to notice in these results that the apparent or uncorrected capacity is *less* than the true in all the tests on the long cable and *more* than the true in all tests on the short cable. Looking for some reason to account for this we find that the tests on both cables were made with the same standard condensers, the insulation resistance of which were about seven megohms per 60 microfarads, or about 420 megohms per microfarad. Turning now to the insulation resistance and capacities of the cables, these are given as one megohm for the 1,331-knot cable and six megohms for the 100-knot length, the true capacities being 0·352 and 0·354 microfarads per knot respectively. The insulation resistance of the long cable was therefore

$$1{,}331 \times 0{\cdot}352 \times 1 = 470 \text{ megohms per microfarad,}$$

or about the same as that of the standard condensers used with it in the tests. On the other hand the insulation resistance of the 100-knot cable was

$$100 \times 0{\cdot}354 \times 6 = 212 \text{ megohms per microfarad,}$$

or only about half that of the standard condensers.

It appears therefore that the uncorrected tests make the apparent capacity of a cable *less* than the true when the insulation resistance of the cable per microfarad *exceeds* that of the condenser tested with it, and *more* than the true when the resistance is *less* than that of the condenser.

From this it appears that, with a certain relation between the insulation resistances per microfarad of the cable and condenser (possibly when equal, or nearly so), the apparent capacity, as given by the test, will be the true capacity, and needs no correction. The author of the Paper has also pointed out that the correction for absorption may become very small when the insulation resistance of the two capacities compared is about the same per microfarad. Mr. E. C. Rimington has also shown mathematically (*Phil. Mag.*, September, 1887) that in comparing capacities by Gott's method the insulation resistance of the cables or condensers compared must be known, and if unequal allowed for in the formula.

The *equalisation* of the insulation resistances per microfarad of the capacities under comparison has fortunately been tried on cables of different lengths with excellent results, shunting either the condenser or cable as necessary; and it has been found that this brings the apparent capacity equal to the true within sufficiently accurate limits, no correction being then required. The method and results are published in a Note to *The Electrician* of February 5, 1892, p. 361, signed by "F. W.," of Alexandria, Egypt. Taking the first example cited in this Note, the cable (of 910 knots) had an insulation resistance of 0·63 megohm and a capacity of 280 microfarads; that is,

$$280 \times 0{\cdot}63 = 176 \text{ megohms per microfarad,}$$

while the condenser used in the test with this cable measured 10 megohms and 99 microfarads; that is,

$$10 \times 99 = 990 \text{ megohms per microfarad.}$$

To make the insulation per microfarad of the condenser equal to that of the cable (176) it is clear that the absolute resistance of the condenser must be

$$\frac{176}{99} = 1{\cdot}78 \text{ megohms.}$$

The condenser was accordingly reduced to this insulation by shunting it with a resistance of $\frac{10 \times 1{\cdot}78}{10 - 1{\cdot}78} = 2{\cdot}16$ megohms, the result being a perfect balance on the slides—that is, the absorption discharge being *nil* and no correction being required. The apparent capacity was then equal to the true capacity within 0·03 per cent.

Another case is cited in which the insulation resistance per microfarad of the cable was *higher* than the condenser; and, notwithstanding that the insulation had to be reduced by an artificial leak at the home end, the test showed the apparent capacity equal to the true within as close a limit as 0·4 per cent. The figures in this were

Cable (331·8 knots)	2·5 megohms and	97 microfarads,
Condenser	0·41 „	59·448 „

The condenser was therefore

$$0{\cdot}41 \times 59{\cdot}448 = 24{\cdot}25 \text{ megohms per microfarad.}$$

The cable resistance had to be reduced (by the artificial leak) to

$$\frac{24{\cdot}25}{97} = 0{\cdot}25 \text{ megohms}$$

to have the same insulation per microfarad as the condenser.

Considering, now, the application of this method to Gott's test, in which it is desired to determine the true capacity of a given cable, the *modus operandi* would be to obtain the balance first in the ordinary way on the slides, and then to adjust the shunt on the condenser (or artificial leak on the cable) until the absorption discharge is *nil*. Then the slide reading n is the correct one to give the true capacity in the formula

$$\text{Cable capacity} = F\left(\frac{10{,}000}{n} - 1\right) \text{ microfarads,}$$

where F is the capacity of the condenser. Generally the approximate capacity of the cable will be known and the shunt can be adjusted very nearly beforehand. Condensers in fairly good condition have generally a higher insulation per microfarad than cables that have been laid some time, and it will usually be found that the shunt has to be applied to the condenser. This method, which the writer of the Note ("F. W.") terms the double-zero method, is simple and accurate, and should prove of considerable utility in the determination of the true capacity of cables, which is of so much importance in furnishing data for the localisation of faults.

In an interesting communication to *The Electrician* (Dec. 12, 1890, page 168) on this subject, Messrs. Harold W. Ansell and Julian E. Young direct attention to the important part played by the insulation and retardation of a submerged cable in the discrepancies that occur between the apparent and true capacity. The authors of this Paper show that, when balancing against each other condensers with similar dielectrics, and therefore having similar rates of absorption, there is still a considerable error to be accounted for, if only a moderate leakage exists on one of the condensers. A very interesting method is given for determining the correction for insulation resistance and retardation of a cable—that is, a correcting factor for deriving the true capacity from the apparent. This factor is arrived at by a consideration of the time of charge, and the approximate insulation and capacity of the cable. The true capacity is proportional to the instantaneous charge, as in a condenser or a short length of a knot or two of cable; but when a long submerged cable is being tested, a certain time must be allowed for the charge to reach and attain its full value at the distant end. Letting K stand for the ratio of the full charge to the instantaneous charge, we have, by Siemens law of the fall of charge,

$$\log K = \frac{t}{2{\cdot}3026\, F R},$$

where F is the capacity of the cable in microfarads, R the insulation resistance in megohms, and t the time of charge in seconds. Assuming the ratio of the apparent to the true capacity to be the same as the ratio between the final and instantaneous charges, at the distant end, we have

$$\text{true capacity} = \frac{\text{apparent capacity}}{K}.$$

The value of the ratio K having been found from the above expression by inserting approximate values for F and R, and putting t the time of charge in seconds, the true capacity is found by dividing the apparent capacity by this number.

The authors balanced condensers of approximately 20 and 80 microfarads against each other, one of them having a leak artificially applied varying from ½ to 3 megohms. The results show that the apparent capacity increased considerably as the insulation resistance was reduced, but that the application of the correction gave the true capacity to within one-half of 1 per cent. The periods of charge were varied from 2 to 15 seconds.

(To be continued.)

The French Association for the Advancement of Science.—The twenty-fourth meeting of this Association is to be held at Bordeaux from the 4th to the 9th prox.

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SCIENTIFIC USES OF LIQUID AIR.*

BY PROF. DEWAR, F.R.S.

When Faraday was working on liquid gases in this Institution about 1823, with such means as were then at his command, his inquiry was limited to the determination of the specific gravities and vapour pressures of such bodies. Twenty years later, by the use of solid carbonic acid, the greatest cold then possible was obtained, and Faraday made admirable use of Thilorier's new cooling agent to extend his early investigations. Just as liquid carbonic acid produced in glass tubes was of no use as an agent for effecting the liquefaction of more resisting gaseous matters, until it could be manipulated in the solid state, so liquid air, until it could be handled, stored and used in open vessels, like any ordinary liquid, could not be said to possess scientific uses in any wide sense. Such operations become easy when double-walled vacuum vessels (such as were described in a former lecture) are employed in the conduct of experiments where substances boiling at very low temperatures have to be manipulated. The chief scientific use of liquid air consists in the facilities it gives for the study of the properties of matter at temperatures approaching the zero of absolute temperature. In this lecture the expression liquid air may mean either oxygen or air. Where a constant temperature is required oxygen is used. Liquid air made on the large scale may contain, after it is collected in open vacuum vessels, as much as 50 per cent. of oxygen. Such a liquid boils between −192°C. and −182°C., and the longer it is stored the nearer it comes to −182°C., or the boiling point of pure oxygen. For a number of experiments of a qualitative character, whether it is liquid air or oxygen that is used makes no difference. In many of the experiments to be recorded, liquid oxygen made from the evaporation of liquid air was employed. In pursuing this subject in consort with Prof. Fleming,† a long series of experiments, involving the use of large supplies of liquid oxygen, have been carried out on the electric resistance of metals and alloys, and the results warrant the conclusion that at the zero of absolute temperature all the pure metals would be perfect conductors of electricity. Under such conditions a current of electricity started in a pure metallic circuit would develop no heat, and therefore undergo no dissipation. Similarly, we infer there would be no Peltier effect at the zero. In other words, the passage of electricity from one metal to another would take place without evolution or absorption of heat.

Further investigation, along with Prof. Liveing,‡ on the refractive index of liquid nitrogen and air, has led to the conclusion that the refractive indices of nitrogen and air are respectively for the D-ray, 1·2053 and 1·2062. In these determinations, instead of using the prisms we have employed the method of Terguem and Trannim, which consists in suspending in the liquid two plates of glass with a thin layer of air between them, and measuring the angle of incidence at which the chosen ray suffers total reflection at the surface of the air. As all the vacuum vessels are either spherical or cylindrical in form when filled with liquid, they act as lenses which are irregular and full of striations. Further, small bubbles of gas being given off in the liquid rendered any image indistinct when viewed with a telescope. In order to avoid the necessity of observing any image through the liquid, it was used simply as a lens to concentrate the light observed on the slit of a spectroscope. Under such conditions the observations were easily executed, and the results satisfactory.

For some time a series of observations on the thermal opacity of liquid oxygen and nitrogen have been projected. It is, however, exceedingly difficult to experiment in such a way as to eliminate the absorbing action of the glass vessels, and as the use of rock salt is impracticable, the absorption of heat of low refrangibility remains for the present undetermined. It is possible, however, to use the glass vacuum vessels to determine approximately the relative thermal transparency for heat of high refrangibility, such as is radiated by a colza lamp. The following results represent the heat transmitted through the same vacuum vessels filled with different liquids, taking chloroform as the unit for comparison and correcting for differences of refractive index :—

Chloroform	1·0
Carbon bisulphide	1·6
Liquid oxygen	0·9
Liquid nitrous oxide	0·93
Liquid ethylene	0·60
Ether	0·50

From this result it follows that liquid oxygen is nearly as transparent to high temperature heat radiation as chloroform, which is one of the most transparent liquids next to carbon bisulphide. Liquid ethylene is much more opaque. These results must, however, be considered only as an approximation to the truth, and as generally confirmatory of the inferences Tyndall drew as to the relation between gases and liquids as absorbents of radiant heat.

Instead of silvering the interior and exterior of the vacuum vessels, it is found convenient when using mercury vacua to leave a little excess of liquid mercury, in order that the act of filling the inner vessel with liquid air should cause a fine silvery deposit of the metal over the exterior surface of the inner vessel. In such a vessel liquid air or oxygen shows no signs of ebullition, the surface remains as quiet and still as if it was ordinary water. The supply of heat is cut down to less than 4 per cent. of what it is without exhaustion and silvering in good vacuum vessels. The result is that volatile liquids can be kept 30 times longer. Such vessels do not, however, maintain indefinitely the high standard of heat isolation they possess the first time they are used. After repeated use all vacuum vessels employed in the storage and manipulation of liquid air deteriorate. Illustrations of the appearance of such vessels are given in Figs. 1 and 2. The rapidity with which a space is saturated with mercury vapour (which we know exerts a pressure of about one-millionth of an atmosphere) is easily proved by simply filling a barometer in the usual way, and then instantly applying a sponge of liquid air to a portion of the glass surface of the Torricellian vacuum space, when a mercury mirror immediately deposits. It is important to know the amount of mercury deposited from a saturated atmosphere which is maintained (containing excess of liquid mercury) at the ordinary temperature, the condensation taking place when liquid air or oxygen is discharged into a vessel surrounded by such a Torricellian vacuum. If the deposit on the cooled bulb is allowed to take place for a given time, the outer vessel can then be broken

FIG. 1.—Vacuum Vessel for Storage of Liquid Air.

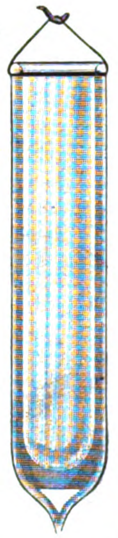

FIG. 2.—Vacuum Vessel for Storage of Liquid Air.

and the amount of mercury which coated the bulb ascertained by weighing. Knowing the surface of the cooled bulb, the amount deposited per unit of area can be calculated. In this way it was found that in ten minutes two milligrammes of mercury per square centimetre of surface was deposited. Considering that one-tenth of a milligramme of mercury in the form of saturated vapour at the ordinary temperature corresponds to the volume of 1 litre, this proves that the equivalent weight of 20 litres had been condensed in the space of ten minutes. This plan of cooling a portion of the surface of a vessel by the application of a liquid air sponge, enables us to test our conclusions as to the amount of matter present in certain vacua. Here is a globe of the capacity of 1 litre. It has been filled with, presumably, nothing but the vapour of mercury, by boiling under exhaustion and subsequent removal of all excess of liquid. Such a flask ought to contain mercury in the gaseous state that would weigh rather less than one-tenth of a milligramme, assuming the ordinary gaseous laws extend to pressures of less than one-millionth of an atmosphere. Now we know by electric deposition than one-tenth of a milligramme of gold can be made to cover 1 sq. cm. of surface with a fine metallic deposit. Considering the general similarity in the properties of mercury and gold, we should therefore anticipate that if all the mercury vapour could be frozen out of the litre flask it would also form a mirror about 1 sq. cm. in area. But after one such mirror is deposited the renewed application of a second liquid air sponge to another portion of the surface would cause no visible deposit. This is exactly what takes place. If, however, two spheres, one much larger than the other, are joined together by means of a

* Friday evening discourse delivered at the Royal Institution.

† "The Electrical Resistance of Metals and Alloys at Temperatures Approaching the Absolute Zero." By James Dewar, F.R.S., and J. A. Fleming, F.R.S. *Phil. Mag.*, 1892. *See* also *The Electrician*, Vol. XXIX., October 7, 1892, p. 611.

‡ "On the Refractive Indices of Liquid Nitrogen and Air." By Profs. Liveing and Dewar. *Phil. Mag.*, 1893.

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tube about 2mm. in diameter and 50mm. long, the whole space being a Torricellian vacuum (with some excess of mercury) then on decanting, the mercury may be transferred to the smaller sphere, as is represented in Fig. 3. Now if an air sponge is applied to a portion of the surface of the larger sphere, a mercury mirror instantly deposits, but on applying a new air sponge to another portion of the surface, no further mercury mirror is formed. The narrow glass tube prevents the excess of liquid mercury in the small bulb supplying vapour rapidly to the larger one, so that the local cooling to $-180°$C. of a portion of the surface has practically condensed all the mercury in the larger space, although the small one is still filled with saturated vapour and a free communication exists between them. If while in this condition the small bulb is inclined so as to allow a drop of liquid mercury to fall into the lower side of the large bulb, which has not been cooled, instant deposition of mercury takes place on the liquid air cooled portion of the upper surface. Under very small pressure of vapour, therefore, equalisation of pressure of two bulbs communicating by a narrow tube is a very slow process.

There are cases, however, in which the application of a sponge of liquid air to the surface of a vessel causes no visible deposit, and yet the inference is that something has been condensed. The best arrangement to show this effect is to select highly exhausted vacuum tubes containing phosphorescent materials like alumina and other minerals, and to arrange the induction coil spark gap of a little greater resistance than the vacuum tube. On starting the coil the

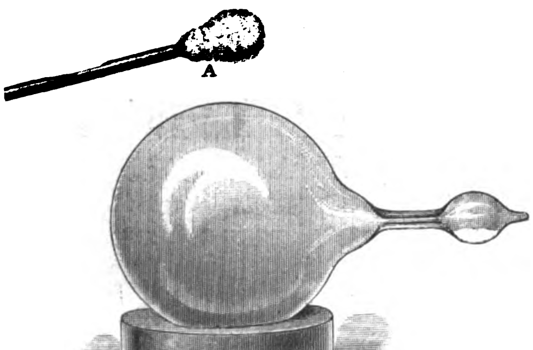

FIG. 3.—Deposit of Mercury Vapour by cooling with Liquid Air.

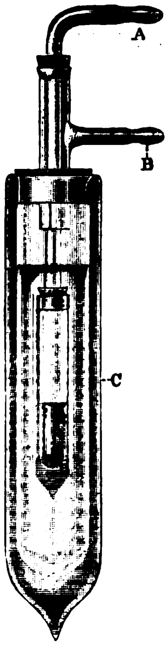

FIG. 4.—Vessel for keeping Liquid Air without Evaporation.

current passes slowly by the vacuum tube, but immediately the liquid air sponge cools a portion of the surface of the bulb, the discharge shifts to the air-gap. During the cooling the phosphorescence of the glass tube is greatly increased, but finally the resistance may become so great that all discharge in the vacuum tube ceases. Some old tubes belonging to the late Dr. de la Rue have given visible deposits near the electrodes, and in many the diameter and distribution of the striæ are materially changed during the local cooling to $-190°$C. When large vessels containing nothing but mercury or iodine vapour as a residuum of the vacuum space are rubbed with a cotton wool sponge of liquid air in a dark room, luminous glows filling the vessel take place occasionally, or bright flashes of light which enable the shape of the vessel to be seen. The ordinary mercury vacuum vessels show the same phenomena, which is doubtless due to electric discharges caused by friction and cooling.

The optical properties of bodies cooled to the temperature of boiling liquid air will require long and patient investigation. An interesting fact easily observed is the marked change in colour of various bodies. Thus, for instance, oxide, sulphide, iodide of mercury, bichromate of potash, all become yellow or orange, while nitrate of uranium and the double chloride of platinum and ammonium become white. Chromic acid, dilute solution of iodine in alcohol, strong solutions of ferric chloride, and other coloured solutions become greatly changed. Such facts are sufficient to prove that the specific absorption of many substances undergoes great changes at the temperature of $-190°$C.

The tranquil atmosphere of air above the surface of the liquid in cylindrical or spherical vacuum vessels is a convenient place to cool very fragile bodies. During the slow ebullition of the fluid, gas between $-190°$C. and $-180°$C. is given off, which has three times the density of ordinary air, and which falls slowly over the mouth of the vessel in a heavy stream. On dipping into this atmosphere small soap bubbles, they contract rapidly and then freeze. If a soap film is made on a circle of thin wire about 2in. in diameter, and allowed to stand until it shows the various orders of coloured bands, and is then carefully dipped into the cool air, it freezes, showing all the original colours. The black band is, however, always broken. Speaking of films, an interesting experiment may be made with a thin stretched sheet of india-rubber, such as is used for making balloons. It is well known that stretched india-rubber contracts when heated and expands when cooled. Now this can be shown very easily by covering a glass funnel or the end of a cylindical vessel with a stretched sheet of rubber as thin as the walls of balloons. Such a surface is quite flat, and fairly transparent. If a sponge of liquid air is drawn across the surface, the course is marked by a series of wrinkles, due to the temporary expansion of the rubber caused by the extreme cold. The sheet of rubber, being extremely thin, soon regains the ordinary temperature, and the surface then is as flat and tense as before. During the continuous motion of the cotton wool liquid air sponge over the rubber surface, it is followed by wave-like depressions, which disappear almost as quickly as they are formed. The elasticity of india-rubber, after cooling to $-182°$C, and reheating, seems unimpaired.

Organic substances that only become solid at very low temperatures may be divided into two classes: those which crytallise, and those which form glasses. Thus, bisulphide of carbon, tetrachloride of carbon, methyl alcohol, hydride of amyl, all form crystals, whereas ethyl alcohol, amyl alcohol, turpentine, ethyl nitrate, chinoline, picolin, are glass-like. If a few dops of bisulphide of carbon are added to alcohol, and the mixture cooled to $-180°$C., a white solid emulsion is formed, whereas the addition of tetrachloride of carbon to the alcohol resulted in the production of a clear solid without any separation. In the same way pure methyl alcohol crystallises easily, but the addition of a few drops of ethyl alcohol prevents crystallisation, and causes a glass to be formed. Thus the examination of the behaviour of organic bodies at low temperatures may be a fruitful means of organic investigation.

For many purposes of investigation it is necessary to keep liquid air without evaporation. This is readily done by the use of two vacuum test tubes, fitting freely one inside the other, arranged as in Fig. 4. The smaller one is filled with liquid air, and after the insertion of an india-rubber stopper and glass tube, is completely immersed in liquid air contained in the larger vacuum vessel. In the figure the tube A connects with the inner vacuum tube and B with the outer. As the latter receives all the radiant and conducted heat, air is continuously boiling off through the tube B; but as the supply of heat is effectually cut off from the inner vacuum vessel, also containing liquid air, no air distils through tube A. This is the most convenient arrangement to use for the production of solid air. For this purpose B is connected with an air pump until the pressure is reduced to about $\frac{1}{10}$in., and therefore the temperature about $-200°$C. Then a good air pump is put on to the inner vessel of liquid air (containing oxygen and nitrogen in the normal proportion of oxygen and nitrogen) by means of the tube A, while maintaining constantly the exhaustion in the outer vessel. In a short time the air in the inner vessel solidifies to a transparent jelly-like mass.

The same principle is used when the latent and specific heats have to be determined. Fig. 5 shows the general plan of the apparatus. Now a definite quantity of heat has to be conveyed into the inner vacuum vessel containing liquid air, with the object of finding the weight of liquid that distils off on the one hand, or the elevation of temperature in the liquid that takes place on the other. For the purpose of adding a given quantity of heat it is convenient in some cases to use mercury (as represented in the figure), or to lower a piece of platinum or silver, or even glass, into the inner vessel; each unit of heat supplied evaporates a definite amount of air, which is readily ascertained by collecting the gas which comes off during the heat conveyance. In Fig. 5, A is the mercury, C the inner vessel of liquid air, D a three-way stop-cock, F a tube for collecting the air given off; E is a barometric tube for observing the pressure when the inner vessel is exhausted. In a latent heat determination all that is necessary is to weigh the mercury added, and to measure the amount of air by volume which has distilled from the liquid state. If the specific heat of the liquid is wanted, then the inner vessel is exhausted (as well as the outer) through the tube F to about $\frac{1}{10}$in. pressure, and the three-way stop-cock turned so as to shut off F and connect the inner vessel with the manometer E. Mercury is now dropped into the inner vessel until the manometer rises to the atmospheric pressure or the liquid reaches its boiling point under atmospheric pressure. Care must be taken to prevent the drops of mercury

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falling exactly in the same place, otherwise a mercury stalagmite grows up rapidly through the liquid, vitiating the results. Another objection to the use of mercury arises from the drops causing the rebound of small liquid air drops, which strike the cork and get evaporated away from the main body of liquid. The amount of mercury added conveys the necessary amount of heat needed to raise the given amount of liquid from its boiling point under ½in. pressure to its boiling point under 30in. The relative pressures give the temperature range, and the weight of liquid air or other gas under observation is easily ascertained, together with the weight of mercury added. In this way the latent heat of liquid oxygen at its boiling point is about 80 units, and the mean specific heat between –198deg. and –182deg. is 0·39.

Seeing that the most powerful chemical affinities are in abeyance at very low temperatures, it is a matter of great interest to ascertain what change comes over the physical force we name cohesion.

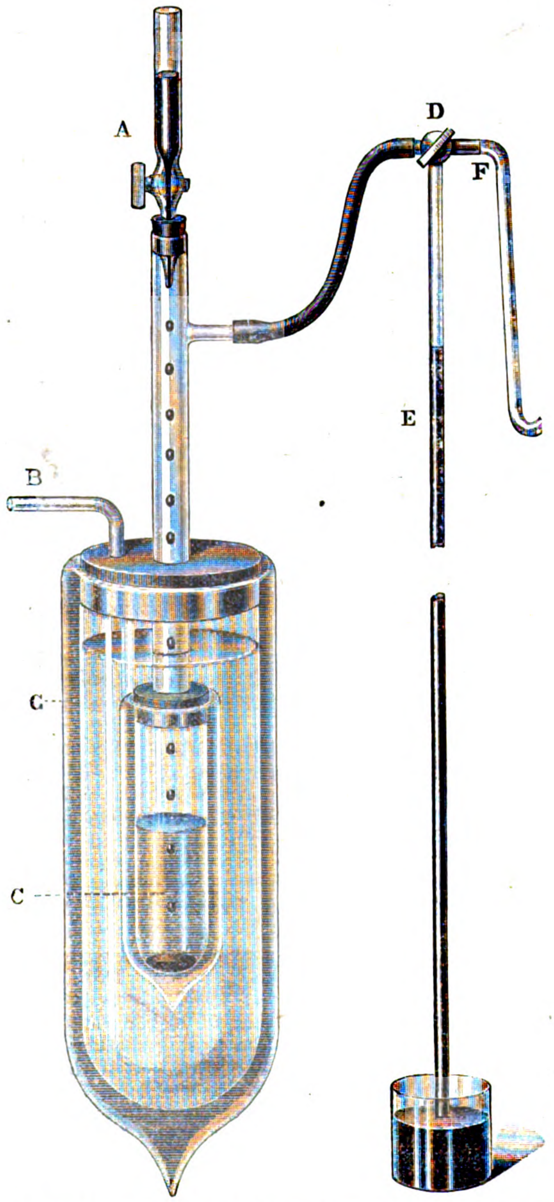

FIG. 5.—Apparatus used in the determination of the Latent and Specific Heat of Liquid Air, &c.

Here we are dealing with the molecular forces which are effective in uniting together the particles of solid bodies, in contrast to the force we name chemical attraction, which exists most characteristically between dissimilar molecules. Both are alike in this respect, that they are insensible at sensible distances. If we accept the theory of matter which regards finite heterogeneousness of the most homogeneous bodies as proved, then Lord Kelvin has shown that gravitation alone would account for the so called cohesive forces. Thus, he says ("Popular Lectures," Vol. I. page 60): "But if we take into account the heterogeneous distribution of density essential to any molecular theory of matter, we readily see that it alone is sufficient to intensify the force of gravitation between two bodies placed extremely close to one another, or between two parts of one body, and therefore that cohesion may be accounted for without assuming any other force than that of gravitation, or any other law than the Newtonian." Another view of the cohesive forces is taken by Mr. S. Tolver Preston, in his work entitled "Physics of the Ether," page 64. He says, "The phenomena of 'cohesion,' 'chemical union,' &c., or the general phenomena of the aggregation of molecules, being dependent on the molecular vibrations as a physical cause, it would therefore be reasonable to conclude that variation of vibrating energy (variation of 'temperature') would have a most marked influence on these phenomena, as is found to be the fact. Further, since when a physical cause ceases to exist the effect also ceases, it follows that at the absolute zero of temperature (absence of vibrating energy) the general phenomena of 'cohesion,' including the aggregation of molecules in chemical union, would cease to exist." If this theory is pressed so as to include the gaseous state, then at the temperature of –274°C. we may imagine the particles reduced to an incoherent layer of dust or powder. The experimental facts do not, however, warrant this conclusion, seeing that at the lowest temperature reached, which is about –210°C., air remains a transparent jelly.

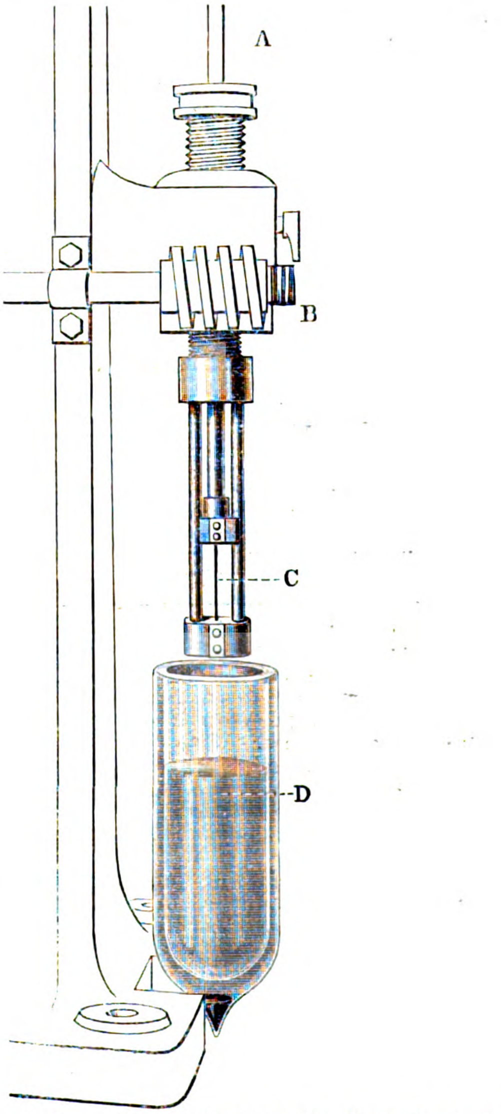

FIG. 6.—Apparatus used for testing the alteration in the Elastic Constants of Metals at Low Temperatures.

That a low temperature causes profound changes in the elastic constants of a metallic body is most easily shown by placing a rod of fusible metal in liquid air, and comparing the deflection produced by a weight when the rod is supported at one or both ends before and after cooling. The Young modulus is increased to between four and five times its amount at ordinary temperatures. In the same way, the rigidity modulus can be shown to be greatly changed by cooling a spiral spring made of fusible metal wire. Such a spring at the ordinary temperature is quickly drawn out into a straight wire, by attempting to make it support an ounce weight. The same spiral, cooled to –182°C., will support a couple of pounds, and will vibrate like a steel spring so long as it is cool. In the same way, a bell or tuning fork of fusible metal gives a

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distinct metallic ring at - 180deg. If two tuning forks are taken of identical pitch, and one cooled to - 182deg., then on simultaneously striking them beats are very distinctly heard. The simplest plan of getting some idea of the change in the cohesive force at low temperatures, is to ascertain the tenacity or breaking stress of the metals and alloys under such conditions, and to compare such results with similar experiments made at the ordinary temperature with the same metallic samples, using the same apparatus. In this way the comparative values are reliable. The only difficulty is the large quantity of liquid air or oxygen required to cool the steel supports of the wires, which have to be broken. Seeing that wires less than one-tenth of an inch in diameter are unreliable, good strong rigid steel supports are needed, and as these have to be cooled each time a wire is broken, the experiments involve large quantities (gallons) of liquid air and oxygen. Further, as not less than three, and in many cases six experiments must be made with each sample of wire, and the stress in each case can only be applied slowly, work of this kind extends over long periods of time, and this means increased waste of liquid gases. Fig. 6 shows the general plan of the part of the testing machine which supports the wires which have to be broken. In the figure, A is the steel rod which is connected to the multiplying levers, the stress being gradually increased as usual by running in water into a vessel hung from the long end of the lever; C is the wire to be tested, B is an arrangement which measures roughly the extension of the wire, and D is a large silvered vacuum vessel holding the liquid oxygen. This latter vessel must be large, in order to avoid any part of the supports of the wire coming into contact with the sides, otherwise the shock of the wire on breaking shatters the vacuum bulb. The rupture must be made while the wire is immersed in the liquid oxygen, and the whole of the supports thoroughly cooled down. The wires must be caught in long V-shaped grooves made in the steel supports in order to avoid slipping, and change in the cross-section of the wire. As a rule, the wires used were one-tenth of an inch in diameter and 2in. long. The following table gives the mean results of a large number of experiments:—

Table I.—*Breaking Stress in pounds of Metallic Wires 0·098in. diameter.*

—	15°C.	-182°C.
Steel (soft)	420	700
Iron	320	670
Copper	200	300
Brass	310	440
German silver	470	600
Gold	255	340
Silver	330	420

An inspection of this table proves that all the common metals and alloys increase in tenacity at low temperatures: thus iron has doubled its breaking stress, and the other metals and alloys are all increased from a third to a half the normal amount. This increase of strength is solely due to the low temperature, and persists only during its continuance. Wires that have been cooled to the temperature of - 182°C. and allowed to regain the ordinary temperature, are in no way changed as regards their breaking stress.

A second series of experiments were made with a set of cast test pieces of metals and alloys. The test pieces, all cast in the same mould, were 2in. long with ½in. spherical ends, the cylindrical portion being two-tenths of an inch in diameter. The spherical ends of the test pieces rested in similar cavities made in a special set of steel supports that fitted on to the testing machine. Crystalline metals give castings that are far from uniform one with another, and it is very difficult to get even comparable results with metals like zinc, bismuth and antimony. The following table gives the experimental results:—

Table II.—*Breaking Stress in pounds of Cast Metallic Test Pieces. Diameter of rod 0·2in.*

—	15°C.	-182°C.
Tin	200	390
Lead	77	170
Zinc	35	26
Mercury	0	31
Bismuth	60	30
Antimony	61	30
Solder	300	645
Fusible metal (Woods)	140	450

It will be noted that in this list the breaking stress, by cooling to - 182°C., has been increased to three times its usual value in the case of fusible metal, and to twice its usual value in the case of tin, lead and solder. The results with zinc, bismuth and antimony are exceptional, seeing they appear to be diminished in tenacity. This, however, may be only apparent, because the stresses set up in cooling such highly crystalline bodies probably weaken some set of cleavage planes so that rupture is then comparatively easy. In any case it must be admitted that no reliance can be placed on the tenacity of highly crystalline metals. The breaking stress of mercury is interesting, and turns out to be at - 182°C. nearly half that of lead at the ordinary temperatures.

The percentage elongation is not given in the foregoing tables, simply because the value of such measurements is of little importance when such short pieces of the metals are under observation. The general results of such observations are, however, interesting; thus, lead and tin at ordinary temperatures elongate before breaking about the same amount, whereas if tin is cooled to - 182°C. it hardly shows any extension, and lead under such conditions shows no change, stretching as much at - 182deg. as at 15°C. Solder and fusible metal stretch less, and the cross-section of the break is much less at - 182deg. than at 15°C.

The above experiments can only be considered as preliminary to a more elaborate investigation of the actual variation of the elastic constants at low temperatures. It will require complex experimental arrangements to get reliable measurements of the Young modulus and the rigidity modulus at the temperature of boiling liquid air. In the case of fusible metal, a first attempt to compare the ratio of the Young modulus at 15deg. and - 182deg. with the ratio of the rigidity modulus between the same limits of temperature, has resulted in finding that both constants are increased in the same proportion. From this it would follow that the resistance to compression of the substance at - 182°C. must be increased in a similar ratio. The comparative behaviour of strong steel spirals at 15°C. and - 182°C. as to their elongation on the repeated addition of the same load was a subject examined on several occasions. The most careful comparison of such spirals, however, revealed no measurable differences in their elongation between the ordinary temperature and that of boiling oxygen. This may be due to the want of sufficient sensibility in the testing machine when applied to such delicate experiments. In the meantime it is reasonable to conclude that the rigidity modulus of very hard steel is not much changed by cooling it to - 182°C. If balls of iron, tin, lead or ivory are cooled to - 182°C. and dropped from a fixed height on a massive iron anvil the elastic rebound is markedly increased in all cases. The flat distortion surface produced on the lead sphere after impact is only one-third the diameter of the circular surface produced at the ordinary temperature when the lead ball falls from the same height.

The examination of the magnetic condition of matter at low temperatures is a subject of great interest and offers a wide field for investigation. In a former lecture the magnetic properties of liquid oxygen and air were discussed. Owing to the experimental difficulties, accurate quantitative measurements of the permeability have not yet been successful. Faraday was the first experimenter who examined the magnetic condition of matter at the lowest temperature that could be commanded in his time, viz., about - 110°C. He did not succeed in making any substance which was non-magnetic at ordinary temperatures assume the magnetic state at the lowest temperature of the solid carbonic ether bath in vacuo. Later experimenters have directed their attention more especially to the action of high temperatures on magnetism, and the work of Profs. Hopkinson and Ewing in this field of research is well known. Prof. Trowbridge examined the effect of a temperature of - 80°C. on a permanent magnet, and came to the conclusion that the magnetic moment was diminished by about 50 per cent. Prof. Ewing found that an increase of temperature of 150°C. above 10deg. caused a reduction of the magnetic moment of a bar magnet by about 40 per cent., and that the magnet on cooling recovered its original state. This result would lead us to expect that if the same law is followed below the melting point of ice as Ewing found above it, then a bar magnet cooled to - 182°C. ought to gain in magnetic moment something like 30 to 50 per cent. The experiment of Prof. Trowbridge is, however, apparently opposed to such an inference. It appears, however, that Prof. Trowbridge cooled a magnet that had not reached a constant state (that is to say, one that on heating would not have completely recovered its magnetisation on cooling), because after the magnet had been cooled to - 80deg. on regaining the ordinary temperature, it had lost 50 per cent of its original magnetic moment. Such a magnet would apparently diminish in magnetic moment on cooling and heating the first time the action was examined, but a repetition of the process when the action of magnetisation and temperature were strictly reversible might lead to an opposite conclusion. To settle this question a series of experiments on the magnetic moment of small magnets cooled to - 182deg. were carried out. Small magnets from half an inch to an inch in length were made of watch-spring or steel wire, and were either used separately or in bundles; they were fixed rigidly in a block of wood by means of copper staples, and in this condition were easily clamped firmly in the field of a magnetometer. The cooling was effected by applying a cotton-wool sponge of liquid air. The relative deviations of the

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magnetometer are proportional to the magnetic moment of the magnet under the respective conditions of +15°C. and −182°C. After the first cooling the magnet is allowed to regain the ordinary temperature, and the operation of cooling and heating is repeated three or four times. The following table gives some of the results, and these may be taken as typical of a large additional number unrecorded.

If the experiment marked (1) is examined we find cooling to −182deg. in the first cycle produced no change of magnetic moment, but that on heating to +15°C. the magnet had lost 30 per cent. of the original strength. In the second cycle cooling increased the magnetic strength of the magnet, in the condition in which it is left after the first cooling by 33 per cent., and heating diminished it by 5 per cent.; whereas in the third cycle cooling showed 36 per cent. increase, and no loss in heating. It was only after three alterations of temperatures from +15°C. to −182°C. that the magnet reached a steady condition. In experiment (3) the first cooling shows a loss of 24 per cent., while in experiment (4) the first cooling shows a gain of 12½ per cent.

Change of the Magnetic Moments of Permanent Magnets at +15°C. and −182°C. per cent. of the value at the beginning of each cycle, which is always 15deg.

—	−182°C.	+15°C.
(1) Hard steel, 0·5in. long and 0·4in. diameter.		
First cycle	+ 0	−30·0
Second „	+33·0	− 5·0
Third „	+36·0	0
(2) Soft steel.		
First cycle	+12·0	−28·0
Second „	+51·0	0
Third „	+51·0	0
(3) Hard steel, 1·03in. long, 0·4in. diameter.		
First cycle	−24·0	−43·4
Second „	+23·0	0
Third „	+23·0	0
(4) Nine steel wires in bundle.		
First cycle	+12·5	+ 3·0
Second „	+38·0	− 2·0
Third „	+33·0	0
Tested four days after.		
First cycle	+50·0	0

It is clear, therefore, that according to these experiments, every magnet has individual characteristics that may either result in no change on cooling or the addition or subtraction of from 12 to 24 per cent. in the magnetic strength. All the experiments, however, show that a repetition of the cycle of heating and cooling brings the magnet to a steady state, in which cooling always causes increase in the magnetic strength of from 30 to 50 per cent., and the re-heating brings about no loss in the original magnetic moment. Such a marked alteration of magnetic strength might be used as a thermometer in low temperature research, and it is my intention to extend the inquiry to the lowest temperature that can be reached by the evaporation of nitrogen in vacua. A simple mode of showing the sudden alteration of magnetic strength on cooling is to surround a permanent magnet made up of a bundle of steel wires with a coil of copper wire, leaving the ends of the magnet to project so that they can be dipped in liquid air. When the copper wires are attached to a galvanometer, and one of the ends of the magnet cooled, an induced electrical current occurs, due to the sudden magnetic change. Accurate observations must be made on the permeability and susceptibility of the magnetic metals at the temperature of boiling liquid air, and the above results are an indirect guarantee that this field of investigation will be fruitful in new scientific facts.

This lecture has already covered a very wide field. It is easy to put into a Friday evening discourse the work of a year. Members and friends have chiefly contributed to the research fund, which has enabled the Institution to extend the experimental plant needed for the prosecution of research in this field of inquiry, and they have strong claims to learn, in the first instance, the results of the general laboratory work. My object has been to illustrate the scientific uses of liquid air. To do this with any satisfaction requires what may be called a good deal of scientific prospecting. It is one thing to discover where the ore lies, it is another thing to produce the refined metal. Investigations on the properties of matter at the temperature of boiling liquid air, must be in the first instance rather qualitative than rigidly quantitative. In my opinion, scientific progress is best served by conducting the inquiry on these lines. It will be easy to refine later on.

I have to acknowledge the great assistance I have received in the conduct of these experiments from my excellent chief assistant Mr. Robert Lennox, and I must also express commendation of the way Mr. Heath has helped in the work.

THERMO-ELECTRIC POWERS OF METALS AND ALLOYS BETWEEN THE TEMPERATURES OF THE BOILING-POINT OF WATER AND THE BOILING-POINT OF LIQUID AIR.*

BY PROFS. JAMES DEWAR, F.R.S., AND J. A. FLEMING, F.R.S.

If one junction of a thermo-electric couple is at a temperature t degrees, and if the two junctions of the couple differ in temperature by a very small interval dt, and if the electromotive force of the couple under these conditions is dE, then the *thermo-electric power* of the couple at the temperature t degrees, denoted by P, is defined by the relation $P = dE/dt$. The well-known thermo-electric diagram of Professor Tait embodies the results of his own investigations on the thermo-electric powers of metals within the limits of the temperatures which can be reached by mercury thermometers and certain temperatures above this range. Starting from the facts first made known by Lord Kelvin in his classical thermo-dynamical researches, Professor Tait showed that on certain assumptions the curves representing thermo-electric power plotted as a function of temperature should be straight lines, and consequently that the lines of thermo-electromotive force obtained by plotting as ordinates the electromotive force in a thermo-electric circuit of two metals, one junction of which is kept at a constant temperature, whilst the temperature of the other junction is varied, should be parabolas with their axes vertical if plotted in terms of the variable temperature as abscissæ. Experiment within the above-mentioned range of temperature confirmed these conjectures for a large number of thermo-couples, but led to the remarkable discovery that the thermo-electric lines of certain metals—notably of the magnetic metals, nickel and iron—are, for temperatures above zero Centigrade, broken lines characterised by sudden changes of direction. This thermo-electric diagram of Professor Tait exhibits in a very elegant manner the chief thermo-electric facts, and enables the temperature of inversion to be determined by inspection.

Having it in our power to carry down the temperature of a thermo-electric junction to values in the neighbourhood of −200°C. by the employment of considerable quantities of boiling liquid air and liquid oxygen, we have been able to conduct an extensive investigation on the thermo-electric powers of metals at temperatures lying between this low temperature and that of the boiling-point of water; and have been thus enabled to continue the thermo-electric diagram down to temperatures not very far removed from the absolute zero. We have accordingly been able to determine the points of electric inversion which lie between 0°C. and −200°C., and to compare those observed values with those predicted by the extrapolation of the existing thermo-electric diagram of Professor Tait obtained from observations at higher limits of temperature. The chief interest, however, attaching to these investigations was the ability to determine whether, over these wide limits of low temperature, the thermo-electric lines of various metals remain straight lines, and whether any of the metals exhibit changes of thermo-electric power at low temperatures which cause their thermo-electric lines to be bent or broken—thus indicating a sudden change in the sign or magnitude of the "Thomson effect" at certain temperatures. The results of these experiments have been set out in a chart of thermo-electromotive forces of the various metals and alloys used in conjunction with pure lead as a thermo-couple.

The metals used by us in this investigation were for the most part in the form of wires, and were in many cases taken from the samples of pure metals employed by us in a series of determinations of the specific electrical resistance of metals at low temperature.†

Omitting as unnecessary an account of much preliminary investigation, we proceed to describe the final experimental arrangements as follows:—A large number of thermo-electric couples were prepared, each consisting of two wires of lead joined by an intermediate wire of another metal M. The lead wire was prepared by pressing pure lead into a wire ·0656cm. in diameter, and the other metallic wires had diameters approximately from about ·025 to ·15cm., or else were used in the form of very thin narrow strips. The lead wires had a length of 50cm., and the connecting wire of the metal or alloy M a length of about 54cm. The junctions of each couple having been carefully soldered together, each wire was covered over with paraffined silk ribbon so as to insulate it, leaving only one junction exposed. A number of these thermo-couples were made up into a bundle, the sets of bare and covered junctions being bound together compactly, the bare in one group and the insulated junctions in another. In all the experiments to be

* Abstract of a communication made to the *Phil. Mag.* of July.

† *See* Dewar and Fleming, "The Electrical Resistance of Metals and Alloys at Temperatures approaching the Absolute Zero," *Phil. Mag.*, September, 1893, p. 271; *see* also *The Electrician*, Vol. XXXI., September 15, 1893, p. 529.

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described, the set of junctions which were insulated was kept at 0°C. by being immersed in finely-crushed melting ice, kept well drained; the other set of junctions was exposed to temperatures ranging from −200°C. to +100°C. Two measurements had then to be made, viz., that of the temperature of the heated or cooled junction and also that of the electromotive force set up in the corresponding thermo-couple by the difference of temperature of the two junctions. The chief experimental difficulty encountered was that of determining the low temperature and determining it at the instant when the electromotive-force measurement of the couple was made. After long preliminary experiments necessary to overcome obstacles in the path, the successful method of dealing with the problem was found. These difficulties arose almost entirely out of the fact that for our purpose it was not sufficient to determine the thermo-electromotive force of the M-lead couple at fixed isolated temperatures, but we desired to terminate it at any of the intermediate points of temperature lying within the range of 300deg. from −200°C. to +100°C. over which we were working. The apparatus finally constructed was based upon the employment of a platinum thermometer of particular form for measuring the temperature, and a measuring instrument which could be changed instantly from a potentiometer into a resistance balance.

of copper. These half-cylinders had bevelled edges. One half-cylinder was soldered to the central tube, and the other half-cylinder was insulated from the tube and from the first half-cylinder by a slip of mica. The whole was formed into a fairly true cylinder on the outside. Two wires of platinoid No. 18 S.W.G. and 30cm. long were then soldered to the two insulated half-cylinders. These platinoid wires were kept apart by distance-pieces of ebonite. A thin sheet of mica was then wrapped round the cylinder, and over this was wound 100cm. of pure annealed silk-covered platinum wire. One end of this wire was soldered to one copper half-cylinder, and the other end to the second insulated half. It will thus be seen that we had a platinum wire connecting the ends of the platinoid wires, but wound on a highly conducting copper cylinder, the over-all diameter of the bobbin being about a centimetre and a quarter. This wire constituted the platinum thermometer which will hereafter be spoken of as the working thermometer. A section and elevation of the thermometer is given in Fig. 1. To the ends of the platinoid wires were soldered long stranded and well-insulated flexible copper connecting leads. A duplicate was then constructed in exactly the same manner, save that it had no platinum wire but had the two copper half-cylinders connected metallically together. The object of constructing this duplicate was to be able to eliminate from all measurements the

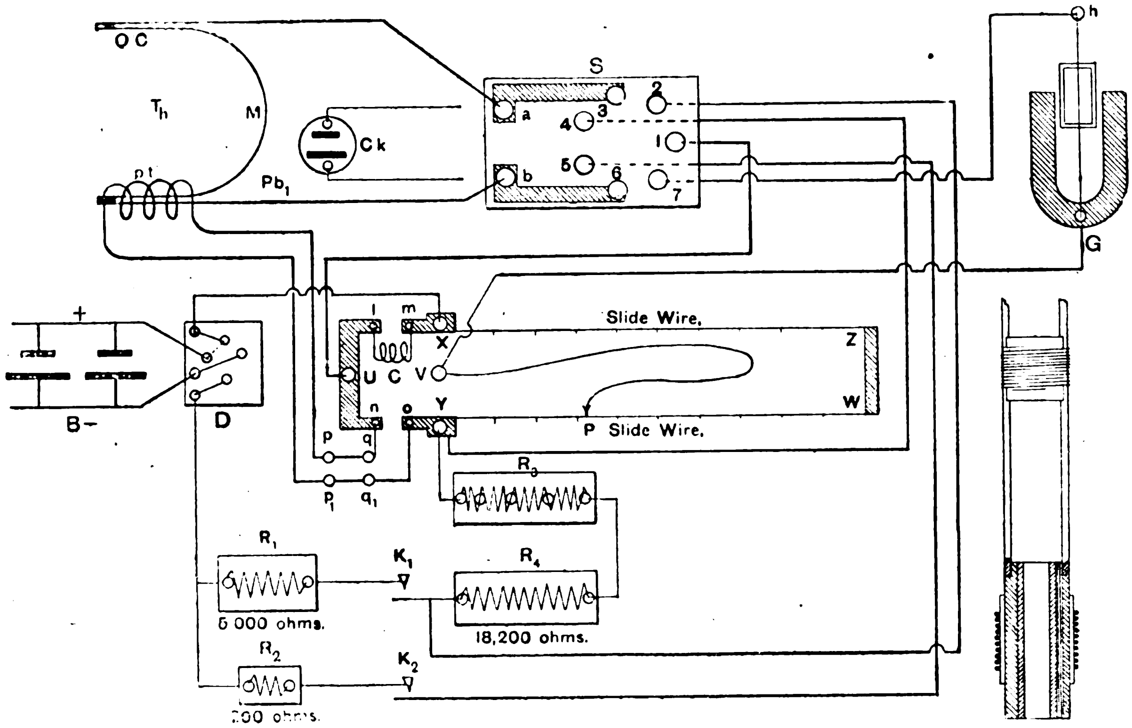

Fig. 2.—Arrangement of Combined Resistance Balance and Potentiometer for Thermo-Electric Measurements. For Bridge, connect Cups 4 to 5 and 1 to 7. For Potentiometer, connect Cups 3 to 4 and 6 to 7. To measure E.M.F. and to check by Clark's cell, Cups 2 to 3 and 6 to 7.

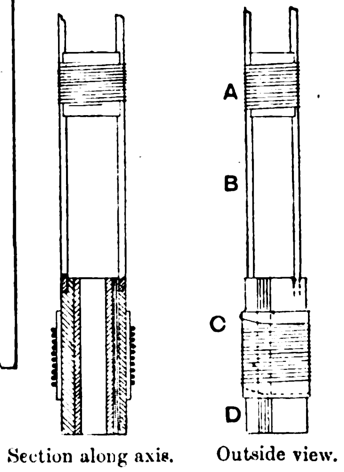

Fig. 1.—Platinum Thermometer used for Thermo-Electric experiments. A = Ebonite Distance-piece; B = Platinoid leading wires; C = 100 cms. of Platinum wire; D = Thin Mica.

In our previous researches on electric conductivity at low temperature, we fully satisfied ourselves that a wire of carefully annealed pure soft platinum can be cooled as often as necessary to the temperature of boiling liquid air or oxygen and yet return always to the same electrical resistance at a normal standard temperature. Professor Callendar has demonstrated that this quality of the constancy of resistance of pure annealed platinum at determined temperatures renders it admirably adapted for thermometric purposes; and Callendar and Griffiths have shown that a properly arranged platinum resistance affords the most suitable means for determining temperatures, and our own work at low temperatures has confirmed this fact. In our investigations on the electrical resistance of metals and alloys, we gave all our temperature-measurements in *platinum temperatures*, as defined by one standard platinum thermometer; and all the measurements in this present thermo-electric research are given in terms of the same standard platinum thermometer, which we shall hereafter mention as our standard platinum thermometer P_1. If at any time it becomes necessary, these temperatures can be reduced to other scales of measurement.

For several reasons it was necessary to construct a platinum thermometer of special form for this thermo-electric work; and this was made as follows:—A small cylinder or tube of copper 3·2cm. long, and having a longitudinal hole through it ·64cm. in diameter, was wrapped round with two other half-cylinders

resistance of the platinoid and copper wires forming the connectors of the platinum thermometer wire.

Our platinum thermometer consisted therefore of a platinum wire and of connecting conductors partly of platinoid and partly of stranded copper wire, and blank or duplicate composed of a loop of an identical platinoid and copper wire. The reason for interposing the platinoid wire was as follows. As will be seen presently, our method of procedure to obtain temperatures intermediate between fixed and known temperatures, such as that of the boiling-point of liquid oxygen and the mixture of solid carbonic acid and ether, was to embed the thermo-junctions in a mass of paraffin wax, and this mass having been cooled down to about −200deg., was allowed very slowly to heat up again. If the platinum thermometer with copper leading-in wires is immersed in this way in paraffin wax, to determine the temperature of the junctions, then, as the thermal conductivity of the copper is greatly increased by cooling it, heat will very rapidly flow into the thermometer along the leading-in wires; and it was found by preliminary experiments quite impossible under these conditions to keep the temperature of the platinum wire used as a thermometer down to the same temperature as the thermo-junction in contact with it. By employing an alloy like platinoid of a rather high specific resistance, and by making the cross-section of these platinoid leading wires relatively somewhat small, it was found possible to greatly hinder the passage of heat along the legs of the thermometer, and yet by the

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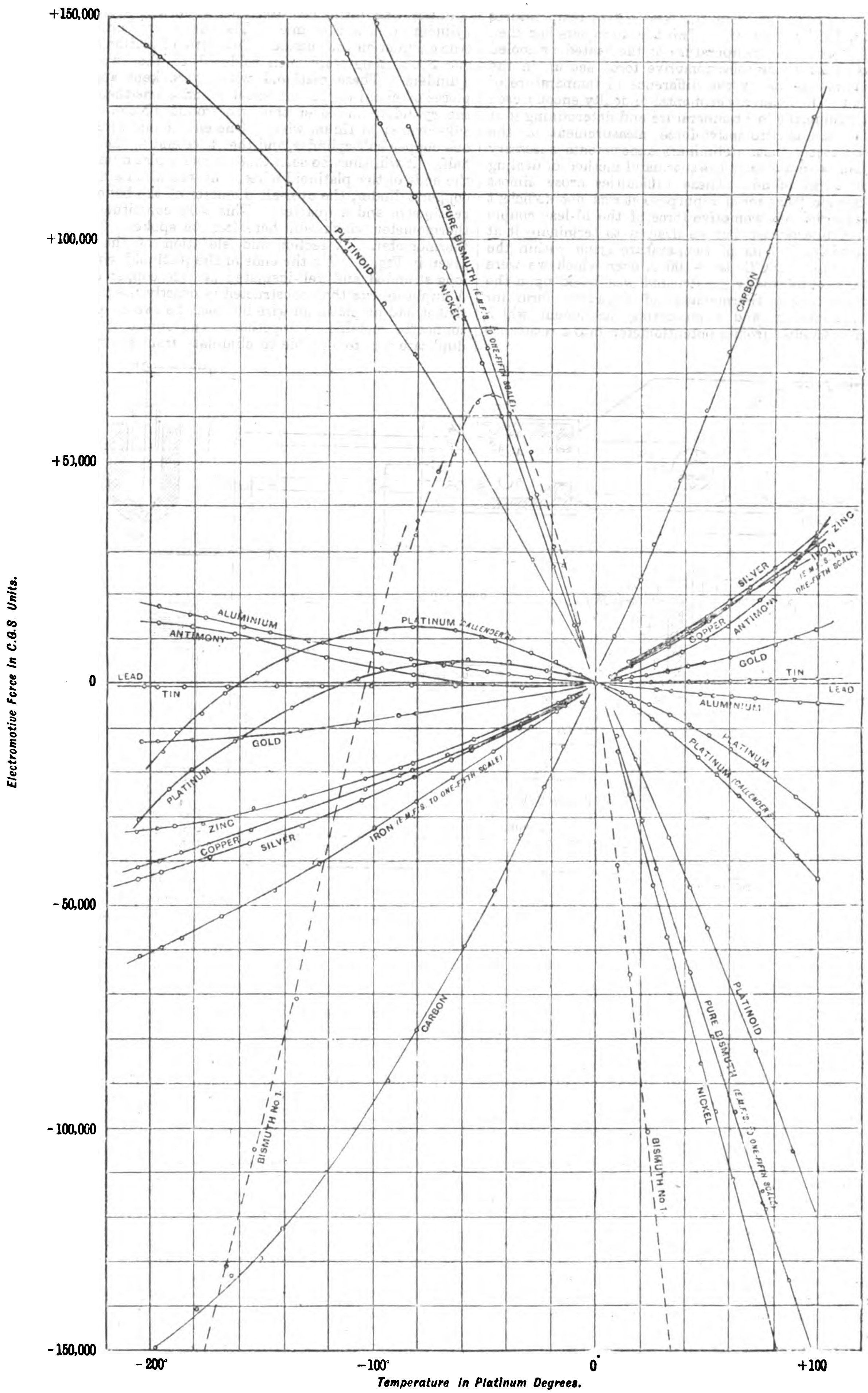

FIG. 3.—Thermo-Electromotive Force Curves of Pure Metals and Alloys

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employment of an identical blank conducting circuit to determine the exact temperature of the platinum wire itself from its measured resistance.

Returning, then, to the construction of the thermometer, we may mention that it was constructed of a length of platinum wire given to one of us by Professor Callendar, and that this specimen was remarkable for its relatively large temperature coefficient. In order to determine the resistance, and therefore the temperature, of this platinum thermometer, a slide-wire bridge was constructed. A length of two metres of uniformly drawn manganin wire was stretched over a two-metre scale. This wire constituted the bridge slide wire. It had a diameter of ·0193c.m. (No. 36 S.W.G.) and a resistance at 15°C. of 26·576 ohms. It was very carefully calibrated for resistance per unit of length. Over this slide wire moved a contact-maker; and the other two arms of the bridge consisted of a coil of manganin wire wound on a small bobbin and having a resistance of 5·000 ohms at 15°C., and the above-described platinum thermometer or the resistance representing its leading-in wires. The battery employed with the bridge was a two-cell lithanode secondary battery, and the galvanometer a Holden-Pitkin suspended-coil galvanometer of 4 ohms resistance. Battery and galvanometer keys were inserted in the circuits as usual.

The first step in the investigation consisted in determining the resistance of the platinum thermometer attached to this bridge, which we shall speak of as the working thermometer P_2, at temperatures defined by our standard platinum thermometer P_1. These platinum temperatures it may be mentioned are defined as follows:—A platinum wire has its resistance determined at 0°C. and 100°C., correction being made for the resistance of its own leading-in wires. A horizontal line on a chart is then taken to represent temperature on the platinum scale and ordinates are set up at distances represented by 100 divisions on this horizontal line, and these ordinates made proportional in length to the true resistance R_0 and R_{100} of the standard platinum wire at 0°C. and 100°C. respectively. Through the summit of these ordinates a straight line is then drawn, and the point where it cuts the horizontal axis of temperature is the absolute zero of temperature by that wire. The platinum temperature of any other body, say of boiling liquid oxygen, is then obtained by measuring the resistance of the standard platinum wire immersed in this medium, and after correcting for the resistance of the leading-in wires, obtaining the true resistance R of the standard wire in the liquid oxygen. On looking out on the chart the vertical ordinate, which to the selected scale represents this resistance, it will indicate by its abscissa the platinum temperature *pt* by that thermometer of the boiling liquid oxygen. For our standard thermometer P_1 the absolute zero is −283°·0 platinum degrees on the above-described scale of temperature.

Having determined the resistance of the working platinum thermometer and of the standard platinum thermometer when immersed together in boiling liquid oxygen, solid carbonic acid and ether, melting ice (0°C.), and boiling water (100°C.), we were able to construct a curve which gave us the true platinum temperature in terms of our standard platinum thermometer P_1 of the working platinum thermometer P_2 when immersed in any medium which gave it a definite resistance, and hence a definite point of balance on the slide wire of the bridge. In order to shorten the labour of correcting the observations, a scale was constructed which enabled us to infer by inspection at once from the actual slide-wire reading the temperature of our working thermometer P_2 in terms of our standard platinum thermometer P_1, all corrections for connections being included. Hence, when the working thermometer P_2 is immersed in any liquid or region of sufficiently constant or slowly varying temperature, and when the position of balance of the contact on the slide wire is found so that the resistance bridge is balanced, then we know from this scale at once the platinum temperature of the wire of our working thermometer in terms of our standard platinum thermometer. This bridge and thermometer has proved of the very greatest use, since it enables us to measure instantly any temperatures between absolute zero and something approaching to 200°C., which is the highest our working thermometer will bear without injury. As an instance of the degree of accuracy in temperature measurement we can obtain with this instrument, we may mention that in the neighbourhood of −196°·7, which is the platinum temperature of boiling liquid oxygen, we can with ease distinguish a change of temperature of one twenty-fifth of a degree. The same degree of accuracy is not obtained at all temperatures; but the temperatures between 0°C. and 100°C. can be determined to within one-tenth of a degree with ease.

The above arrangements therefore enabled us to instantly determine the temperature of the platinum wire of our working thermometer, and therefore, when the temperature was constant or very slowly varying, to determine the temperature of the hollow copper cylinder on which the working platinum wire was wound.

The set of bare junctions of the thermo-couples prepared as described above was then inserted into the hollow interior of the little copper cylinder of the working thermometer, and kept tightly pressed against the copper by a small conical wooden peg. We satisfied ourselves by experiment that under these conditions, if the temperature of the region in which the copper cylinder was placed was constant or very slowly varying, the temperature of the platinum wire wound round the copper cylinder was the same as that of the junctions packed into the interior of the cylinder. This being the case, we had at once the means of determining the temperature of the junctions by means of one measurement, made instantly, of the resistance of the platinum wire.

We have next to describe the arrangements for determining the thermo-electromotive force set up in the couples when one set of junctions was kept at 0°C., and the other varied. This was accomplished by the employment of a potentiometer arrangement (*see* Fig. 2). The calibrated manganin wire used for the resistance balance serves also as a potentiometer wire, and the same secondary battery and galvanometer by a different arrangement of connections are employed to complete the potentiometer. A platinoid resistance of 18,200 ohms was constructed, and also a set of four coils of manganin wire of the same diameter as the bridge wire were prepared, and the whole of these coils joined in series with the bare manganin wire stretched over the scale. These four coils had resistances respectively equal to one, two, three, and four times that of the bridge slide wire. We then constructed an arrangement by which we could use the same slide wire either as a bridge to measure the resistance of the working platinum thermometer, and hence to determine the temperature of the junctions inside it, or to measure the electromotive force set up in the thermo-couple by balancing it against a variable standard potential difference calibrated with reference to a Clark cell.

It was necessary to make provision for changing the bridge into a potentiometer very rapidly, and for the purpose the connections of the different parts of the apparatus were arranged as shown in Fig. 2, so that by one movement of a double copper connecting-piece the connections of the apparatus could be instantly changed from a bridge to measure the temperature of the thermometer, to a potentiometer to measure the electromotive force of the thermocouple. The whole of the electromotive-force measurements are therefore referred to a Clark cell. The arrangement of the combined bridge and potentiometer may be described a little more in detail as follows, and will be easily understood by reference to the diagram (Fig. 2).

The operations of measurement were then as follows:—One set of the thermo-junctions being immersed in melting ice, the working thermometer, with the other set of thermo-junctions packed inside it, was placed in a small copper tube closed at the bottom end, not touching the tube, and this was filled full of melted paraffin wax. The copper tube was then placed in a test tube and the whole filled with melted paraffin wax, to between the copper tube and the glass test tube. When the wax was solid, the mass containing the thermometer wire and junctions enclosed within it was cooled down by the employment of considerable quantities of liquid air to a temperature of about −200deg. As soon as the temperature had become constant, the mass of paraffin was lifted out and placed in a vacuum-jacketed vessel that it might become heated up by conduction and radiation very slowly. A series of observations was then taken for each junction in rotation, measuring first the temperature of the junctions by the thermometer-wire resistance, then changing the connections, and measuring the electromotive force of the couple, then changing back again to the bridge arrangement to get the temperature of the junction again; and so on for each couple in rotation, as the mass of paraffin slowly warmed up. In this manner a series of observations was obtained which, when reduced, gave the electromotive force of the couple in absolute C.G.S. units and the standard platinum temperature (*pt*) of the variable junction at that instant, the other junction being kept at 0°C. all the time.

By the employment of carbonic acid and ether and a paraffin-oil bath the series of observations for closely adjacent temperatures was continued for each thermo-couple from the boiling-point of liquid air up to the boiling-point of water. In addition to this, very careful observations were taken of the E.M.F. of all the couples at fixed stationary temperatures, such as that of the boiling-point of liquid oxygen, the melting-point of solid carbonic acid, the melting-point of ice, and the boiling-point of pure water, and the intermediate observations were made in some cases with the temperature of the junctions rising, and in some cases falling, to give assurance that the temperature of the platinum wire was the same as that of the junctions, and did not lag behind it. Satisfactory evidence was obtained that the temperature of the platinum wire did truly represent the temperature of the thermo-junction buried in the interior of the thermometer.

We were thus enabled to obtain a series of numbers for each metal, representing at defined temperatures the thermo-electromotive force of that metal against lead. Having still in our possession a small quantity of exceedingly pure lead prepared in M. Stas's laboratory which was kindly given to us by Mr. George Matthey for our previous resistance experiments, we were enabled

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to measure the thermo-electromotive force of a couple formed of this pure Stas's lead and the ordinary lead used by us as the associated metal for all the couples. It was thus possible to reduce all our observations of thermo-electromotive force to a statement of the electromotive force in C.G.S. units of a couple formed of a metal M and of chemically pure lead, one junction being at 0°C., and the other being at a platinum temperature *pt* as defined by our standard platinum thermometer P_1. The results of some of the corrected observations are graphically shown plotted down in the chart (Fig. 3).*

These lines of thermo-electromotive force thus found in terms of platinum temperature are in all cases curved lines. Wherever the curve has a maximum point so that its tangent becomes parallel to the line taken as the axis of temperature, the temperature at which this occurs is the neutral point of that metal or alloy with regard to lead. If at any temperature the tangents of the curves of two metals are parallel to one another, that temperature is the neutral point of those two metals with regard to each other, or is the temperature of inversion. The diagram of thermo-electric powers can be at once obtained from that of the thermo-electromotive forces by drawing a series of lines, the ordinates of which represent to a proper scale the *slope* of the curves or thermo-electromotive force.

With regard to the purity of the metals employed in this research, we may mention that the samples of platinum, gold, silver, palladium, copper, tin, lead, cadmium, magnesium, nickel, (Mr. Mond's nickel deposited from nickel carbonyl), zinc, and aluminium were either the same wires as were used by us in our investigation on specific resistance, or were of equal purity. The antimony and bismuth were prepared for us by Mr. George Matthey, to whom our thanks are especially due for valuable assistance in this matter. The other alloys used were taken as found in commerce. The iron was a sample of the softest annealed transformer iron obtainable. As regards the manganese steel, two samples of Hadfield's 12 per cent. manganese steel were used, one in its ordinary non-magnetic cóndition, and one of the same composition but which had been rendered sensibly magnetic by heating it to a full red-heat. It will be seen that this operation quite appreciably alters its thermo-electric value. The carbon used was a carbon filament from an incandescent lamp.

We propose to reserve for a future communication a full discussion of the interpretation of these curves and the bearing of the facts they disclose on the usually accepted thermo-electric theory. Meanwhile it may be sufficient to note that none of these thermo-electric curves are true parabolas over their whole extent. Many of the curves as drawn in the chart are curves of double curvature, and in some cases point to the existence of more than one neutral point with lead. We propose to convert this chart of electromotive forces into a chart of thermo-electric powers, in which last condition it will lend itself better to a discussion of results.

A few remarks may, however, be made respecting the thermo-electromotive force curves shown in the chart. The lines of iron and pianoforte steel, as well as some others, have changes of curvature at certain points which indicate that the thermo-electric lines are broken lines. The line of antimony has two points at which its tangent becomes parallel to the line of lead, indicating that the thermo-electric line of antimony cuts that of lead twice. The bismuth lines are very peculiar. The curves marked Bismuth No. 1 and Bismuth No. 2 are specimens of impure or commercial bismuth; but both these and the curve of pure bismuth have a sudden break or discontinuity in their course at about −80deg., which we think is not due to errors of experiment. These and many other points are receiving consideration, and will be discussed in a subsequent communication.

We must, in conclusion, express our great obligations to Mr. D. K. Morris, as well as to Mr. C. Jakeman, for the valuable assistance they have rendered to us in the laborious work of taking and reducing the observations above recorded, as well as in the construction of some of the apparatus used in this research.

* In the full Paper all the results are plotted and are also given in tables.

LONDON COUNTY COUNCIL.

THE ELECTRIC LIGHTING OF THE THAMES EMBANKMENT AND BRIDGES.

At the weekly meeting of the London County Council, held at the County Hall on Tuesday, Sir Arthur Arnold presiding, the Highways Committee reported having last year submitted to the Council a scheme for the electric lighting of the Victoria Embankment and Gardens and Westminster and Waterloo Bridges, for which purpose the Council obtained powers in its General Powers Act of 1893, and £15,000 was provided in the Money Act of that year. The scheme which they then proposed would have involved a capital expenditure of £20,000, and an annual expenditure for maintenance and interest and redemption of loan of £3,880. On that occasion the Council adjourned the question till the spring of the present year. The Committee had since reconsidered the scheme with a view to reduce not only the expenditure on capital account, but also the cost of maintenance, and having regard to the fact that the Embankment Gardens only required lighting for a short period of the year, in the new scheme they had made no provision for lighting them. In the revised scheme which they now proposed duplicate plant was provided for either set of plant, being capable of lighting the Embankment and the bridges; the generating station was of fireproof construction, so securing the maximum of safety; whilst the cost of the buildings had been reduced by the omission of ornamentation, leaving them as efficient as before. The electric lamp standards would be placed on the kerb on each side of the footways, leaving the parapet lamps to be lighted when required by gas as at present, and the existing lamp standards on the two bridges would be provided with the electric light. It was proposed to provide 83 lamps in all. Should the Council decide to adopt the scheme they proposed to ask the Technical Education Board to allow its inspectors of art schools and classes to assist them in preparing designs for the lamp standards, and they hoped to be able to obtain a design for a standard of lamp which would be worthy of being placed in that, the first thoroughfare in London. The capital cost of the scheme was estimated at £16,590, made up of the following items:—Buildings, £4,600; boilers and machinery, £5,200; mains, £2,250; lamps and standards, £4,240; salaries, £300; of which about £3,000 was included in respect of the two bridges. The estimated annual cost of maintenance was £2,768. In making the estimates it had been assumed that the repayment of the loan would be spread over 42 years, which was the period for which the Council was now granting loans to vestries for electric lighting purposes. They recommended "That, subject to an estimate being submitted to the Council by the Finance Committee, as required by the statute, the Highways Committee be authorised to take all the necessary measures for establishing at a cost not exceeding £16,590 electric lighting for the Victoria Embankment and the Waterloo and Westminster Bridges (but exclusive of the Embankment Gardens) authorised by the Council's (General Powers) Act, 1893; and that for this purpose the Committee be authorised to obtain tenders and to enter into contracts on behalf of the Council.

As the recommendation deals with a capital expenditure of over £5,000 the matter, in accordance with the standing orders of the Council, was adjourned for a week.

THE FIRE AT THE SARDINIA STREET STATION.

The Highways Committee of the London County Council on Tuesday reported to the Council that they had received notice from the Metropolitan Electric Supply Company with plans to lay mains in Little and Great Wild-streets, Kemble-street, Russell-street, Wellington-street, Exeter-street, and part of the Strand, the work being necessitated by the recent fire at the Company's generating station in Sardinia-street. They recommended that the plans be passed on condition that the works in the Strand, when commenced, shall be carried on continuously both by day and by night until completed; that the mains be inclosed in iron pipes or efficient casing, and be laid under the footways wherever it is found practicable to do so; that drawings of the proposed street boxes, showing adequate means for ventilating them and also showing the exact positions in which they are to be placed, be submitted to and approved by the Council's chief engineer before the work is commenced; that as an additional precaution against accident through defective insulation of the mains, each of the street boxes be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable, and that the outer cover, which shall consist of an iron frame filled in with material to suit the paving, shall be efficiently connected to earth.—The recommendation was agreed to.

BOOKS RECEIVED.

"Life and Labour of the People." Vol. VI. By Charles Booth (London: Macmillan and Co.) 7s. 6d.

Proceedings of the American Association for the Advancement of Science. Vol. XLIII. Edited by F. W. Putnam. (Salem: Geo. A. Aylward.)

"Étude sur le Transport de l'Energie a Grande Distance par l'Electricité et sur les Transmissions Electriques par Courant. Continu." By Georges Dumont and Gustave Baignères. (Paris: A. Grelot.)

"Electrical Engineers and Students' Chart and Handbook of the Brush Arc Light System." By H. C. Reagan, Jun. (London: E. and F. N. Spon.)

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CORRESPONDENCE.

SHIPBOARD GALVANOMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. Wilkinson: With regard to my galvanometer, as described in *The Electrician* of March 22nd last, might I state that, in comparing electrostatic throws, the damping device is not required, the instrument being, in itself, sufficiently dead-beat and slow of movement to allow of such observations being made with facility and exactitude. The camel's hair brush, or as I may be permitted to term it, the *extra* damping device, is mainly useful in cases where absolute deadbeatness, together with reduced sensibility, are desirable; (as, for example, in mirror speaking through very short and practically non-inductive lengths of cable), and therefore it is so arranged that it can be instantaneously applied or withdrawn from action at will.

In the latter case, this form of galvanometer combines with great deadbeatness an entire freedom from shifting of zero or creeping, and what is alike indispensable in an instrument of precision, the deflections are proportional to the current.

Any mechanical damper must, of necessity, introduce in greater or less degree creeping or zero trouble, besides want of proportionality between current and deflection; hence the convenience of the brush damping arrangement, which can be immediately applied or withdrawn from use, as occasion may require.

The other general and marked advantages of this type—namely, its independence of external magnetic disturbances such as changes in the ship's course, &c; the facility with which it can be balanced for rolling; its deadbeatness, simplicity and portability—were pointed out in your article.

The figure of merit of the instrument as suspended for sea use now well exceeds that of the ordinary "Thomson Marine," wound to 6,000 (ohms), and I may add that the simplicity and success of its balancing device has been fully proved on an important cable-laying expedition for which this form was adopted.—Yours, &c.,

29, Ladbroke-square, W., H. W. SULLIVAN.
July 8, 1895.

WAVE FORM SYNTHESIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Prof. Ayrton has kindly called my attention to an oversight in the diagram (Fig. 1) in my letter in *The Electrician* of July 5th.

Rheostats R_1 R_2 R_3 are shown in series with the three circuits of the elemental armatures, but, of course, there should be resistances *in shunt* across terminals t_1, t_2, t_3 t_4, and t_5 t_6 respectively.—Yours, &c., JAMES MARK BARR.

THE THWAITE-CAWLEY CONDUIT SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the leading article of your issue of last week you have been kind enough to refer to a Paper read by me before the Tramways Institute, in which I attempted to give an outline description of a new electric traction system intended for urban tramways, and I should be obliged if you would afford me space for a few words in the way of reply.

You state that my Paper "was received with some distrust." Granting, for ease of argument, that such was the case, I am inclined to think that a spirit of distrust is a commendable one for receiving any suggested innovation in the first instance. It would have been a good thing for many investors if this spirit had been more general a few years ago, when company promoters were enjoying a decidedly rosy time. No inventor can reasonably complain at having his claims received at first in a qualified manner. It is generally understood that he is in the position of a special pleader, whose business it is to extol the merits of his invention. But he may ask, and with reason, that any claims he may put forward should be criticised from an impartial standpoint, and with a full knowledge of the details upon which his claims are based. As regards my Paper, I endeavoured to make it entitled to this method of criticism by dealing as impartially as I could with present methods of electric traction in respect of their fitness for meeting the requirements of British tramway enterprise.

Now, with regard to the measure of "distrust" with which you state my Paper was received, permit me to point out that not a single objection was made to the conduit system I described by anyone directly connected with tramway management. The discussion was mainly carried on by two gentlemen of well-known engineering reputation, but I am not quite sure that their connection with rival systems is so remote as to include them within the category of impartial critics. There is an excellent rule observed in our courts of law in pursuance of which a judge is expected *not* to hear cases where his personal interests might be considered to bias his judgment. If such a rule be thought advisable in order to give weight and credit to the judgments of men eminently fitted by training and natural bent of mind to reason fairly, it seems even more necessary in the case of laymen, and had it been rigidly observed by the critics of the system I described it is not improbable that their *rôle* would have been one of silence.

However, as they decided to speak, it is a pity they had not taken the trouble to study the details of the proposed scheme. They probably thought that a few random shots would suffice to vanquish this youngest appellant for tramway favour. But the lack of precision in attack left the reply on my part an easy task. For instance, one speaker doubted whether motors of the power stated could be carried with eight-inch driving wheels, and the remark would be true with motors as usually applied under the cars; but in the culvert of this system there would be no difficulty in putting motors of double the stated power on eight-inch wheels, as the culvert rails can stand any required height above the base of the culvert. The same speaker then ridiculed the idea of obtaining the required tractive effect between the driving wheels and the rails by any other means than that of simple weight upon the wheels, as in the case of a railway locomotive. He had failed to observe that the method adopted for automatically increasing the pressure upon the driving wheels, in accordance with the tractive force required, permitted a gradient of any steepness to be mounted, while the ordinary electric tramcar is confined to a limited gradient. In this respect the proposed system possesses all the advantages of cable traction, or of the grip-rail system as used on mountain railways. In short, it may be looked upon as the cable tramway system in electrical dress.

So much for the value of the criticisms directly affecting the scheme described by my Paper. Although the scheme was only indifferently presented to the meeting in an outline and suggestive form, I think that I may fairly claim that the discussion, so far as it went, did not materially affect a single claim made on behalf of the system.

Another part of the discussion was directed against accepting Papers relating to schemes which have not been practically carried out; but as I was officially invited to read my Paper, any remarks under this head do not directly concern me. The point raised is entirely one of policy, and each Institution must decide this for itself. No doubt the astute and able President of the Tramways Institute is quite capable of adopting the policy which will best serve tramway enterprise in this country, and I do not think it will be one less liberal than that followed by similar institutions in close touch with our industrial life which do not think it "mere waste of time" to discuss proposals which have not yet reached the fulness of maturity. What of the Bessemer method of making steel, cited by me in the discussion—one of the most important and far-reaching inventions the world has yet seen? Was the discussion on this deferred till the process was matured? Of course not; and the same is true of a number of inventions and schemes now of great public advantage.—Yours, &c., GEO. CAWLEY.

29, Great George-street, Westminster, S.W.,
July 10, 1895.

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices* :—

LABORATORY NOTES AND FORMS.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio price 12s. nett, or bound in strong cloth case price 12s. 6d. nett (*now ready*). Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s.—each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

A SHEET TABLE showing Total Capital Outlay and Receipts and Expenditure for the year 1894 of the Statutory Electric Supply Undertakings of the Metropolis is now ready, printed on thick paper, price 6d. each.

TENDERS INVITED.—The Brighton Borough Council invite tenders for the supply and erection of steam and feed piping, cast-iron storage tanks, feed water filters, electrically-driven feed pumps, circulation economiser, coal elevator and sundries. Also and erection of evaporative brass-tube surface condensers, electrically-driven air pumps, exhaust and condenser piping. Tenders must be in by 10 a.m. on Monday next.

——— From our advertisement columns it will be seen that the Metropolitan Asylums Board require tenders for the supply and running of mains in the grounds, and for the wiring of buildings now being erected at the North-Western Fever Hospital, Haverstock Hill, N.W. Copies of the conditions and specifications may be obtained at the offices of the Board, Norfolk House, Norfolk-street, London, W.C., and tenders must be sent in by 11 o'clock on Thursday next, the 18th inst.

——— The Urban District Council of Wellington (Salop) invite tenders for lighting the district by electricity or gas. Tenders before noon on Monday next, July 15th.

——— The Crown Agents for the Colonies require tenders, to be delivered by 11 a.m. on Thursday, August 1st, for the supply of materials in connection with the installation of the electric light in the Civil and War Department buildings at Malta. The materials required comprise cables and wires, tools, &c., fittings, fixtures, &c., and sundries.

——— Tenders are invited by the Vestry of Hammersmith, London, W., for complete schemes for public and private lighting, and for the supply of motor power in the compulsory area of the Vestry's Provisional Order. Further particulars can be obtained of Mr. H. Moir, Surveyor to the Vestry, and tenders have to be sent in by 6:30 p.m. of Wednesday, September 4th.

——— The Barker's Bridge House Trust, Datchet (Berks.) require tenders for lighting the village of Datchet, from October to March, with electricity, oil or gas. Tenders, addressed to the Trustees, care of Mr. H. L. Prior, the Priory, Datchet, must be in by the 20th inst.

TENDERS ACCEPTED.—The Birkenhead Town Council have now accepted the tender of Mr. John Shaw (a local firm), for erecting the electricity generating station in Bentinck-street for the sum of £4,900. It will be remembered that the contract was originally awarded to Messrs. Holme and Green, of Liverpool, but owing to an error that firm asked leave to amend their tender, but this the Council refused.

TENDERS ACCEPTED.—The Hanley Town Council have accepted the tender of Messrs. Crompton and Co. (Limited) for 30 arc lamps and 29 cast-iron pillars for £539.

——— The Portsmouth Corporation have received the following tenders for the supply of conduits and electric mains for lighting the Infectious Diseases Hospital at Milton :—

	£	s.	d.
J. Southey, Southsea	£211	0	0
Walker and Co., Portsea	202	12	6
Bowerman Bros., Southsea	208	10	6
Sotheby and Co., London	188	10	0
W. H. Sabine, Southsea (accepted)	152	0	0

——— The Taunton Town Council have accepted the tender of Mr. F. M. Newton (a local firm), for the supply of a main switchboard for the electricity works.

APPOINTMENT VACANT.—The Bradford Corporation are prepared to receive applications for the appointment of engineer to take charge of their electricity works at a commencing salary of £300 per annum. Applications must be sent in to Mr. W. T. McGowen, Town Clerk, Town Hall, Bradford, by the 17th inst. Some further particulars are given in our advertisement columns.

——— The Governors of the Northern Polytechnic invite applications for the post of principal. After the 25th March next the stipend will be at the rate of £500 per annum, and from September 29th next to March 25th at the rate of £300 per annum. Applications must be sent in to Mr. E. Griffiths, secretary, St. Mary's Vestry Hall, Islington, N., by Monday next.

——— The Governing Body of the Northampton Institute, Clerkenwell, E.C., are prepared to receive applications for the appointment of a principal. The salary attached to the office has been fixed at £600 per annum, and the duties will commence on January 1st next. Applications must be sent in, before 10 a.m. on September 4th, to the Clerk (*pro tem.*), Mr. J. J. Lambert, 8, Dowgate-hill, Cannon-street, London, E.C. Some further particulars appear in our advertisement columns.

DISSOLUTION OF PARTNERSHIP.—Messrs. John Bilbie and Tinsley Waterhouse, carrying on business at 80, Queen Victoria-street, E.C., as engineers, have dissolved partnership.

CAUTION.—Persons are cautioned by an advertisement elsewhere against negotiating or otherwise dealing with any parties claiming to have authority to treat for the sale of the Chaplin Vacuum Pump, French Patent No. 239,302 (1894). Messrs. Templer, Down and Miller, 3, Pope's Head-alley, London, E.C., are solicitors for the patentee.

BANKRUPTCY.—In the case of the failure of E. A. Berry, electrician, of Burnley, notwithstanding the order of the Court calling upon the debtor to file accounts from December 1st up to the date of the receiving order, no such accounts have been filed, and at the Bankruptcy Court, Burnley, last week, a further adjournment took place till August 1st, the debtor being ordered to file particulars within seven days.

"THE ENGINEERING MAGAZINE."—A special railroad number of this magazine is issued for July, and is now ready. The magazine opens with a set of handsome plates showing famous views on the American railroads, produced in a style familiar to readers of the magazine, the contents including articles on "First Principles in Railroad Management," "The Legislative Regulation of Railroads," "Reforms in Railroad Management," "Will Trunk Lines be Operated by Electricity?" (by Frank J. Sprague), "The Architecture of Railroad Stations, with Views of the Principal Railway Termini of England, France, Italy, Germany, Holland, Switzerland, and Belgium." Other articles deal with "The Financial Aspect of the Railroad Industries," "The Car Building Industry of the United States," "The Modern Railroad Machine Shop," "A Review of Railroad Invention," "The Causes of Railway Accidents," and the usual exhaustive Review of the Industrial Press. For railway men the July issue of the *Engineering Magazine* is indispensable.

DIRECTORIES.—It is not unusual for persons obtaining Governmental or Departmental sanction or assistance in the preparation of lists of names and addresses to claim either some special degree of accuracy or a monopoly in the compilation of such names and addresses. It is satisfactory, therefore, to find that Messrs. Kelly and Co., the proprietors of the well-known "Post Office London Directory," and who can fairly lay claim to the credit of compiling what has for many years proved to be the most accurate list of names and addresses ever produced, have proved successful in an action for damages for libel, and have also obtained an injunction restraining the proprietor of a directory of registered telegraphic addresses from publishing similar libels. Those responsible for the compilation of directories, and especially those who devote time and intelligence to the work in order that accuracy may be secured, are well aware that existing lists are only more or less complete, and that in order to secure perfect accuracy it is necessary that considerable individual effort should be made.

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ACTON.—At the last meeting of the District Council a letter was read from the Capital and Counties Electricity Supply Company, notifying their intention of applying to the Board of Trade for an electric lighting Provisional Order. It was stated that the Council would oppose the application.

ALDERLEY EDGE (MANCHESTER).—The Altrincham and Bowdon Electric Lighting Company have notified the District Council of their intention to apply for a Provisional Order to enable them to supply electricity to the district. The discussion on the matter was adjourned to the next meeting of the Council.

ASHFORD.—The Guildford Electric Supply Company (Limited) notify the District Council of their intention to apply for a Provisional Order to enable them to light the district electrically, but the Council have decided to oppose the application. Much dissatisfaction is expressed at the present system of gas lighting, and a committee has been appointed to consider the lighting question generally.

ASYLUM LIGHTING.—At the last meeting of the Governors of the Belfast District Lunatic Asylum, a further report on the electric lighting of the new Purdysburn Asylum was under consideration. An estimate obtained in February last put the initial outlay at £1,800, and the annual cost of working, &c., at £250. The report states that as it is now contemplated to use steam power in the laundry and for various other domestic purposes, and as 10 per cent. extra would provide sufficient power to drive the lighting plant, the Committee thought it would be better to adopt the electric light, and they asked the Board to reconsider the question. After a lengthy discussion it was decided to refer the matter back to the Committee for further consideration and to have a proper specification prepared, upon which tenders will be invited.

BARNET (HERTS.).—At the last meeting of the District Council the Clerk reported that the Board of Trade would extend the time for complying with the provisions of their Provisional Order provided the Board were satisfied that the Council were doing something in the matter. At the same meeting a motion for the appointment of a special committee to consider the lighting and water supply questions, and to report thereon to the Council once a quarter, was defeated by 5 votes to 4.

BUENOS AYRES.—The *Financial News* states that the signature of the Provincial Government of Buenos Ayres has been appended to the purchase deed of the electric light installation for the city. The price paid is $239,230.50 gold, which is to be paid off by the Government at the rate of 5 per cent. per annum for the first five years, and 10 per cent. for each succeeding year till the entire amount is cancelled.

BRIGHTON.—The Town Council have now obtained the formal sanction of the Local Government Board for borrowing the further sum of £43,650 for electric lighting extensions, &c.

CARDIFF.—Last week Col. Ducat, R.E., held an inquiry into the application of the Corporation for sanction to borrow £16,000 for various local improvements, including £1,270 for lighting the Town Hall and Market by electricity.

CHAPEL LIGHTING.—Brunswick Chapel (Burnley) is now lighted electrically. The work has been carried out to the specification of Mr. S. V. Clirehugh by Messrs. Fletcher, Hirst and Co., of Blackburn.

CORK.—In our last issue we announced that the Cork Electric Light and Power Company had notified the City Council of their intention to apply for a Provisional Order to enable them to supply electric current for public and private purposes within the city. Similar notices have now been given on behalf of the local gas company and the Electricity Supply Company for Ireland (Limited).

COMMISSION OF SEWERS (LONDON, E.C.).—At the last meeting of the Commission it was decided to refund the three sums of £1,000 each deposited by the City of London Electric Lighting Company as security for the due fulfilment of the contracts entered into for lighting the City by electricity, together with the interest that had accrued thereupon, all the conditions of the contract having been complied with by the Company to the satisfaction of the Streets Committee.

COMPTON GIFFORD.—The Brush Provincial Company have notified the District Council of their intention to apply for a Provisional Order authorising them to supply electric current within this district.

COWES (ISLE OF WIGHT).—Mr. F. H. Medhurst, the expert appointed to examine the report of the surveyor to the West Cowes Council on the lighting of the district by electricity, has submitted his report, and it was presented to the Council at their last meeting. Mr. Medhurst is of opinion that sufficient expenditure has not been allowed for as to site and buildings. A suitable installation might be put down for a sum not exceeding £8,500, and points to the success of Portsmouth, Bedford, Cambridge, Taunton and other provincial towns. It will not be advisable to charge more than 6d. per unit for the current, and at that rate the electric light will be much cheaper than gas at Cowes. The revenue is estimated at £1,350 for 3,000 lights. There would be a minimum probable profit of £100 per annum as soon as the plant was fully loaded with its 3,000 lights, and the lighting in the streets would be many times more effective than at present.

DEVONPORT.—The Brush Provincial Company have notified the Town Council of their intention to apply for a Provisional Order to enable them to supply Devonport and Stonehouse with electric current. The Council have decided to oppose the application.

DOUGLAS (ISLE OF MAN).—An application to authorise the acquisition of land required for the purposes of an electric railway to the summit of Snaefell, the highest Manx mountain, came before the Manx Legislature this week.

EAST GRINSTEAD.—An attempt is being made to ascertain the views of the ratepayers in regard to the introduction of the electric light into the town, and should there be sufficient support forthcoming a company will be formed for lighting the district electrically. The consulting engineers for the undertaking will be Messrs. Owen Lucas and Pyke, of Victoria-street, London, S.W.

EDINBURGH.—The Town Council have decided to light the Waverley Market electrically at an estimated cost of £650. The Council also decided to adopt an improved system of ventilation for the Market. Rotary fans, propelled by electricity, are to be installed at a cost of about £500.

ELECTRIC CONSTRUCTION COMPANY (LIMITED).—It is stated that this Company have intimated to their employés their intention of paying them a bonus of 6d. in the £. This will be distributed during the month, and it is understood the Directors of the Company have under consideration a further scheme for giving their employés a direct financial interest in the success of the firm.

ELECTRIC LIGHTING OF TRAMWAY CARS.—At the half-yearly meeting of the London Tramways Company, on Tuesday last, the Chairman (Mr. D. P. Sellar) said that those who travelled on their cars would have noticed that many cars were now lighted by electricity. By next winter they hoped that in many more cars oil lamps would be dispensed with, and the electric light be introduced. They had to spend money to make those who used their cars as comfortable as they could, and in that way to induce them to use the accommodation which they afforded. In winter all the cars were heated, and now many of them were so well lighted that a newspaper could be read without straining the eyesight.

ELECTRIC TRACTION IN NEW YORK.—Notwithstanding the very heavy cost of the conversion to electric motive power on the New York elevated railroads, a great saving will ultimately result. It is stated that many of the railroads in the Eastern States are running freight trains with electric motors capable of drawing 450 tons at the rate of about 25 miles an hour, and passenger trains from 45 to 80 miles an hour.

FIFE.—At a meeting of the County Board on Tuesday, Mr. Haig, convener of the Sub-Committee on Telephones, stated that he had interviewed Lord Balfour as to the rent for telephone poles and wires throughout the county. The Committee had formerly agreed to demand 2s. 6d. per mile, and if the Company refused to pay this, to cut the wires. It had turned out, however, that the trunk lines of the telephone had been taken over by the Post Office, and the Postmaster-General refused to pay anything in the shape of rent. They were legally advised that they would run themselves into danger of litigation if they were to cut the wires, though he was not of that opinion himself. The fact was that Lord Balfour had the advantage of them in that he knew what was going on between the Company and the Post Office, and he had been putting them off till a convenient time.

GREAT CROSBY (LIVERPOOL).—At the last meeting of the District Council letters were received from two electric lighting companies giving notice of their intention to apply for Provisional Orders authorising them to supply electric current within the district.

HAMPSTEAD (LONDON, N.W.).—At the last meeting of the Vestry the recommendation of the Lighting Committee that further extensions of the electric lighting mains be effected at an estimated cost of about £360 was agreed to.

ILFRACOMBE.—The electric lighting question was discussed at the meeting of the Town Council last week, and it was stated that notice had been served of the intention of a private company to apply for a Provisional Order for lighting the district electrically. A special meeting has been called to consider the advisability of the Council applying for a Provisional Order, the advantages of the electric light being forcibly advocated by several members.

LEWISHAM (LONDON, S.E.)—At the last meeting of the District Board of Works a letter was received from the Capital and Counties Electric Supply Company notifying their intention to apply for a Provisional Order to supply electric current in the area of the Board's jurisdiction.

LONDON, E.C.—The extensive book room of the Primitive Methodist New Connexion, recently erected in Aldersgate-street, London, has been fitted throughout for the electric light by Messrs.

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J. H. Pickup and Co. (Limited), who have, in addition, fitted an electro-mechanical system of ventilation which has proved very effective.

The Ministry.—Amongst the members of Lord Salisbury's Government are several names well known in connection with the electrical industries. Lord Balfour of Burleigh, who is Vice-President of the National Telephone Company, has been appointed Secretary for Scotland, with a seat in the Cabinet; Mr. G. W. Balfour, the Chief Secretary for Ireland, is a Director of the St. James' and Pall Mall Electric Light Company, the West India and Panama Telegraph Company, and the Aluminium Company; the Hon. W. St. John F. Brodrick, the Financial Secretary of the War Department, is a Director of the African Direct, the Brazilian Submarine, and the Globe Telegraph and Trust Companies.

Monmouth.—Col. W. M. Ducat, R.E., last week held a Local Government Board inquiry at the Shire Hall into the application of the Corporation for sanction to borrow £19,000 for the purposes of carrying out a combined sewage disposal and electric lighting scheme. Mr. Ram, who gave particulars of the scheme on behalf of the Corporation, stated that the necessary motive power would be derived from the water of the river Monnow. A petition, signed by 100 ratepayers (principally shareholders in the local gas company), was presented against the electric lighting part of the undertaking. The engineers for the scheme are Messrs. Bramwell and Harris and Mr. C. N. Lailey.

Newport (Mon.).—Last week Col. W. M. Ducat, R.E., held a Local Government Board inquiry into the application of the Town Council for sanction to borrow, amongst other sums, £1,725 for wiring and fitting the Town Hall, Corporation Baths, the Provision Market, Free Library and School of Art for the electric light.

Ossett.—The Town Council at their last meeting decided to apply for an electric lighting Provisional Order. It was explained by Mr. Audsley, who brought the matter forward, that the obtaining of electric lighting powers was intended to safeguard the rights of the Corporation, as notice had been received from an electric lighting company that they intended to apply for an Order.

Plymouth.—The City Council, at their last meeting, had under consideration the report of the Technical Instruction Committee, which announced that during the year a new feature had been introduced into the schools by the fitting up of an electrical and mechanical engineering shop, which they hoped would have the effect of advancing technical education in the town. The report was approved.

Queenstown.—Owing to the non-success of the efforts of the Town Commissioners to make satisfactory arrangements with the local gas company as to the public lighting of the town, the proposal that an effort should be made to light the district electrically has received the approval of the Commissioners, although one further attempt is to be made to arrive at a satisfactory understanding with the gas company.

St. Pancras (London, N.W.).—At Wednesday's meeting of the Vestry the report of the Financial Committee recommended that £75,000 be borrowed from the National Bank at 3 per cent. interest, mainly for the Vestry's electricity scheme. It was explained that the total saving effected by obtaining this money from the Bank instead of from the London County Council would be £5,626. Repayment is to be spread over a period of 42 years. The initial expenses of the loan from the Bank will be £102. In the course of the discussion the chairman (Mr. Churchwarden J. Thornley) stated that an additional loan of £100,000 would shortly be required for a further extension of their electricity works. It was decided to approve the Finance Committee's recommendation.

Sale (Cheshire).—At the last meeting of the District Council a letter from the Altrincham and Bowdon Electric Lighting Company, notifying their intention of applying for a Provisional Order to light the district by electricity, was referred to the Parliamentary Committee.

Scarborough.—The Sanitary and Lighting Committee of the Town Council have considered a proposal from the Scarborough Electric Supply Company (Limited) for lighting certain streets in the borough by electricity at an annual cost of £915. 5s., but recommend that the matter be not entertained for the present—a decision which has been confirmed by the Council.

Selangor (Straits Settlements).—The local passenger station at Kuala Lumpur has been installed with the electric light by Messrs. Howarth Erskine (Limited), whose electrical engineer, Mr. G. E. V. Thomas, has supervised the work. The same firm have completed installations of a similar character at Saigon, Bangkok and Singapore, and have in hand the lighting of the smelting works of the Straits Trading Company at Pulau Brani, Singapore. Brush generating plant has been put down at Kuala Lumpur, where five 2,000 c.p. arcs and about 70 incandescents are used. It is considered probable that this installation will be the forerunner of a complete electric lighting scheme for the town, which is one of considerable importance.

Sevenoaks.—The Guildford Electric Supply Company (Limited) have notified the District Council of their intention to apply to the Board of Trade for a Provisional Order to supply electricity for public and private lighting within the district.

Shoreditch (London, E.C.).—The Board of Guardians have replied to the Vestry's inquiry as to the supply of current for lighting the workhouse to the effect that they would prefer to have the supply under their own control. The Vestry thus loses a good customer unless the Guardians can be induced to alter their views.

Southport.—The Local Government Board has sanctioned the borrowing of an additional sum of £14,428 for electric lighting purposes by the Town Council.

Spain.—The Barcelona Tramways Company is considering the question of substituting electric for horse traction.

Sport.—Two members of the electrical profession were successful in obtaining awards at the Amateur Athletic Championship Meeting at Stamford Bridge Grounds, S.W., on Saturday last, the third and fourth places in the high jump championship being secured respectively by Mr. P. S. Perry, of Crompton and Co., and Mr. W. E. Lane, of the Brush Company, both gentlemen being awarded the standard medal of the Amateur Athletic Association.

Telephone Trunk Lines.—The Post Office intimates that on Monday next, the 15th inst., the Department's new trunk lines for telephone working will be open for use by exchange subscribers and private wire-renters of the Department, or by members of the public using the call offices at the various post offices affected. It has also been arranged with the National Company that subscribers to that Company's exchange system shall be allowed to use the Post Office trunk wires through the Company's exchanges for conversations between the more important towns in the kingdom.

The Lighting of Harbour Approaches.—The installation of a double row of electric lamps on either side of the Gedney Channel, Sandy Hook, has, it is stated, converted that narrow passage, hitherto only navigable at great risk after dark, into a well-lighted thoroughfare and easy of approach. The high-pressure cable is under water and 6½ miles in length, and posts attached to floating buoys keep the electric lamps at a level of about 12ft. above the water.

Tonbridge.—The Guildford Electric Supply Company (Limited) have notified the District Council of their intention to apply for a Provisional Order to supply electric current within the district.

Torquay.—The Guildford Electric Supply Company (Limited) and Edmundsons (Limited) have both notified the Town Council of their intention to apply for Provisional Orders to enable them to supply electric current within the area of the Council's jurisdiction.

Tunbridge Wells.—At the last meeting of the Town Council the report of the Lighting Committee, which recommended the expenditure of an additional £12,000 in electric lighting extensions, was adopted, and it was decided to apply to the Local Government Board for sanction to borrow this sum. In reply to a question, Councillor Wood said that the electric current would be turned on as soon as the alterations to the Town Hall had been completed.

Tunnel Lighting.—The Glasgow Harbour Tunnels, which were opened for traffic last week, are lighted by electricity, incandescents being used. The installation was carried out by Messrs. Paterson and Cooper.

Waterloo with Seaforth (Liverpool).—The Guildford Electric Supply Company and the Liverpool District Electric Lighting Company have both notified their intention of applying for powers to supply this district with electric current.

Whitechapel.—At the last meeting of the Board of Works notice was received from the Capital and Counties Electric Supply Company (Limited) of their intention to apply for a Provisional Order to supply electric current to the district.

Wimbledon.—At the last meeting of the District Council, on the recommendation of the Roads and Drainage Committee, it was decided to send out circulars to occupiers of houses of £40 rateable value, inquiring how many lights they would be prepared to take if the electric light were introduced into the district by the Council. The Chairman stated that when a previous scheme was introduced 480 similar circulars were sent out, and 190 replies (representing 1,202 lights) were received. Mr. Preece's scheme gave the cost of each 8 c.p. lamp at 10s per annum, exclusive of fitting up, and in the 1890 scheme the cost of wiring was estimated at from 20s. to 30s. per lamp.

Worcester.—The reduced scale of charges for electric current for motive power purposes has been agreed to by the City Council. The Deputy Mayor, in proposing the reduction, said that they had already a full night load, and the alteration was made in order to encourage the development of a day-load. At the same meeting the Deputy Mayor stated that he had no doubt whatever of the financial success of the electricity scheme.

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COMPANIES' MEETINGS.

United River Plate Telephone Company (Limited).

The ninth annual ordinary general meeting of this Company was held on Tuesday at Winchester House, Mr. J. Irving Courtenay (Chairman), presiding.

The SECRETARY (Mr. Robert Herring) read the notice calling the meeting.

The CHAIRMAN said: Gentlemen, in moving the adoption of the report and accounts for the year ended March 31st last, I have much pleasure in congratulating the shareholders upon the improved position of the Company, and in finding that the expectations I ventured to set forth at the meeting last year have been, to a fair extent, realised, so that the Directors feel justified in recommending a dividend of 3 per cent. on the Ordinary share capital. The condition of affairs in the Argentine Republic is a subject of such interest to so many people in this country as to occupy a large space among the topics which are discussed with intelligence and thoroughness in the daily and weekly Press, and upon which you all thus have a full opportunity of forming an opinion. The advices from the Company's representatives in the River Plate point, in spite of frequent fluctuations, to a distinct general improvement in business there. The tendency in all directions is towards a permanent improvement; but we must not shut our eyes to the hindrances there are to a rapid return of prosperity, especially the existence of an enormous amount of paper money. The depreciation of this paper is, as the accounts testify, a source of serious loss to our Company; but we must face it, and deal with the position as best we can. The collections for the year under review, £149,262. 2s. 9d., are the largest we have ever had for a similar period, and, taking everything into consideration, cannot but be deemed to be most encouraging. The number of subscribers has increased from 5,363 to 5,798 on March 31st last, and the increase continues. Upon this point Mr. C. H. Krabbé, one of our consulting Directors in the River Plate, who was with us the year before last, and whose partner, Mr. Mold, is with us to-day, writes:—"Every day the telephone is becoming more of a necessity and less of a luxury; and so we go on getting a very satisfactory and steady increase in subscribers, and I see no reason why this should not go on in the future." I said, when I addressed you last year, that we must be prepared for a substantial increase in working expenses. There has been an increase in many items of expenditure, but the bulk of it is due to a general rise in wages. Then, again, the increase of subscribers has caused a larger amount of work, and has necessitated a corresponding increase in the number of electricians and linemen. In the construction and maintenance department our force has been extremely busy, and considerable modifications, alterations, and repairs have been made to our plant and wayleaves. Constant repairs and alterations are rendered necessary by the building operations that are in progress. The severe storms, more particularly those of October 16th, January 5th, and March 25th, did a great deal of damage to our wayleaves, and caused a large sum to be spent upon repairs. The repair of the La Plata plant has been the most important work in the maintenance department; in fact, we are building entirely new La Plata lines, and other important suburban work is in course of execution. The general condition of the branch offices is satisfactory. We have had to increase the capacity of the switchboards to keep pace with the increase of subscribers. This increase has been especially great at the central office, and has made the work there very heavy. Our employees have been called upon to exert themselves to the utmost, and have done so willingly and with excellent results. Especial commendation is due to our general manager in the River Plate, Mr. Chappell, and his able assistant in Buenos Ayres, Mr. Parker. The progress of the province of Buenos Ayres Telephone Company, in which, as you see from the balance sheet, we hold a considerable share interest, is reported to be quite satisfactory. As in previous years, the Directors have transferred the sum of £3,000 standing to the credit of the depreciation and renewal fund to the credit of cost of conversion of Seven per Cent. Debentures and issue of Five per Cent. Debenture Stock; reducing the balance of that account to £14,209. 13s. 8d. I wish to add that the investments are taken at cost, which is less than their present market value. The liability on bills receivable discounted, viz., £4,000, does not now exist, as the bills have run off in due course. I have briefly called your attention to the various matters that appeared to me to deserve comment, and I now beg to move—

"*That the report and accounts submitted to this meeting be, and they are hereby received and adopted, and that the Company declare the dividend recommended in such report, namely, 3 per cent. on the Ordinary share capital for the year ended March 31, 1895, payable on the 10th inst.*"

Mr. FRANK W. JONES (Managing Director), in seconding the resolution, said he thought it was a matter for congratulation to the shareholders, as well as the Board, that they were able on that occasion to recommend the proposed dividend, and there seemed every reasonable probability that they would not fail to do as well in the future.

The resolution was then adopted unanimously.

The CHAIRMAN proposed the re-election of Mr. Frank W. Jones, one of the retiring Directors.

Mr. J. OWEN UNWIN seconded the proposition, and it was agreed to unanimously.

The CHAIRMAN next proposed the re-election as a Director of Mr. Alfred Le Rossignol.

Mr. J. E. KINGSBURY seconded the proposition, which was also carried unanimously.

Mr. BISHOP moved the reappointment of Messrs. Cooper Bros. and Co. as auditors at a fee of 25 guineas.

Mr. F. A. BILLETER seconded the motion, and it was adopted.

Mr. FRANK W. JONES said he thought they should pass a resolution approving the conduct of their general manager in the River Plate, Mr. Chappell, and his assistant, and also to their able consulting Directors on the other side, Messrs. Fels and Krabbé. He would therefore move—

"*That the thanks of the meeting be given to the General Manager in the River Plate, Mr. Chappell, the Buenos Ayres manager, Mr. Parker, and their general staff; also to the local consulting Directors, Messrs. Fels and Krabbé, for the ability and zeal with which the business of the Company in the River Plate has been conducted during the past year.*"

Mr. F. A. BILLETER seconded the resolution.

The CHAIRMAN, before submitting the resolution to the meeting expressed a hope that it would be carried with cordiality, as they were much indebted to the gentlemen referred to in it for the successful position the Company had attained.

The resolution was then carried *nem. con.*

Mr. MOLD, in acknowledging the resolution on behalf of his partner, Mr. Krabbé, remarked that he did not think he could add anything to what the Chairman had said. He felt no hesitation, however, in confirming all that the Chairman had said with regard to the Company's prospects in the River Plate, always provided that no unexpected catastrophe took place. There was no doubt that the progress made last year in the number of subscribers, which was the essential point, continued. The premium on gold seemed at present to be working in favour of the Company, and he sincerely trusted it might continue to do so.

Mr. J. OWEN UNWIN then moved a hearty vote of thanks to the Chairman and Directors for their able management of the Company's affairs.

Mr. J. E. KINGSBURY seconded the motion, and it was unanimously carried.

The CHAIRMAN, in reply, said: I thank you heartily for the vote of thanks you have just given us. It is, of course, very pleasant for us all, shareholders and directors alike, that this Company, after a hard fight for five years, has again, by to-day declaring a dividend, re-entered the dividend-paying list, and I hope it may long remain there.

The proceedings then terminated.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1895, pages *304-332, &c. &c.*]

AMAZON TELEGRAPH COMPANY (LIMITED).—This Company was registered on July 5th with a capital of £250,000, in £10 shares, to acquire and carry out a concession from the Government of the United States of Brazil, dated April 29, 1895, for the establishment and working of telegraphs in the States of Pará and Amazonas (United States of Brazil), to establish, or acquire, construct, work, and maintain sub-fluvial or other electric telegraphs or telephones in the said States or elsewhere, to acquire and obtain from the Brazilian Government or from the said States of Pará or Amazonas, or either of them, or from any other Government, State or Power, any existing or other concessions, powers, rights and privileges, for the purposes of, or in furtherance of, or in connection with any of the objects of the Company, and to enter into working or other arrangements with any telegraph or other company, or person, or with any Government upon any terms and conditions. The subscribers are:—

	Shares.
W. S. Andrews, 18, Old Broad-street, London, E.C. (Chairman of the Western and Brazilian Telegraph Company, Limited)	200
Lord Richard H. Browne, Reigate, Surrey, Director of Western and Brazilian Telegraph Company	100
John Coppen, Ashford, Middlesex, Director of Western and Brazilian Telegraph Company	400
D. H. Goodsall, 17, Devonshire-place, W., Director of Western and Brazilian Telegraph Company	200
Alexander Wood, Abbey Wood, Kent, Managing Director of the Western and Brazilian Telegraph Company (Limited)	500
R. M. Cunningham, Blomfield House, London Wall, London, E.C., Secretary of the Western and Brazilian Telegraph Company (Limited)	100
E. S. Hodson, "Lamorna," King Charles-road, Surbiton, Surrey, accountant	1

The first Directors are:—W. S. Andrews, Lord Richard H. Browne, C. W. Earle, J. Coppen, D. H. Goodsall, and Major Alexander Wood. Qualification for office: the holding of shares or stock of the nominal value of £1,000. Remuneration, £1,500 per annum, to be divided between them as the Directors themselves determine. Registered office, Blomfield House, London Wall, London, E.C.

HARROW ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—This Company was registered on July 5th with a capital of £25,000, in shares of £5 each, to carry on at Harrow-on-the-Hill, Middlesex, or elsewhere, the business of an electric light and power company in all or any of its branches, and of manufacturers and suppliers of electricity, and to take a transfer of all or any of the powers, duties, and liabilities granted

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to and imposed upon the undertakers under the Harrow Electric Lighting Order (1894), and of any other authority granted or to be granted for the supply of electricity in Harrow or its neighbourhood, and to carry the same into effect. The subscribers, with one share each, are: J. G. C. Welldon, head master of Harrow School; C. Colbeck, E. R. B. Denniss, R. C. Gilson, E. W. F. Stiven, M.D.; F. S. Winkley, and A. P. Charles. The first Directors are: C. Colbeck, E. R. B. Denniss, R. C. Gilson, E. W. F. Stiven, M.D., and F. S. Winkley.

ALBERT ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return to November 14th has been recently filed. Out of a nominal capital of £10,000, in shares of £5 each, 407 have been taken up, and the full amount has been called on 400, while a call of £1 per share has been made on the remaining seven.

ALLIANCE METER COMPANY (LIMITED).—The statutory return to June 12th has been filed. The nominal capital is £5,000 in £1 shares, and of these 2,007 have been taken up; 2,000 have been issued as fully paid to William Coward, and the full amount has been called on the remaining seven shares, but has not yet been paid in.

AUTOMATIC ELECTRIC RAILWAY SIGNAL COMPANY (LIMITED).—The annual return to May 2nd has been filed. The nominal capital is £10,000, in £1 shares, and of these 5,940 have been taken up: 4,300 shares have been issued as fully paid, and the full amount has been called and paid on the remainder.

BAILY, GRUNDY AND BARRETT (LIMITED).—The annual return to June 4th has been filed. The nominal capital is £10,000, in £5 shares, of which 662 have been subscribed for and allotted. The full amount per share has been called and paid.

BENHAM AND FROUD (LIMITED).—The annual return to May 14th has been filed. Out of a nominal capital of £50,000, in £10 shares, 2,907 have been subscribed for and allotted, and the full amount has been called and paid thereon.

BROWETT, LINDLEY AND CO. (LIMITED).—The annual return to April 22nd has been filed. The nominal capital is £20,000, in 1,600 Ordinary and 400 Preference shares of £10 each; 1,362 of the former and 200 of the latter class have been taken up, and 800 have been issued as fully paid. The full amount has been called and paid on the remaining 762 shares.

DENISON AUTO-TELEGRAPH MACHINE SYNDICATE (LIMITED).—The statutory return to November 21st has been filed. The nominal capital is £1,000 in 20 shares of £50 each. Of these 16 have been subscribed for and allotted, and eight have been issued as fully paid. The full amount has been called on the remaining eight shares.

CITY NOTES.

AMAZON TELEGRAPH COMPANY (LIMITED).—The prospectus has been issued this week of the above Company, which is formed to connect by cable the city of Manaos, the capital of the State of Amazonas, with the city of Pará, at the mouth of the river Amazon, with a number of intermediate stations or branch lines. At Pará the Company's cable joins the land lines of the Brazilian Government and the cables of the Western and Brazilian Telegraph Company, thereby completing the connection with the rest of Brazil and the Argentine Republic, and by means of the cables of the Brazilian Submarine Telegraph Company communication with Europe and the whole telegraphic system of the world is secured. The capital of the Company is £250,000, in shares of £10 each, payable £1 on application, £2 on allotment, £2. 10s. on September 16th, £2. 10s. on November 15th, and £2 on January 15th next. The Company starts with an annual subsidy granted by the Brazilian Government of £17,125 per annum for 20 years, payable quarterly in gold; and the Directors prove their confidence in the success of the Company by personally subscribing for £12,000 worth of the shares at par. At the expiration of 30 years the Company's system reverts to the Federal Government, which has power to purchase after 10 years at a price to be agreed upon. The prospectus points out that an attempt made by the Brazilian Government to effect a land-line communication with the points now attached by the cable has, owing to difficulties experienced in the forests and swamps bordering on the river, proved unsuccessful, and has had to be abandoned. The contract for making the cable has been placed with Messrs. Siemens Bros. and Co, who will provide the apparatus, repairing machinery, &c., and hand the system over complete and in working order for the sum of £211,000, to a specification approved by the Company's engineers and electricians, Messrs. Clark, Forde and Taylor. The total length of the cables is about 1,365 miles, and the contract time for completion is March 1st next. Calculations are made which show a net revenue equal to over 10 per cent. interest on the capital. The Chairman and Directors of the new Company are the Chairman and Directors of the Western and Brazilian Company, and Mr. R. M. Cunningham, Blomfield House, London-wall, London, E.C., is secretary. The subscription list closed on Wednesday last, and we understand that the capital was over-subscribed.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ending July 7th were £915, as against £879 in the corresponding week of 1894, being an increase of £36.

CAPE TOWN AND SUBURBAN ELECTRIC LIGHTING SYNDICATE (LIMITED).—Messrs. Davis and Soper notify the payment of a dividend at the rate of 7 per cent. per annum by this Syndicate.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The transfer books and register of members of the Six per Cent. Preference shares of this Company will be closed from the 15th to the 24th July inclusive, for the purpose of preparing the interim dividend warrants. This interim dividend for the six months ended June 30th last is payable on and after the 25th inst. The gross revenue returns of the Company for the quarter ended June 30, 1895, is as follows:—Sale of current for public lighting, £3,501, against £3,162 in the corresponding period of 1894; private lighting, &c., £12,283, against £7,153; other sources, £200—total, £15,984, again £10,315—an increase of £5,669. The equivalent of 8-c.p. lamps connected on June 30, 1895, was 159,250, against 99,140 on June 30, 1894. The increase of 8-c.p. lamps connected during the past quarter was 10,656 against 15,927 in the corresponding quarter last year.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The Directors of this Company have resolved to recommend a final dividend of 2s. per share, free of income tax, payable on and after the 31st inst. This makes, with the interim dividends already paid, 2 per cent. for the year ending June 30th last, and after placing £7,000 to reserve fund account, a balance of £1,410. 0s. 9d. is carried forward. The transfer books will be closed from the 15th to the 30th inst. inclusive.

EASTERN TELEGRAPH COMPANY (LIMITED).—Subject to final audit, the accounts of this Company show, after placing £100,000 to the reserve fund, a balance available sufficient to pay at the forthcoming general meeting the fixed dividend of 3s. per share, being at the rate of 6 per cent. per annum on the Preference shares, less income tax, and a final payment of 2s. 6d. per share, with a bonus of 3s. per share, both free of income tax, on the Ordinary shares, making, with previous payments on account, a total distribution of 6½ per cent. on those shares for the year ended March 31, 1895. The transfer books will be closed from July 18th to 25th inclusive.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The interest on this Company's Four per Cent. Mortgage Debenture Stock for the half-year ending 31st inst. will be paid on August 1st. The Four per Cent. Mortgage Debenture Stock register will be closed from the 27th to the 31st inst. inclusive.

ELEKTRIZITATS AKTIEN-GESELLSCHAFT (vormals Schuckert and Co., Nuremburg).—The Board of this Company is proposing a dividend of 10 per cent. for last year, as against 9 per cent. for the previous year.

GLOBE TELEGRAPH AND TRUST COMPANY (LIMITED).—A further distribution of 3s. 3d. per share is announced on the Ordinary capital of this Company, leaving about £1,200 to be carried forward.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this Company for June were £25,200, and the total receipts during the period from January 1st to June 30th were £149,200, as against £132,800 and £129,800 in the corresponding periods of 1893 and 1894 respectively.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended the 7th inst. amounted to £1,250. The amount for the corresponding week last year was £917; increase, £333.

MAUDSLAY, SONS AND FIELD (LIMITED).—The report of the Directors of this Company, just issued, states that the results of the past year's working do not admit of payment of dividend on the Preference shares.

NATIONAL TELEPHONE COMPANY (LIMITED).—The transfer books of the Preference and Ordinary shares of this Company will be closed from the 13th to the 26th inst. inclusive. The dividend warrants will be posted on the latter day.

REDUCTION OF CAPITAL.—Notice is given that the Order of the Chancery Division of the High Court of Justice, dated June 25, 1895, confirming the reduction of the capital of Crompton and Co. (Limited) from £300,000 to £280,000, was registered by the Registrar of Joint Stock Companies on the 5th inst.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee appointed Wednesday last, July 10th, a special settling day for £120,000 Four and a-Half per Cent. Twenty-Year First Mortgage Debentures (Nos. 1 to 1,200) of the Royal Electric Company of Montreal, and have ordered the same to be quoted in the official list. The Committee have also appointed Wednesday, July 17th, as a special settling day for 11,303 Seven per Cent. Cumulative Preference Shares (Nos. 1 to 11,303) of the British Aluminium Company (Limited).

SUBMARINE CABLES TRUST.—Notice is given that on and after the 15th inst. the sum of £1. 5s., balance of the coupon due April 15th last, will be paid by Messrs. Glyn, Mills and Co., Lombard-street, E.C. Coupons to be left four days for examination.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LTD.).—The Directors of this Company have declared an interim dividend of 12s. per share.

VAN HECKE'S FUEL ECONOMISER SYNDICATE (LIMITED).—An extraordinary general meeting of this concern was held on Wednesday to consider a proposal that debentures should be issued for the payment of principal sums not exceeding £10,000, and also to increase the capital of the Company to £25,200 by the creation of 2,000 new shares of 2s. each. Capt. Bickford, who presided, said that the vendors had assigned the patents to the Company. The apparatus was in use on the District Railway, and the Directors had received an order to fit one of the Great North of Scotland engines for trial. A large measure of success had been achieved in France, and about 50 contracts had been entered into, among which were those with the Naval Department and the War Office. The proposal was approved.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended July 5th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,969.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, July 3.		Price Wednesday, July 10.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending July 10. Highest	Lowest
			TELEGRAPHS					£ s. d.			
£1,012,880	Stock	10 0	Anglo-American	47	49	47	49	4 1 8	Jan., Apr., July, Oct	..	..
£2,993,560	Stock	20 0	Do. Preferred	88	89	88	89	4 9 11	" "	89	88
£2,993,560	Stock	5/0	Do. Deferred	8¼	8¾	8¼	8¾	..	..	..	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer) xd	101	104	102	105	3 16 2	January and July	103½	..
130,000	£10	3/0	Brazilian Submarine xd	13	13½	13¼	13¾	4 14 6	Mar., June, Oct., Dec	13½	13⅛
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906) xd	110	114	110	114	4 7 9	June and December	..	..
10,000,000	$100	1¼%	Commercial Cable Capital Stock xd	165	170	160	165	4 4 10	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	13½	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	3½	4½	3½	4½	4 8 11	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10½	9¾	10½	4 7 7	" "	9¾	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each xd	103%	105%	103%	106%	4 4 11	" "	..	—
60,710	20	2/0	Direct United States Cable, 1877	9½	9¾	9½	9¾	4 0 5	Jan., Apr., July, Oct.	9 11/16	9½
400,000	10	2/6	Eastern	16¾	16⅞	16¾	16⅞	3 17 2	" "	16⅞	16¾
70,000	10	6%	Do. 6 per Cent. Preference	17½	17¾	17½	18	3 6 8	" "	17¾	17½
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	123	126	124	127	3 3 0	May and November	126	125
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	109	107	110	4 12 7	February & August	..	..
250,000	10	6/6	Eastern Extension	17	17¼	17¼	17½	4 0 0	Jan., Apr., July, Oct.	17⅝	17 1/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	124	127	124	127	3 3 0	February & August	..	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900 xd	102	106	103	106	4 14 4	January and July	103½	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	102	106	103	106	4 14 4	" "	103	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	107	110	107	110	3 13 11	February & August	108½	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	111%	114%	111%	114%	3 10 8	May and November	..	—
180,227	10	2/3	Globe Telegraph and Trust	10	10¼	10⅛	10⅜	4 7 0	Jan., Apr., July, Oct.	10½	10⅛
180,042	10	6%	Do. 6 per Cent. Preference xd	16¾	17	17	17¼	3 9 7	" "	17¼	16⅞
150,000	10	5 0	Great Northern	21¾	22¼	21¾	22¼	3 16 3	Jan., April, and July	21⅞	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	..	..
17,000	25	37/6	Indo-European	49	52	49	52	4 16 2	May and November	51½	50½
37,548	10	2/6	London Platino-Brazilian	5	7	5	7	..	" "	..	—
£100,000	100	6%	Do. 6 per Cent. Debentures	106	110	106	110	5 11 1	March & September	..	—
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	xd 105	108	106	109	3 13 5	..	..	—
11,839	8	4/0	Reuter's	3½	4½	3½	4½	..	April and October	..	—
3,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	124	129	124	129	4 13 0	" "	..	..
15,609	10	5/0	West African Telegraph	4½	5½	4½	5½	..	January and July	..	—
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	102	105	103	105	4 16 10	March & September	104½	103½
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	—
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902 xd	98	103	98	103	7 15 4	June and December	100½	—
88,321	10	6d.	West India and Panama	¾	1	¾	1	..	..	..	—
34,563	10	6%	Do. 6 per Cent. 1st Preference	9¾	10½	9¾	10½	5 6 8	May and November	10¼	10
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	5 13 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.) xd	109	112	109	112	4 9 3	June and December	..	..
64,242	15	6/0	Western and Brazilian	10½	11	11	11½	4 1 11	May and November	11¼	10¾
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6¼	6¾	6¼	6¾	..	—	..	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4½	4¾	4½	5	..	—	4 13/16	4¾
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	103	107	104	108	5 13 9	February & August	..	—
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	103	107	104	108	5 13 9	" "	..	—
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	5 19 8	May and November	..	—
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 17 8	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	—	..	—	..
224,850	10/0	1½d.	Consolidated Telephone Const. & Maintenance	⅛	⅜	⅛	⅜	..	May and November	..	—
171,504	£1	3·2 5 1.	Oriental Telephone and Electric (fully paid)	9/16	1⅛	9/16	1⅛	..	Yearly	..	..
484,597	5	2/6	National	5⅝	5⅞	5¾	6	4 3 4	June and December	6	5 15/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15½	16½	16	17	3 10 7	" "	17	16
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½	15½	14½	15½	3 17 5	" "	..	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅞	6⅜	5⅞	6⅜	4 1 8	—	6 1/16	..
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.) xd	105	107	105	107	3 5 5	January and July	105	—
58,000	5	1/0	United River Plate	2	3	2½	3	..	" "	2⅝	2⅝
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.) xd	92	97	92	97	5 3 1	" "	94	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	14½	15½	15	16	1 11 3	—	15⅞	15½
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	16	16½	16	17	3 10 7	—	16 13/16	16 7/16
£100,000	Stock	5%	Do. 5% Debenture Stock (red.) x	131	134	131	134	3 12 9	June and December	131	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	—	5⅞	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	..
8,322	£5	..	House-to-House Electric	—		—		..	—	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		—		..	—	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	—	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7¾	7⅞	7¾	7⅞	..	—	..	..
111,000	5	..	London Electric Supply	..		..		..	—	..	—
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	10½	11	10½	11	2 14 7	..	10 13/16	10 7/16
£150,000	Stock	4½%	* Do. 4½% Debs. xd	115	117	115	117	3 16 11	June and December	117	116½
6,452	£10	2 0	Notting Hill Electric	8	8½	8¼	8¾	..	..	..	—
19,980	£5	4 6	St. James and Pall Mall	8¼	8¾	8¼	8¾	..	—	8½	..
20,000	£5	7%	Do. 7 per Cent. Preference	9	9½	9	9½	3 13 8	—	..	..
59,900	5	5%	Westminster Electric Supply (fully paid)	7¾	8	7¾	8	3 2 6	—	..	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2¼	2½	2¼	2½	6 0 1	—	2¼	2 3/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅝	2⅞	2⅝	2⅞	5 1 1	—	2½	2⅜
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	112	115	112	115	3 19 4	March & September	113½	—
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2	2½	2	2½	..	January and July	..	—
12,139	5	..	Edison and Swan United	1¾	2¼	1¾	2¼	..	..	..	—
£1[illegible]	Stock	4%	Do. 4% Mortgage Debenture Stock xd	104	107	104	107	4 4 1	..	..	..
£50,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		..		..	..	—	..
120,000	2	..	Electric Construction	¾	1	¾	1	..	..	1⅜	—
12,845	2	2/9⅝	Do. 7 per Cent. Cumulative Pref.	1¾	2¼	1¾	2¼	..	..	2	—
91,195	2	10/0	Elmore's Patent Copper Depositing	1	1½	1	1½	..	..	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	1¼	1½	¼	¾	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	20	22	20	22	4 11 11	February & August	21⅝	20
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 7 5	March & September	..	—
15,995	£10	..	International Okonite Ordinary	..		..		..	—	..	..
16,000	£10	..	Do. 8 per Cent. Preference	—		..		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)		⅛		⅛	..	..	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	43	45	43	45	5 6 8	March and July	44⅞	43½
£150,000	100	5%	Do. 5 per Cent. Bonds xd	104	107	104	107	4 13 6	January and July	..	—
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	—
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£33,[illegible]70	10	12/0	W. T. Henley's Telegraph Works Ordinary	10½	11½	10½	11½	5 4 4	..	11⅛	11
£[illegible]00	10	7%	Do. 7 per Cent. Preference	14	15	14	15	4 13 4	..	14¼	..
£[illegible]	Stock	4½%	Do. 4½% Mortgage Debenture Stock	104	107	104	107	4 4 1	..	..	—
			RAILWAYS AND TRAMWAYS.								
£6[illegible]000	Stock	1½%	City and South London Railway	42	44	42	44	2 16 10	May and November	..	—
7,0[illegible]	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	..	—
£67,130	Stock	4%	Do. 4% Perpetual Debenture	132	134	133	135	2 19 3	May and November	134⅞	134
37,500	£10	2%	Liverpool Overhead Railway	9 15/16	10 1/16	9 15/16	10 1/16	1 19 10	—	..	..
6,295	10	5%	Do. 5% Preference	14¾	15¼	14¾	15¼	3 5 7	—	..	—
125,000	Stock	4%	Do. 4% Debenture xd	110	112	110	112	3 11 5	January and July	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 896. [No. 12. Vol. XXXV.] FRIDAY, JULY 19, 1895. PRICE SIXPENCE.

NOTES.

A SOMEWHAT larger shower than usual of notices of intention to apply for electric lighting Orders appears this year to have fallen upon the various local authorities of the United Kingdom. Perhaps the institution of District and Parish Councils has something to do with it; at any rate many of these infant local governing bodies seem not a little puzzled as to what may be the correct attitude to adopt under the circumstances. They have been educated in the orthodox faith that nothing that a local authority can possibly do at a loss should be done by a company at a profit; nevertheless, as business men the members see very well that the electric lighting of English villages, even on a perfect system, is likely for the most part to prove a decidedly hazardous venture. Such being the case, doubtless much will be attempted either by public or private enterprise that had better have been let alone, and many a village community may spring at a single bound from the petroleum lamp to the glow lamp. Caution in these matters is the better part of permanent progress.

LITTLE did Prof. DOLBEAR know what he was bringing upon himself when, in the lightness of his heart, he wrote to the *Electrical Engineer* of New York last May to claim for Prof. TROWBRIDGE, of Harvard, "whatever merit and utility" there may be in connection with the origination of "doing telegraphic work by means of earth conduction." Mr. PREECE, so far as we are aware, makes no claim to have been the first to have *thought* of telegraphy without wires. On the other hand, he has certainly been the first to persistently experiment in this direction, and to attain anything approaching practical success. Moreover, judging by the titles of many of his Papers, and by their contents, he does not think that "earth conduction" plays any appreciable part in the matter, pinning his faith to "induction," though conclusive experiments with two completely-metallic thoroughly-well insulated circuits are wanting. But however this may be, priority in suggesting telegraphy without wires belongs, it would appear, to this side of the Atlantic. That veteran telegraphist, Mr. J. W. WILKINS, states in a letter to be found in our "Correspondence" columns this week that he publicly suggested the idea of wireless telegraphy between England and France so far back as 1849, having previously made some tentative experiments with the aid of a moving-coil galvanometer of his own design. Mr. WILKINS, we are glad to see, is not inclined to attach over much importance to a mere suggestion, even when, as in his case, it had for basis considerable experiment and the invention of a now indispensable form of instrument; neither does he imply, as does Prof. DOLBEAR on behalf of Prof. TROWBRIDGE, that his work has been intentionally ignored. As Mr. WILKINS puts it, "it cannot be expected that everyone shall get to know what everyone else has done in any particular direction."

To all who like vigour and sprightliness of expression we commend the article on "English Internationalism," by M. HOSPITALIER, a translation of which will be found in another column. The subject of magnetic symbols and nomenclature threatens to become a trifle wearisome even to those whom such things interest; and our further reference to the matter shall be brief. We asserted that modern magnetism took its growth in England. The correctness of this statement is admitted, but its modesty, alas, is impugned. Furthermore, in Royal Society Papers of 1885 M. HOSPITALIER can find no block letters, the use of which to denote magnetic quantities had, we alleged, become well established in this country. That is not surprising; Maxim guns are not to be found in a battle-piece of a century ago. A glance at Prof. SILVANUS THOMPSON's "Dynamo-Electric Machinery" of 1892, or Prof. EWING's "Magnetic Induction in Iron and other Metals" of 1891 will reveal the existence of block letters in sufficient quantities to support our contention. As to M. HOSPITALIER's remarks on the use of the term "gauss" in two senses, there is surely no need to again travel over our ground; are not our arguments to be found on pp. 144 and 282 of the present volume? M. HOSPITALIER would appear to think that the consideration of the convenience of printing offices in the matter of type is beneath the dignity of science. Possibly it is; but a little less dignity and a little more attention to such common-sense considerations would tend to oil the wheels of progress. As a matter of fact, however, we do not believe there is any foundation for the suggestion that a parsimonious printer was the proximate cause of the introduction of block letters. Finally, M. HOSPITALIER seems to imply that we have doubts as to the utility of international symbolism. We have none whatever. We merely desire to "hasten slowly," and to make sure that the resounding adjective "international" shall be something more than a synonym for "French," such as it is, for instance, in connection with the so-called Société Internationale des Elec-

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triciens. It is quite possible that truly international sanction may ultimately be given to $\mathfrak{B}$'s, $\mathfrak{H}$'s, and $\mathfrak{J}$'s, and that we may even then still be guilty of the heresy of saying a mistake had been made; but we should, nevertheless, loyally acquiesce in any authoritative decision, and make immediate use of the execrable symbols M. Hospitalier so much affects.

In a Paper by Dr. Werner Bolton, the gist of which we give elsewhere, an impressive array of evidence is adduced in favour of the belief that a dilute solution of mercuric iodide in potassium iodide contains monovalent mercury ions, that is to say, behaves in the manner proper to a solution of mercurous iodide. This startling result is arrived at by consideration of the fact, experimentally established by Dr. Bolton, that dilute solutions of mercuric iodide show an amount of electrolytic change (consisting in solution and corresponding deposition of mercury) approaching that taking place in a mercury voltameter in which the mercury is in the mercurous condition and included in the same circuit. The neat and satisfactory conclusion that a certain further dilution, deduced from the curve representing the results observed, would suffice for the completion of the change of valency, was not realised by experiment, that modicum of original sin present in all matter, living or dead, doubtless serving to defraud the investigator of a deserved consummation. While admitting the solid character of the data from which Dr. Bolton draws his conclusions, we confess that it appears eminently desirable to obtain collateral evidence, involving physical and chemical considerations wholly distinct from those concerned in the present experiment, before finally accepting the view that actual change of valency may occur by mere dilution. Possibly the continuation of the same research with copper in place of mercury will meet this requirement.

An interesting feature of Mr. H. T. Haws' Paper, recently read before a students' meeting of the Institution of Electrical Engineers, is the criticism of the electrical profession which the author indulges in. We reprint the Paper in another column, and our readers can therefore themselves peruse Mr. Haws' caustic remarks. The sad fate of electric mining in England, as pourtrayed by Mr. Haws, is attributed to the lack of good electrical mining engineers, who, he says, can be counted on the fingers of both hands. There is undoubtedly a good field for our superfluous young electrical geniuses in this quarter; but the requirements are many and varied, combining, as they do, a knowledge of both mining and of electrical work. "There are plenty of men possessing the one and thinking they possess the other"; but the number possessing both qualifications seems, alas! to be only as per previous digital estimate. But if the outlook for mining applications is not altogether rosy, according to Mr. Haws the future of electric supply is to his mind much brighter; indeed, Mr. Haws would not "mind saying that in eight or ten years the electric light companies in London will work at full load day and night." Eight or ten years is, perhaps, rather a long time to wait for this rich harvest, and we are sorry that the author could not see his way to somewhat shorten the vogue of the lean kine; but even as it is, he has left the supply companies time enough before the expiry of their 42 years of grace to feather their nests very warmly.

Several important points are raised by the action, reported in another column, brought by the Direct Spanish Telegraph Company against the owners of the s.s. "Caloric." The Master of the Rolls, in one of his numerous interruptions of the plaintiffs' counsel, called the plaintiffs' cable "a beastly serpent;" and certainly in his remarks showed little sympathy for the very serious loss occasioned by the action of the captain of the "Caloric," whether justifiable or otherwise. It is clear from the evidence that an amendment of the Submarine Telegraphs Act is necessary, and nothing short of a positive prohibition against anchoring within a certain distance of a cable in shallow waters will be any protection to cable companies' property; and where cables are lying in bays or harbours, or in proximity to the coast, it is advisable that a provision should be made for the marking, either by buoys or on authorised charts, of the approximate course of submarine cables. At present most inadequate protection is afforded by the Convention of 1885.

Electrical engineers will no doubt be glad to learn that "Mr. Hogan, of the Yale Psychological Laboratory," has, according to the *Daily Chronicle*, made "a discovery of considerable value." Mr. Hogan, we are assured, "finds that by an instrument, the details of which are not made public, patent rights being meditated, he can readily utilise the high voltage city current for low voltage instruments like those employed in telegraphy, telephones, electric forks, bells, induction coils, &c." This discovery, we are further told, supplies a long-felt want, and will tend to advance "the use of the latest illuminant." Possibly!

Cable Interruptions.—There are no cable interruptions to report this week.

Verband Deutscher Elektrotechniker.—The membership of this Association has increased in the last year from 765 to 1,543.

Post Office Trunk Telephone Lines.—The trunk telephone wires of the Post Office were opened for use to the public on Tuesday last.

University College, Bristol.—The 1895-6 session of this College commences on October 3rd. Further particulars appear in our advertisement columns.

Yorkshire College, Leeds.—The next session begins on October 8th; and some particulars of the Electrical Engineering course appear elsewhere in our columns.

Owen's College, Manchester.—This College gives complete instruction in the Physics Department to students preparing for the electrical profession. Special courses of lectures are delivered, the subjects including Dynamo Design.

University College of North Wales, Bangor.—Prof. A. Gray begins a systematic course of instruction in Electrical Measurement and Practical Electricity in October next. Additional particulars will be found in our advertisement columns.

The Maxim Glow Lamp Patent.—On Sunday, the 21st, the legal existence of the Maxim glow lamp patent, No. 3,189 of 1881, comes to an end. This patent related to a method of manufacturing glow lamps, involving improvements in the sealing of the wires into the globe, and in the preparation of the carbon strips and certain accessory devices. There were 17 claims.

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King's College.—It is announced that King's College, London, will shortly open a new department for the training of teachers for secondary schools. The course is spread over two years, and may be attended by students concurrently with their preparation for the B.A. degree of the University of London. Six exhibitions are offered for competition. Names of candidates are to be sent in before September 16th.

Budapest Tramway Company.—With reference to our Note in last week's *Electrician* regarding the above, we may say that Messrs. Siemens and Halske, of Berlin, have secured the contract for the electrical equipment of all the lines. In the town the conduit system, as already installed on one line, will be used, and in the suburbs the overhead system will be applied. All cars will be so arranged that they can easily change over from one system on to the other.

Telephonic Experiments with Solar Radiation. — M. Semmola shows in a recent number of the *Comptes Rendus* that on causing intermittent sunlight to fall, by means of a lens, on the gilded metallic plate, 2mm. thick, of a Hunnings microphone, the telephone put in circuit produces a slight but very distinct sound. If the luminous ray be suppressed, the sound ceases. The intensity of the sound increases or decreases according as the intermittences of the radiation becomes more or less rapid. The best radiations are the thermal radiations.

Firth College, Sheffield.—The *Athenæum* says that the town trustees of Sheffield have voted a sum of £10,000 towards the endowment of Firth College, with a view to enabling the authorities to affiliate it to Victoria University. The actual endowment of the college is £23,000, in addition to its income of £12,000 from the State and £800 from the Corporation. It is understood that a total of £50,000 would be sufficient, but no more than sufficient, for the purpose of affiliation. A further sum of £5,000 has been conditionally promised by Sir Henry Stephenson, and a public appeal is contemplated for the remaining £12,000.

An Electrical Automatic Marine Fog Signal.—A marine fog signal, the invention of Mr. F. H. Berry, of 14A, Clerkenwell-green, has been fitted to the British India Steam Navigation Company's steamship "Dunera." The object of the apparatus is to give, at the regular interval required by law in case of fog, the whistle or bell signals. On the bridge of the vessel is mounted a switch, by turning which the officer in charge can cause an electric current to actuate either the whistle or the ship's bell at regular intervals. The proper interval between the sounds is obtained by clockwork. At the same time that the whistle is blown or the bell sounded, a pen is brought into contact with a continuous band of paper, which is marked with divisions. As the paper is wound off at a uniform speed by the clockwork, an autographic record is obtained showing when the fog signals, by bell or whistle, are sounded. On Monday the apparatus was worked experimentally in the presence of certain Government officials and officers of the British India Steam Navigation Company.

The Cox Thermo-Electric Generator.—In an article in a recent issue of the *Electrical Engineer* of New York, an illustrated description is given of the Cox thermo-electric generator. The main point of this apparatus appears to be that the oxidation of the junctions is overcome by having practically no real junction point, for what in ordinary cases is a junction is in this apparatus so formed as to produce what is termed a graduated alloy; that is, two alloys composing the element are graduated one into the other so that there is no real point of junction. To prevent the oxidation of the metals by the atmosphere the complete element is cased in cement, which is afterwards vitrified. No mention is made of the nature of the alloys employed. A Cox thermo-electric generator consuming 1½ft. of gas per hour and weighing complete 3lb., and being 1¾in. high, 1in. internal diameter and 4in. external diameter, has been found to have a useful output of 5·5 amperes at 5 volts. It is stated that with a total gas expenditure of about 7 cubic feet per hour the New York office of the Commercial Cable Company operated its entire lines for several weeks with these generators, and that as a result of the trial the Company's entire system is to be equipped with them.

Science Research Scholarships.—Her Majesty's Commissioners for the Exhibition of 1851 have made the following appointments to science research scholarships for the year 1895, on the recommendation of the authorities of the respective Universities and Colleges. The scholarships are of the value of £150 a year, and are tenable for two years (subject to a satisfactory report at the end of the first year) in any University at home or abroad, or in some other institution approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country:—

Nominating Institution.	Scholar.
University of Edinburgh	John D. F. Gilchrist, M.A., B.Sc.
University of Glasgow	Walter Stewart, M.A., B.Sc.
University of St. Andrews	Henry C. Williamson, M.A., B.Sc.
University College, Dundee	James Henderson, B.Sc.
Mason College, Birmingham	Robert H. Pickard.*
University College, Bristol	Samuel R. Milner.
University College, Liverpool	John T. Farmer, B.Sc.
University College, London	Emily Aston, B.Sc.
Owens College, Manchester	William H. Moorby, B.Sc.
Durham College of Science, Newcastle-on-Tyne	Alexander L. Mellanby, A.Sc.*
University College, Nottingham	Martin E. Feilmann.
Queen's College, Belfast	William Hanna, M.A.
M'Gill University, Montreal	Robert O. King, B.Sc.
Queen's University, Kingston, Canada	Thomas L. Walker, M.A.
University of Sydney	John A. Watt, M.A., B.Sc.
University of New Zealand	Ernest Rutherford, M.A.

* Conditional appointments.

Hysteresis of Steel at Different Temperatures.—In a recent number of the *Proceedings* of the American Academy, Messrs. F. A. Laws and H. E. Warren publish the results of some experiments on the relation of hysteresis to temperature in the case of a specimen of steel. Alternating currents were used, and the losses determined by a wattmeter designed by the authors. The furnace used for heating the specimen was of fire brick and heated by three blast jets. The supplies of gas and air were regulated by slide valves. The jets were directed into the furnace tangentially and with a slight upward inclination, the effect being to establish a good circulation and keep the interior of the furnace at a uniform temperature. The specimen was composed of so-called French steel, which showed on analysis over 0·5 per cent. of manganese and 0·97 per cent. of carbon, with traces of phosphorus, silicon, and sulphur. Temperatures were determined by a Le Chatelier pyrometer. The experiments showed that for this sample of steel a moderate elevation of temperature up to about 270deg. had but a small influence on the hysteresis loss; that at this point a change takes place, and the diminution of hysteresis, with rise of temperature, is much more rapid, the decrease being such that at 675deg. the loss is but 13 per cent. of its value at ordinary temperatures. After heating above the inflection point the specimen showed on cooling a marked decrease of the hysteresis loss from its value at the same temperature on the ascending curve. If the specimen be heated again, a change of direction of the curve takes place, but at a lower temperature. Other measurements showed that there is practically no change of hysteresis for a diminution of temperature to about −80°C. The experiments are to be continued.

Colour Vision.—In the *Comptes Rendus* of July 8th, M. Georges Darzens put forward a theory of his own as to the physical perception of colour. In order to explain colour vision, Young and Helmholtz both assumed that each nerve which ran from the optic nerve to a cone was composed of three fine fibrils, respectively sensitive to red, green, and violet rays. This hypothesis, slightly modified by Clerk-Maxwell and by Fick, although it explains many facts, leaves many others quite as important without logical explanation. Thus it is somewhat difficult to conceive of an optical resonator being so accurately fashioned as to be excited by waves of say, 0·620 μ, and not at all by others slightly longer or shorter. M. Darzens' theory is as follows:—A luminous ray after having traversed the different layers of the retina usually reaches the pigmentary layer; there it is reflected and comes into interference with the incident ray. From this it follows that in front of the pigmentary layer inside the retina itself there is a system of stationary waves at a distance

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of λ/2, as in the experiments of O. Wiener and those of Lippmann on colour photography. It is these stationary waves that excite the ends of the optic nerve—the rods and cones of the eye. M. Darzens then goes on to point out that the rods consist of cylindrical parallel fibrils of equal length, whilst the fibrils of the cones are of unequal length. One can, therefore, very well imagine that whilst the former merely give a sensation of light, the latter are the source of colour vision, a theory which is borne out by the fact that the *fovea*, the recognised centre of colour vision, is entirely composed of cones, and that the eye of night birds have no cones, whilst those of birds which live on coloured insects are rich in cones. The retina must thus no longer be considered as a mere laboratory screen, but as one which perceives different colours at different depths.

Effects of the Recent Lightning Flash in Ben Nevis Observatory.—The following are some of the particulars sent to *Nature* by Mr. William S. Bruce, with regard to the effects of the recent lightning flash which struck Ben Nevis Observatory:—

Whenever a thunderstorm passes the summit of the Ben, there occurs almost invariably a discharge from metallic bodies in the Observatory as the cloud is passing away. A flash of greater or less extent is given off the stoves, accompanied by a sharp crack. In January, 1890, there was an exceptionally severe flash; "one of the observers was almost knocked down when sitting writing, and the telegraph wire was fused and all communication stopped for five days." But more destructive than any previous flash was that which occurred this year on June 19th, when the Observatory narrowly escaped being destroyed by fire. Between two and three o'clock on that afternoon, repeated clicks on the telegraph instrument were heard by one of the assistants who was sitting in the office; he had been carefully noting the times at which the clicks occurred, when suddenly the whole office was filled with a brilliant flash and deafening roar. A pillar of smoke was discharged from the telegraph instrument and from the stove-pipe, filling the room. A second slighter discharge took place immediately after, when the writer had entered the office to commence the 15 hours' observations. The discharge hurled two boxes and a small picture, that were in the vicinity of the lightning protector, across the kitchen, and blew off the button and outer casement of the electric bell in the visitors' room. The solder on the kitchen chimney outside, a copper fastening of the lightning conductor, and many portions of the telegraphic wire and apparatus were fused, and the woodwork of the Observatory was scorched in several places. The great flash occurred at 14h. 57½min., and the hourly barometric reading was taken at 15 hours. as usual. There was a very heavy fall of snow at the time, equivalent to 0·470in. of rainfall for the hour, but in the confusion the writer omitted to take the rain-gauge with him, and had to return for it. This was a fortunate incident; for it was only on leaving the office for a second time that he observed smoke and flame issuing from behind the panelling between the kitchen and the office. Assistance was secured, and the fire—which was in a very awkward and dangerous place—was overcome in good time, and the damage done was very slight. The damage done to the telegraphic apparatus, however, was serious. The lightning protector was badly fused, the plates showing a patch of fusion as large as a sixpence. All connecting wires within the building were rendered useless. The majority were so heated as to melt the insulation off, and in one or two cases the copper conductors were melted by the discharge. In one case the fusion set fire to the woodwork. The coils of Neale's sounder were fused and rendered useless. The keys suffered worst of all. The vacuum protector at Aslimtee, the base of the cable, also the plate protector in Fort William Post Office, were fused, but only slightly, the main discharge having expended itself on the summit. The Low Level Observatory Instrument and protector were unimpaired, and communication between there and Fort William Post Office was carried on as usual after the removal of the fault in the Post Office protector. The registering aneroid shows a slight upward kick at the time, but the curve is otherwise fairly steady; the temperature was 31·7 F., the wind south-south-east and light. Heavy snow was falling at the time, which, with a fall on the 17th, made a total depth of nine inches on the summit. St. Elmo's Fire was very strongly felt and heard until after 17 hours.

The Niagara Falls Scheme.—From the confused accounts which reach us from time to time through both the daily and technical Press, it is somewhat difficult to disentangle what has actually been done from what it is proposed to do at Niagara. To this end we take the following facts from a lengthy and well illustrated account of "The Work that has been done at Niagara," which appeared in the *Electrical Engineer* of New York of June 26th. This account is unusually sober; but its writer is nevertheless constrained to commence as follows: "No one contemplating the scene of the falling waters at Niagara can fail to be inspired with the sense of power there concentrated, and even the savage, ignorant of applications of motive power, as he gazed upon the scene before the white man set foot within it, must have been imbued with a sense of the great force and constant action before him. Civilised man, however, &c., &c." The plan finally adopted by the Niagara Falls Power Company embraced, we are then told, the construction of a canal about 1½ miles above the American Fall, tapping the Niagara river. Wheel pits sunk along the edge of this canal lead the water to turbines at the bottom, the discharge being carried off through a 1¼ mile long tunnel, 19ft. by 21ft. high. Round about the Falls the Niagara Company has purchased land to the extent of 7,500 acres, which it is proposed to let out for the building of factories and residences. The power belonging to the Company may either be obtained by factory owners sinking their own wheel pits or by taking it from the turbines of the Company, or by having it electrically transmitted to them. The electric power station at present erected is designed for an ultimate capacity of 50,000 H.P., but at present only three 5,000 H.P. two-phase generators have been erected. The electrical equipment, as our readers no doubt recollect, was carried out by the Westinghouse Company, Prof. George Forbes acting as consulting electrical engineer. The generators have stationary armatures and rotating field-magnets, and develop at a speed of 250 revolutions a two-phase 25 ∾ current at a pressure of 2,250 volts. The armature core is made of thin oxidised iron plates, held together by eight nickel-steel bolts. In the outer edge of the plates are 187 rectangular holes, in each of which are placed two rectangular copper bars $1\frac{1}{4}$in. by $1\frac{5}{16}$in., surrounded with mica. The outer rotating bell-shaped field-magnet consists of a wrought-steel ring, to which are bolted 12 inwardly projecting massive cast-iron pole-pieces. The magnet winding is also composed of copper bars, air insulated. The turbines were designed by MM. Faesch et Piccard of Geneva, and special methods were adopted to relieve the bearings of the pressure of the superincumbent mass. The weight of the 50ft. long steel shaft, and attached portions of the dynamo, amounts to 68 tons; this shaft consists of a shell about a foot in diameter with solid portions at the journals. Large conduits have been provided on the Niagara Falls Estate for the purpose of taking current-carrying conductors to the *in futuro* factories. The internal dimensions of these conduits are 5ft. 6in. high by 3ft. 10in. wide, the conductors being carried on insulated brackets on the walls. A track extends throughout the length of the conduit, upon which an electrically propelled car will carry the linemen between the wire screens protecting them from the conductors. Judging from our contemporary's statement that "rights of way for a pole line to Tonawanda, directly north of Buffalo, have already been secured," it would appear that the underground conduit to Buffalo, which was the object of so much criticism at the hands of those who discussed Prof. Forbes' Institution of Electrical Engineers Paper, has been, at any rate temporarily, abandoned. At present there would appear to be one actual user of power, and two prospective ones. The actual user is the Pittsburgh Reduction Company, taking 2,000 H.P. electrically. As the reduction of aluminium necessitates the use of a continuous current, the following arrangement is employed. The 2,000 volt alternate current is taken to stationary transformers, and there converted into an alternating current of 115 volts pressure. This low-pressure alternating current is then led to rotary transformers and converted into a continuous current at 160 volts pressure. The plant of the Reduction Company will have a working capacity of 7,000 amperes. The prospective users of power are the Niagara Falls Paper Company, who have contracted for 6,000 H.P. developed from their own turbines at a cost of $9 per H.P per annum, and the Carborundum Company, who have erected works close beside those of the Pittsburgh Reduction Company, and will start with 1,000 H.P. All this relates to the work done on the American side of the Falls, but our contemporary states that plans are already complete for the utilisation of the Falls on the Canadian side. This work will be carried out by a company closely affiliated with the American Company, and the plans proposed by it have been accepted by the Canadian Government. These plans contemplate the ultimate erection of two power houses of 125,000 H.P. capacity each. Each power-house will be fed by a separate canal, and the water discharged by the turbines will be carried to the outlet through short tunnels of 200ft. and 800ft. in length respectively.

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THE VALENCY OF MERCURY AND COPPER IN CERTAIN ELECTROLYTES.

The first part of a Paper, dealing with the valency of mercury in dilute solutions of the iodide, and incidentally describing a well-devised mercury voltameter, has lately been published by Dr. Werner Bolton in the *Zeitschrift für Electrochemie.* Such portions as appear of more than usual interest are here presented.

The point which the author desired to investigate was whether an undoubtedly *mercuric* salt, such as the red iodide HgI_2, was capable, when examined as an electrolyte in dilute solution, of behaving as a *mercurous* salt—that is, of becoming monovalent instead of divalent. The better to deal with this problem, a mercury voltameter was designed in order that comparison between the amount of metal deposited in the voltameter and that in the experimental cell might be made directly without the need for a connecting factor. The high electro-

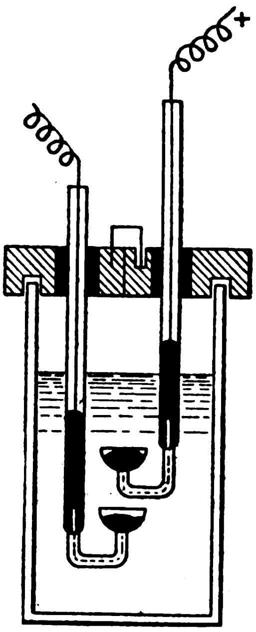

FIG. 1.

chemical equivalent (199·8) of mercurous mercury is an incidental advantage and a substantial additional reason for the employment of this particular metal.

In Fig. 1 is shown the form of voltameter adopted by the author. An ordinary beaker holding about 200 cubic cm. is provided with a well-fitting wooden cover, split for convenience of removal, and held together, when in position, by wire fastenings. The electrodes consist of mercury contained in cups blown at the end of the vertical glass tubes shown immersed in the liquid. Connection is made by means of a platinum wire, sealed into the horizontal portion of the electrode, with a column of mercury in the longer limb of the glass tube and thence to the source of current. The mercury in the cups is wholly distinct from that in the vertical column, and can be removed and weighed. The upper electrode is made the anode, so that risk of fouling the surface of the mercury by crystallisation of the strong solution of its salt flowing away from the anode is avoided. The electrolyte is a decinormal solution of mercurous nitrate, in which the whole of the mercury is monovalent. It is prepared by digesting a weighed quantity of the commercial salt with pure mercury and dilute nitric acid in a warm place for several days. No separation of basic salt need be feared when the preparation has been thus conducted. When the mercury in either cup is to be weighed it is dried by means of blotting paper as far as possible, and poured into a gutter of filter paper supported in a sloping glass tube with a draw-out end delivering into a weighing bottle, as shown in Fig. 2. Any globules of mercury sticking in the paper gutter are driven downwards to the bottle by judicious tapping.

With this instrument the loss of weight of the anode and gain of the cathode are equal in amount, and two such voltameters on the same circuit give substantially identical results, the maximum error being within that which may be properly termed experimental in a case of this kind, viz., 0·1 per cent. A table of observed values is given bearing out these statements. With a voltage of 3·74 volts, a slight evolution of gas from both electrodes was at first perceptible, but this soon disappeared and caused no alteration in the constant equality of increase and decrease of the weight of the cathode and anode. The range of the instrument is considerable, a small current operating for hours being valued as readily as a comparatively large current for a few minutes. No special precaution is requisite in removing the electrodes for weighing; on stopping the current the electrodes can be taken out at leisure, as they suffer no change in weight by mere immersion in the electrolyte. The mercury is carefully purified, so that about 1 cubic cm. of the metal can be evaporated in a porcelain dish without leaving a trace of fixed matter.

That portion of the research comprised in the present abstract is confined to the examination of the result of electrolysing aqueous solutions of mercuric iodide in potassium iodide. The solution of potassium iodide was in all cases of normal strength (166 grammes per litre). The quantities of mercuric iodide used were chosen so that the strongest solution corresponded with the formation of the salt K_2HgI_4 with the whole of the potassium iodide present. The remaining solutions were such that $\frac{1}{3}$rd, $\frac{1}{6}$th, $\frac{1}{12}$th, &c., up to $\frac{1}{384}$th of the potassium iodide could be considered as present in the form of the salt K_2HgI_4.

The figures obtained by performing an electrolysis with the mercury voltameter already described, and a similar cell containing as electrolyte one of the solutions defined above, in series, are given in the following table. In all cases the mean value from the + and − values of the two electrodes is taken.

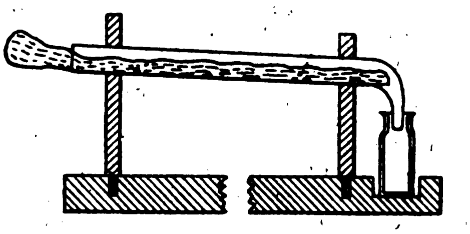

FIG. 2.

The figure thus obtained for the voltameter, in which the mercury is constantly monovalent, when compared with that given by the experimental cell, allows the valency of the mercury in the electrolyte of the latter to be at once deduced:—

Ratio of molecules of K I as K_2HgI_4 to total K I.	Weight of deposit.		Ratio of valencies.
	Voltameter.	Experimental cell.	
$\frac{1}{1}$	0·1425	0·0714	1 : 1·996
$\frac{1}{3}$	0·0812	0·0041*	1 : 1·980
$\frac{1}{6}$	0·2881	0·1435	1 : 2·007
$\frac{1}{12}$	0·1658	0·0824	1 : 2·012
$\frac{1}{24}$	0·3576	0·1788	1 : 2·000
$\frac{1}{48}$	0·4636	0·2411	1 : 1·923
$\frac{1}{96}$	0·1223	0·0685	1 : 1·786
$\frac{1}{192}$	0·1524	0·1026	1 : 1·486
$\frac{1}{384}$	0·2504	0·2172	1 : 1·153

From these figures it is evident that up to a dilution corresponding with a content of $\frac{1}{24}$th molecule of KI as K_2HgI_4 for each molecule of KI, only divalent ions are present; with a solution of half this concentration—viz., $\frac{1}{48}$th molecule—the ratio of the deposited metal in the two cells indicates that a portion of the mercury in the dilute electrolyte is present as monovalent ions, precisely as if mercurous iodide in place of the mercuric salt had been used. This change thus indicated becomes increasingly marked as the dilution is made greater. On plotting a curve from these results it is apparent that the solution may be expected to behave as if the whole of the mercury were in the mercurous state (*i.e.*, were monovalent)

* *Sic.* Probably should be 0·0410.

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when a dilution corresponding with the presence of $\frac{1}{511}$th molecule of KI as K_2HgI_4 for each molecule of KI has been reached. This extrapolation is not justified by experiment, for when this dilution is approached, electrolysis ceases to go smoothly, and identity of the + and − values for cathode and anode no longer obtains. The result nearest to the theoretical limit was observed with a dilution of $\frac{1}{427}$th, when the ratio of valencies became 1:1·141. At great dilutions the scarcity of mercury ions causes the appearance of hydrogen instead of mercury at the cathode, while solution of mercury at the anode continues until the concentration of the electrolyte with respect to mercury is increased, and the balance between the deposition and solution is restored.

The author has also examined the polarisation and its distribution at anode and cathode of a cell containing HgI_2 in increasingly dilute solution, as in the previous series of experiments. He finds that the anode and cathode values are substantially identical, and that the total polarisation does not increase with the voltage employed up to a dilution of $\frac{1}{6}$th. At a dilution of $\frac{1}{12}$th, and beyond, the cathode value increases and that of the anode decreases, the difference becoming greater with an increase of voltage. This accords with a dictum due to Ostwald, who states that the polarisation of a metal in a solution of a salt of that metal increases as the concentration of the ions decreases, and that this holds in the presence of the ions of other metals, for each metal acts in all cases solely towards its own ions. The influence of concentration of ions upon polarisation may be conveniently stated thus: In the case of an electrolyte, in which is only a very small quantity of a salt of the metal composing the electrodes, it is evident that but few ions are in a state of migration. Suppose there be n ions at the anode, and the same number at the anode, and that of these r ions give up their charge at the cathode, and that a like number are contributed by the anode to the electrolyte. Then we have at the cathode $n-r$ ions and at the anode $n+r$ ions. Seeing that n is small in this particular case, and that r is constant for all concentrations, the latter in a highly dilute solution will be but little smaller than n, so that the fraction $\frac{n+r}{n-r}$ is comparatively large, *i.e.*, the number of the available ions at the anode will be considerably greater than that of those at the cathode, and their polarisation values will be correspondingly different. When r is small relatively to n the values of anode and cathode become approximately equal. This, as stated above, was observed to hold good up to a dilution corresponding with the presence of one-sixth of the total molecules of KI in the form of K_2HgI_4.

REVIEWS.

Electrical Influence Machines. By JOHN GRAY, B.Sc. (Whittaker and Co.)

Mr. Gray's work on influence machines is an honest attempt to bring this subject into line with modern ideas. He starts off with elementary notions about the electric field and the properties of dielectrics, and adopting the Maxwell-Lodge device of representing the action of displacement in the dielectric by elastic displacements in "cells," proceeds to discuss on this basis electrostatic forces, and the tendency of points to discharge. Then follows a useful but somewhat irrelevant chapter on electrometers (chiefly the quadrant), ending with a description and picture of one of Lord Kelvin's graded potential galvanometers. The latter is apparently recommended as suitable to measure the currents given by influence machines. We then enter upon the main part of Mr. Gray's book. Beginning with the electrophorus, we are led on by the historical path of development, from Bennet's doubler and Nicholson's revolving doubler to the more perfect machines of Belli, dating from 1831, which were unearthed by Prof. Silvanus Thompson in 1888. We then come to the modern epoch of Varley, Kelvin, Toepler and Holtz, the machines of the last-named being described in considerable detail, extending over 40 pages. The Holtz machine "of the second kind," which is described on pp. 141 to 143, is of interest as being a crude forerunner of the modern Wimshurst type, with oppositely-rotating plates. The suggestion, on p. 147, to prevent "reversals" in this machine by using a diagonal conductor curiously resembles one made lately by Schaffers in the *Annales de Chimie.* Mr. Gray then describes the Wimshurst machine, giving some account of its early history. The date of its first appearance is given as 1883. There seems to be some error here, as it was certainly publicly described and shown in the spring of 1882. Various subsequent forms are described, including the great 7ft. machine at South Kensington. At this point Mr. Gray returns to Lord Kelvin's water-dropping collector, and to the replenisher, winding up this part with an abstract of Maxwell's theory of a "regenerator" for the machine. The third and last part of the book is all too short. It describes in detail, with dimensioned sketches, the construction of Wimshurst's machines in a manner entirely admirable, even dealing with such matters as the proper mode of cutting glass discs. Incidentally, we are recommended as the best cement that used for bicycle tyres. The general notes on construction and use of Wimshurst machines, on p. 222, are excellent. Mr. Gray has not hesitated to borrow from those who have written before him on this topic; but he does so with honourable acknowledgment of his indebtedness.

The Wimshurst Electrical Influence Machine: its Construction, Theory of Working, and Experiments that can be performed with its aid. By WILLIAM PHILLIPS MENDHAM. (King, Mendham and Co., Bristol.)

Mr. Mendham's handy and unpretending manual goes straight to a general description of the ordinary forms of Wimshurst's machines, with two and with multiple plates. A short section on pages 19-23 is devoted to a simple non-mathematical exposition of the theory of the machine. Then comes a section on Leyden jar experiments, followed by a chapter in six pages on electrometers, in which the utterly antiquated balance of Coulomb overshadows all the modern electrometers. The best part of the pamphlet is the last chapter, entitled "Experiments with the Wimshurst Machine"; for, though many are familiar by age, they are redeemed by such modern additions as Lodge's notable experiment on the deposition of dust and smoke.

OBSERVATIONS ON THE HOLTZ THEORY OF INFLUENCE MACHINES WITH OPPOSITELY ROTATING DISCS.

BY JAMES WIMSHURST.

All physicists must be interested in the Paper recently published by Prof. Holtz, which contains his views of a theory for influence machines which have oppositely rotating plates. He has done good work in the cause, and his view commands respect, but his strictures directed towards others who also have done good work are less liberal than might have been expected.

It must, I think, be freely admitted that no one at present knows definitely the character of electricity, nor do we yet know the whole of its behaviour. Moreover, we daily see experiments which may be used either to support or to condemn a theory; nevertheless, it is always desirable to work upon some hypothesis. For my own part I frankly confess I have not been able to accept any theory which has been advanced as conclusive or true.

Prof. Holtz, in common with many others, appears to treat of the subject from the view of an existence of two electricities. No one can say he is wrong; but this view tends rather to complicate than to explain matters. It is very much more simple, and I think nearer the truth, to approach the subject from the standpoint of there being but one electricity existing, and afterwards to deal with an excess on the one hand and a deficiency on the other hand, which are commonly referred to by the terms positive and negative, supplementing this by

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the further view that all dielectrics behave as though they carry a normal charge upon them, distributed uniformly over their surfaces, forming, so to speak, an elastic film, the one side of which acts in harmony with the other side. As an example of this, let us suppose the usual vertical plate of glass upon the table, and that we are about to show the effects of induction; let us suppose that the plate is coated on both sides with an electrical film; let a positive charge be brought near to the one side; the film on that side is then pressed in by the positive charge, and the film on the far side is pressed out. If the positive charge be withdrawn, the vertical plate again becomes normal. Then let us again present the exciting positive charge, and at the same time touch the plate on the far side, so as to allow of the induced positive charge escaping; upon the removal of the exciting charge it will be found that both sides of the plate are negatively charged. To produce equilibrium, the positive charge which was allowed to escape from the far side of the plate must be replaced; in other words, a positive or excess charge induces another positive or excess charge, and it is only by a supplemental act—that is, the permitting of this induced positive charge to escape—that a deficiency or negative charge is obtained.

Applying this hypothesis to the transference of the charges common to all influence machines, commencing with Wilkie in 1762, Volta in 1775, Bennet in 1786, Cavallo in 1787, and the first influence machine having revolving carriers, that by Nicholson in 1788, up to the Carré, the Varley, the Holtz, and the Voss of recent years, I could not resist the conclusion, after observing the behaviour of these machines, that the fixed inductor plates were conducive of a considerable amount of waste, and that better results would be obtained by making both plates active, and that this might be done by rotating the plates or surfaces in opposite directions. With this thought I constructed a machine having an endless band of gutta-percha, extended by two rollers, using other intermediate rollers to hold the surfaces near to one another; these intermediate rollers answered also as brushes or contacts. The instrument worked, and gave fair results. Following this, I designed the type in which there are two oppositely rotating plates, and so little doubt had I of its behaviour that I spun the glasses round with my fingers as soon as they were mounted and the brushes in place; the excitement was immediate. My next endeavour was to so construct a machine, suitable for lecture purposes—that is to say, one which would work in almost any condition of atmosphere—that it should furnish a constant flow or current for outside use, and that the direction of this flow should not change, all previous machines being subjects of that objectionable defect. Metal sectors were used only to act as reservoirs, and to deliver by metallic contact the small charges gathered from a large area. The combs and the terminals were added in order to preserve a circuit for use outside the machine, and certainly not for the purpose of adding to the excitement, but when properly placed they are objectionable only in a very slight degree, for if they were not present the high charges would escape either into the air or would travel over the surface of the plates to the nearest brushes.

It was some time after I had done all this that I showed a machine so completed to a scientific and literary friend. He was charmed with it, and, like other literary men, began to search and find what others had done. This led him a few days later to bring me a picture of the second form of Holtz machine, which consists of two plates rotating oppositely in a horizontal plane, the axis being vertical. Each plate had two combs to the upper plate and two combs to the lower plate, situated at right angles to each other. The machine was not self-exciting, and of course when the circuit between the combs was broken to any distance the excitement practically ceased.

This was the nearest type of instrument which could be found, and I endeavoured to find some Continental maker from whom I could obtain one; but up to the present day I have been unable either to find such a machine or to hear of any person who had seen one of them. Prof. Holtz may therefore accept my word of honour that I did not know a single feature of his second machine until after mine had been at work for some time, and he may well believe that the details which he condemns were not added in the mistaken idea that they contributed to an increase of the charges—they are simply additions, made in the least objectionable manner, in order to produce a useful and reliable instrument.

In respect to the electrical changes which take place in these machines when fully excited, I would refer to the diagram, in which the plates or discs are represented as cylinders, and that the changes may be more apparent, I assume the machine to be fully excited. The relative values of the charges at the several parts are indicated by numbers, which are intended to indicate only a rising or a falling of the charge, and have no quantitative value. The plates rotate in the direction shown by the arrows, and the brushes are shown by A B C D. The front plate passes away from the brush A, moving to the right with a small − charge, followed by neutrality, then a small + charge; but as soon as it reaches a point opposite the brush C the charge increases rapidly, almost to its maximum. This is owing to the considerable transference of electricity from the inner surface of the back plate to the inner surface of the front plate. The maximum charge is reached at about the horizontal line; this condition holds good for a short distance further, when it begins to diminish owing to leakage towards the brush B. At this brush the charge almost vanishes, but a small portion of the charge remains after contact with the brush, then

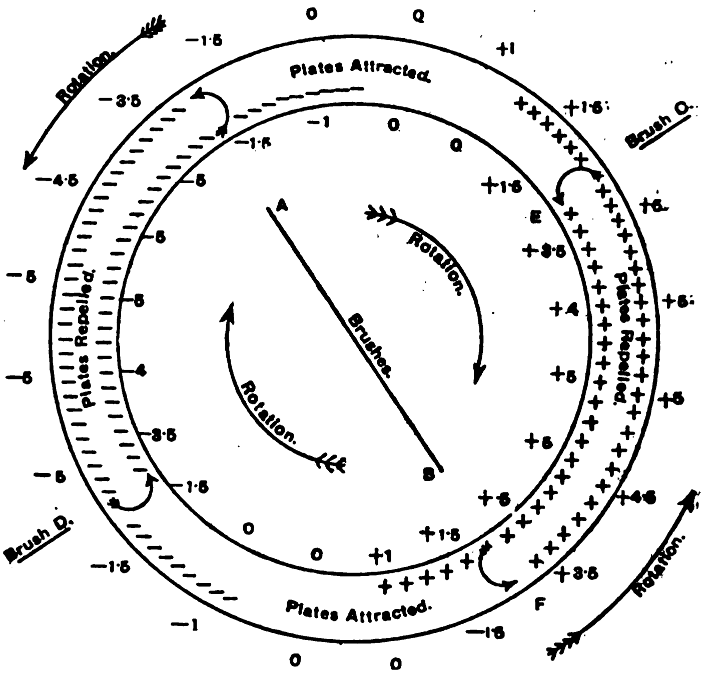

Diagram illustrating the Distribution of Charge in a Wimshurst Machine.

comes neutrality, the second half of the plate follows in the same order. The charges on the back plate follow in a similar manner to those on the front plate, but the rotation of which, it must be remembered, is in the opposite direction.

We may now consider the changes which take place between the plates, and it is here the real work is done. Let us commence at the point marked E, bearing in mind the hypothetical elastic electrical film. This film on the outer surface of the back plate is pressed in by the brush C (or the excess of electricity is removed by this brush), the effect of which is to release a considerable charge from the inner surface of the back plate, and this released charge is transferred to the inner surface of the front plate, as shown by the curved arrows. It is this continuous transfer of electricity to the inner surfaces of the plates opposite to the brushes, and its carriage back to the horizontal diameter by the plates, that increases or adds to the excitation, for it must be remembered that these carried charges on the right of the diagram are all +, and all on the left side are −. They being of the same sign, they naturally repel each other; the energy put into the machine, however, thrusts them together and produces the large charges of free electricity of a like sign upon the outer surfaces of the plates.

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Let us now see what takes place at the top and the bottom portions of the plates. Commencing at the brush B, a part of the + charge escapes the brush, and is carried to the left. A like + charge is also carried on upon the inner surface of the plate, while at the brush D a − charge escapes and is carried by the back plate to the right; the inner surface of this plate also has its charge of −. These charges on both surfaces of both plates are − on the left hand and + on the right hand; the motion of the plates brings these charges of opposite sign together, and at about the vertical line neutrality of all four surfaces is produced. These actions are rendered very apparent by using flexible discs which forcibly repel one another in the horizontal line and as strongly attract one another in the vertical position. I exhibited this action at the Royal Institution in 1888.

All these changes have been many times tested by me on machines varying in diameter from 2in. to 7ft. The most useful size, perhaps, is a machine having plates of 3ft. 6in. diameter, and made so that the plates may be set any distance apart within certain limits. When set at 3in. apart and with suitable analysers, all these changes may be beautifully seen in a darkened room. Another feature is that when such plates are separated one-twelfth of their diameter they are capable of just producing visible excitement, but not sufficiently to give a spark. When, however, a fairly large initial charge is given to the combs on one side of the machine, the excitement increases, and the machine will give one spark of the maximum length, and the excitement again falls to be only just appreciable.

With regard to the sectors, they are necessary evils, and the less of them the better. I have obtained very good results from 16 strips of tinfoil $\frac{1}{16}$in. broad upon each plate, but the more metal the more reliable is the machine in damp atmospheric conditions.

I am afraid that I am trespassing too far upon your space, so I will end my remarks by suggesting that no person benefits from undervaluing the work done by others. It must be remembered that influence machines are now more than a century old, yet we appear to know little about them which can be accepted as reliable. Every worker therefore should be encouraged. I have given years of time and hundreds of pounds in perfecting and introducing a sound, useful type with no other reward than to see it adopted and valued; and while I cannot disagree with Prof. Holtz in the statement that there is nothing wonderful or special in a self-exciting influence machine, still, if that truism were the only compliment or reward a worker had to look forward to I rather fear that anything like painstaking trials and improvements would speedily be ended.

THEORY OF THE INFLUENCE MACHINE WITH OPPOSITELY ROTATING DISCS.*

BY W. HOLTZ.

I have up to the present not felt called upon to give a complete account of the theory of the influence machine with oppositely rotating discs, since for a long time only a few physicists were in possession of such a machine, and it would only be of interest to them. In the last few years the case has been altered; the machine is coming more into use, especially abroad, where latterly several modifications have been introduced. But it is just the character of these modifications which shows me that the theory is as yet little understood, since quite secondary details are apparently considered as essential, and their introduction is supposed to amount to new discoveries. I should therefore like to set forth this theory pretty completely, and to point out the various forms which may be given to the machine.

The Fundamental Principle of Excitation.

Let two endless strips of an insulating substance continuously pass, the one to the right, the other to left (Fig. 1). Let a comb be placed in front on the left and at the back on the right, the points being directed towards the strips. Let the combs be connected with each other, so that the connection may be easily broken somewhere. Let a negatively electrified body be placed momentarily opposite the comb a behind the strip. The influence effect of the electrified body causes the two combined electricities of the face of the front strip to be separated. The similar negative electricity flows into the comb, while the positive proceeds with the strip. Through the influence of the latter change the electricities of the back strip are separated, the similar positive electricity flowing into the comb, and the negative passing on with the strip. Since, therefore, negative electricity arrives opposite the comb a, it looks as if the electrified body was no longer necessary for the continuance of the process. But this is only conditionally true. Each strip charges the other, but not necessarily to a greater density, and eventually to a less density than it was charged itself. If each new charge is less dense, the electromotive activity must soon be lost after the exciter is removed. The induced charge will only support itself when it is denser, and then it will not only support but increase itself, and that will continue until the losses, which increase with an increasing density of charge, do not permit a further intensification.

On introducing a gap into the connection of the combs, the displacement of electricity, and hence also the charging of the strips, is impeded. If the electromotive activity was kept up before, it may now be lost after introducing the gap. In any case this will happen on continually increasing the gap, as soon as the electricity can no longer pass across it.

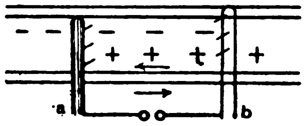

FIG. 1.

The Various Forms of the Machine.

Two discs may be regarded as two endless strips, and the principle enumerated may be applied to them in various ways, so that the same machine, constructed on the same fundamental principle, may have different forms. Fig. 2 shows the simplest construction, with two combs, a and b, which only serve for the charging of the discs, and a double comb, c, which only discharges the discs and makes them return unelectrified. Let the exciter always be negative, and placed opposite the comb a. Then the + and − signs indicate the actual electrical condition of the discs. That the signs for the front disc lie on a larger circle, and those for the back disc on a smaller one, must not be interpreted as meaning that each disc is only electrified in such a circle. This first form of the machine is very feeble as regards quantity, since it is evidently only the charge current which flows through the electrodes; and

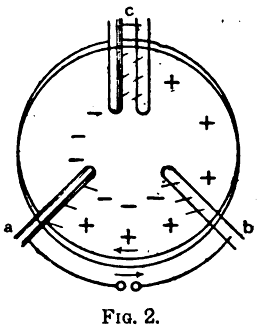

FIG. 2.

it is also feeble as regards intensity, since the electrodes cannot be much separated without stopping the action of the machine. This form was also given in my first work.*

Fig. 3 is produced by substituting two double combs for the one, and introducing the spark gap between these, while the two charging combs remain constantly connected. This form acts quantitatively like the first, since the discharge current is always quantitatively equal to the charge current; but it gives much longer sparks, since the electrodes may be separated to any extent without stopping the actions. If instead of the two double combs there is one, the effect is essentially the same, but it is unsymmetrical, since the density at one of the poles is always greater than at the other. In this form, and with one of the poles to earth, I mentioned this type in my first Paper (p. 135), and in an addendum on p. 169 I pointed out the advantage of having a second double comb. A drawing like Fig. 3 was produced in a later Paper of mine.

Fig. 4 shows the machine provided with four simple combs, arranged so that they are alternately on different sides of the discs, in which case it is indifferent whether the electrodes lie between c and d or between a and b. This form is practically simpler, but theoretically more complicated, since each comb has here to effect

* *Wied. Ann.*, No. 1, 1895.

* *Pogg. Ann.*, 130, p. 134, 1867.

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a discharge and also a new charge. Thus the comb *a* takes its negative electricity from the front disc, but receives more negative electricity from the same disc through the influence of the back disc; the front disc becomes positively electrified, so that the comb discharges the disc and gives it a new charge. The same thing happens with the other combs. Hence a double current, so to speak, now flows through the connecting wires, the charge current and the discharge current, and this form will therefore act twice as strongly as the first two. The intensity is also slightly higher than in the first case. For if with an increasing spark gap between *c* and *d* the charge current ceases, the machine continues to work according to the plan sketched in Fig. 3, though with lessened quantity. But if the discharge current also momentarily ceases, its activity is at once impaired, since the wrong electricities now approach the combs *a* and *b*.

If the connection *a b* is omitted, but *a* is joined to *c* and *b* to *d*, we obtain Fig. 5. For it is evidently indifferent whether the electrodes remain between *c* and *d* or are introduced between *a* and *b*, as in Fig. 5. The electric condition of the discs is exactly the same as in Fig. 4, where the combs *a* and *c* become similarly electrified, and also the combs *b* and *d*. Into the first, negative

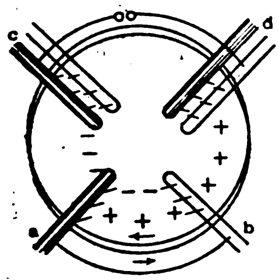

Fig. 3.

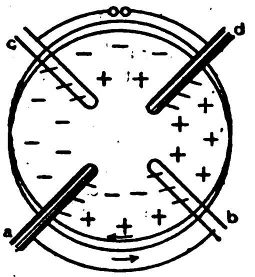

Fig. 4.

electricity is conducted from two sources; into the latter, positive electricity in the same manner. With this connection, then, the machine must act quantitatively twice as strongly as the former, and four times as strongly as the first form. But as regards intensity, it must act like the first form, since with the cessation of the charge current its activity must cease. This form I particularly emphasised in my first work, but I added that its external effect sometimes ceased unless a double comb were substituted for the single one, for the reason appended on p. 169, viz., because otherwise the discs sometimes divide up into two oppositely electrified zones. I shall not develop this any further here, but will only add that the Fig. 4 type, probably owing to the same cause, sometimes loses its external effect.

Fig. 6 is developed from Fig. 4 by connecting the combs *a* and *d* and also the combs *b* and *c*, and having them made up of one piece. Such double combs of straight or curved rods, placed across

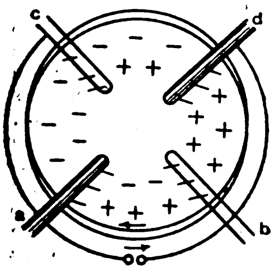

Fig 5.

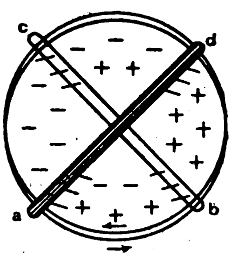

Fig. 6.

the centre of the disc, have been called diametral conductors. Each comb acts as in Fig. 4, *i.e.*, it serves simultaneously for the charging and discharging of the discs, except that the double currents, which formerly flowed through the bent wires, must here run through the diametral conductors. The form as it is does not, of course, give any external effects, however active it may be internally, since the circuit remains closed. I only enumerate it as a transition form to the next, which thereby becomes more intelligible.

Fig. 7 is at once obtained from Fig. 6 by adding the combs *e* and *f* connected with the electrodes. The action of these combs may be understood from the following considerations. Fig. 6 shows that between *a* and *c* both discs are negatively and between *b* and *d* positively electrified, and also shows that the withdrawal of these electricities cannot destroy the activity of the machine. For the comb *a* will charge the other disc positively as before, since the back disc when approaching is still negative, and the comb *b* will charge the back disc negatively as before, since the front disc when approaching is still positively electrified. The same applies to the combs *b*, *c*, and *d*.

Another question is whether the new combs, which only approach the front of the disc, can also discharge the back of it. As far as external effect goes, they do this, at least in the main, since they take up more electricity than the front is charged with, just as a rubbed ebonite plate loses its charge by a one-sided comb. Regarded in this way, Fig. 7 also represents the electric condition at the part of the plates in question. In reality the case is slightly different. The front disc loses by the influence effect of the other more than its own charge, so that when it leaves the comb it is not unelectrified, but oppositely charged. If, however, the external effect were as if both discs were discharged, a double comb, as was once recommended by Musæus, would be unable to increase it. A different case would be presented by two connected combs displaced relatively in the direction of rotation, as Musæus also recommended, and has recently been again proposed by Schaffers.*

Let us next consider the form shown in the figure, which I published as early as 1869.† It is evident that as regards quantity it must yield about the same as Fig. 4. But, as for intensity, it

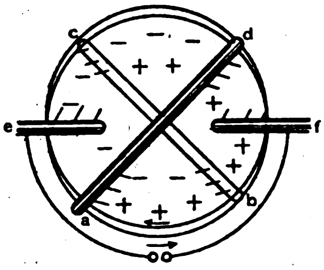

Fig. 7.

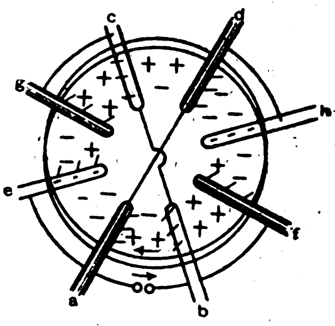

Fig. 8.

must yield more; as much, in fact, as Fig. 3, since in both cases the activity of the machine is quite independent of the position of the electrodes. But if, according to Musæus' plan, the combs *e* and *f* are replaced by two pairs of combs, as in Fig. 5, the machine may indeed yield the same in quantity as Fig. 5, but must lose considerably in intensity.

Fig. 8 shows a form with two combs, each of which acts simultaneously for charging and discharging, the combs being connected so that the total quantity of electricity generated flows through the electrodes. For into the combs *a*, *e*, *d* and *h* negative electricity flows from two sources, and into the combs *b*, *f*, *g*, and *c* positive electricity from two sources. Connection is established by two diametral wires, one of which has a bend in the middle. This form must give eight times the quantity of Fig. 2, or four times that of Fig. 4 or Fig. 7. But as regards intensity, it yields less than Fig. 2, and its activity ceases with the cessation of the discharge

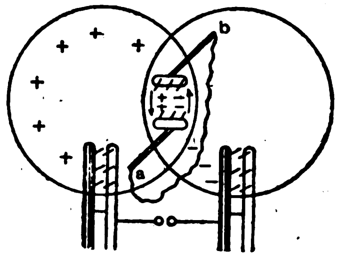

Fig. 9.

current. It has the further drawback that sometimes the torrent of sparks suddenly ceases, owing to the above-mentioned formation of zones. This form was also described in *Uppenborn's Centralblatt*, p. 684, 1883.

Finally, Fig. 9 shows an arrangement in which the discs only half cover each other. Opposite the superposed portions are two combs, which only serve for the charging of the discs; whilst in the places where they do not overlap, a double comb is placed for the discharge of each disc. The electrodes are placed between these combs. It might be thought that the discs would be sufficiently discharged by one simple comb each. This would be the case if their external surfaces only were electrified. But the inner faces are also electrified, since the round edge of the one acts, so to speak, as a comb towards the other. Hence its effect is considerably less than that of Fig. 3, although theoretically the similarity is very great. I cursorily mentioned such a machine in my first Paper (p. 137).

* *Compt. Rend.*, September 24, 1894.

† *Pogg. Ann.*, 136, p. 171.

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The Fundamental Principle of the Process of Intensification.

I said that the electromotive activity was maintained only if each new charge was stronger than the last. But it may further be asked, Under what conditions is this assumption true? I have already developed at length the chief condition or fundamental principle of the intensifying process in my first Paper, not only for uncovered discs, but also for such as are provided with narrow strips of tinfoil at right angles to the direction of motion. If opposite the charged plate of a condenser we put a plate of equal size and touch it with the finger, the density of the charge thus produced will doubtless be smaller than that of the first. But if we place a small sphere in the neighbourhood of the first plate and put it to earth in the same way, the density of its charge will very probably be greater than the density of the first. In general, when a charged surface influences another of equal size, and so that it must be charged all at once, the density of the new charge will invariably be smaller than the density of the first. But when it influences another and a smaller one, or when it is so arranged that the second surface can only be charged gradually in separate parts, the density of the new charge will generally be greater than that of the first charge. In our influence machine we have the latter case. Here the influence proceeds from larger surfaces upon surfaces which can only gradually assume a charge, *i.e.*, only in the radius which momentarily passes the points of the comb. But in most forms of the machine there is another intensifying influence at work.

It will be seen from Fig. 10 that the front strip is negatively electrified when opposite the comb *a*. In the absence of this negative charge, the new charge would, by the previous reasoning, probably be already denser than the charge of the back strip. But that negative charge also favours this result by drawing, from a distance, positive electricity on to the surface of the strip, and more than is necessary for the instantaneous neutralisation of the portion under the comb. That is also the reason why the plate of a frictional machine is not unchanged when leaving the earthed comb, but is negatively electrified, as anybody may prove by trial. I formerly called this effect "side attraction." Riess afterwards called it "influence of an electrified surface upon itself."

But when, in spite of all, the desired effect is not always obtained, this is due to other opposing factors. Thus, the discs may not always be sufficiently insulating in a circular direction for this is what we are dealing with), and this may be due to the material of the plates, or to the fact that the humidity of the air makes them conducting. Further, the plates are often not as close together as they might be, or the combs are not close enough to them; or the combs have too few points, or the latter are not fine enough. The last case impedes the transference of electricity and thus contributes to the diminution of the charge. Eventually the latter will be so great that feeble charges no longer pass. Then the desired effect only takes place with stronger charges of the exciter. If the resistance to transference is altogether absent, the intensifying process takes place all the sooner, and the feeblest electric influence will start it. This is attained by covering the discs with radial strips of tinfoil, and using contact brushes instead of combs, or better, by retaining the combs and attaching to each a little brush which touches the disc. I published this as early as 1881,* and I recall this now because two years later Wimshurst† described a machine thus arranged as his own invention. But the metallic armatures referred to have the disadvantage of favouring dissipation, and thus enfeebling the effect of the machine in quantity and intensity. They also favour a change of polarity, which is due to the fact that the inner faces of the discs also become electrified and work with this charge when the outer surfaces momentarily lose their charges. They also impair the transparency of the machine, and thus intercept the luminous phenomena which otherwise are such a valuable aid to the study of the theory.

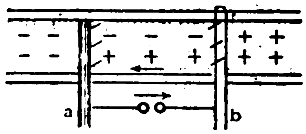

FIG. 10.

The Self-Exciting Process.

The metal strips on the discs and the contact brushes make the machine self-exciting. The reason for this is that a feeble impulse will now start the intensifying process, and that this impulse is given by the frictional electricity itself. The contact brushes touch the insulating surfaces at intervals, so that some assume positive and others negative charges, and there will never be a perfect balance between the charges thus produced in different portions of the plate. Hence a self-exciting machine is nothing wonderful or special, and its theory is none other than the theory of the ordinary machine. It is more convenient, of course, but it has all the drawbacks of machines with metal-covered plates.

* Uppenborn's *Zeitschrift für angewandte Elektrizität*, p. 199

† *Engineering*, XXXV., p. 4, 1883.

ON THE THEORY OF THE WIMSHURST MACHINE.*

BY V. SCHAFFERS, S.J.

The attempts which have been made up to now to explain the action of the Wimshurst machine have related mainly to the way in which a charge produced at a given point spreads over the plates. The normal action when the machine has once been charged has been deemed to be sufficiently explained by assuming that the combs discharge the sectors. As a matter of fact the quadrants embraced by the combs are of the same sign, and their charges ought consequently to repel one another. The plates are therefore supposed to be neutral from the combs to the next brush in the direction of rotation. Now it is this very part of the theory which is the most imperfect and the least in conformity with experience. In reality the plates are not neutral at any point, and we shall see that the part played by the combs must then be very different to that actually assigned to them. At the same time it may quite well be admitted that in a perfectly symmetrical machine the action may be that assumed by existing theories, though, as we shall see, it is a very special case.

Let us draw a diagram of the machine according to M. Bertin's classic plan, in which the cylindrical sections B B′ and D D′ represent the two plates. Let us assume, first of all, that we start the machine after having removed the combs; the distribution of

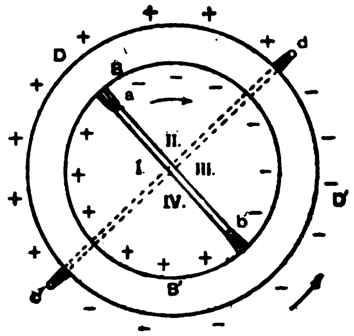

FIG. 1.

charge will be represented by Fig. 1, the quadrants I. and III. being of the same sign on both plates, whilst the quadrants II. and IV. are of opposite sign. If we walk up to the machine in the dark, comb in hand, it will be seen to give discharges in front of quadrants I. and III., but not in front of II. and IV., for the charges induced on the combs by these quadrants neutralise each other. Let us now replace the horse-shoe shaped combs, and approach the moving points. We shall no longer obtain, as before, discharges all over quadrants I. and III., but only in one half; for instance, between E and *a* and between H and *b* (Fig. 2). Thus, between E and *c* and H and *d* the plates are of opposite sign, like the quadrants II. and IV. This fact is evidently incompatible with the theory which assumes that the combs only serve to discharge the plates, for in that case the phenomena ought to be the same on both sides of the combs, the first plate being neutral between E *a* and H *b*, and the second between E′ *c* and H′ *d* (Fig. 3). The observed lack of symmetry can only be explained on the assumption that the combs have only acted on one of the plates, on D D′, for instance, in the present case (Fig. 2); and, secondly, that they have not merely neutralised the sectors, but have communicated a charge of opposite sign to them, the conductors *c d* remaining inert. Conversely, in the case of the plate B B′ it is the conductor *a b* which alone acts to change the sign, and the combs E H do no work. The action is thus the same as when the machine has no combs, with the single exception that one pair of combs plays the part of one of the diametral conductors.

In order to better investigate these phenomena I made use of a machine which had no U-shaped combs, but in place thereof separate pairs of combs. Each pair of combs was connected to a distinct pair of electrodes. With the exciter closed this apparatus works like any other; but if the electrodes are only separated on one side no sparks are obtained, and one observes in the dark that the separation of the electricities then takes place on the side of the open exciter at the diametral conductor, and on the other at the combs. With the two pairs of electrodes open sparks only

* From the *Annales de Chimie et de Physique*, May, 1895.

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pass between the two balls nearest each other; the others once again are replaced in action by the diametral conductor facing the same plate. As a rule, therefore, the machine only makes use of half its brushes and combs, and the active combs are those which form part of the circuit in which the movement of the electricity is the easiest.

On the ordinary machine the same phenomenon takes place. The combs do not act to the same degree on the two plates, although connected to the same circuit. Even a minute difference in their distances from the surfaces of the glass, or some other lack of symmetry in the apparatus, always causes the action of one of the two halves to predominate, and instantly the diametral conductor on the opposite side becomes active and takes the place of the other half of the comb in the working of the machine. One-half of the horse-shoe combs is, therefore, useless and even detrimental; for one may make sure in the dark that it gives a feeble flux of the

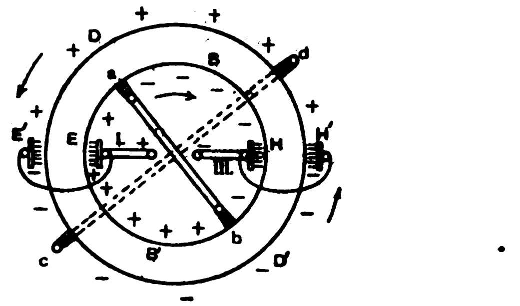

Fig 2.

same kind as active diametral conductor on the same side. *Straight combs should therefore be used.** For the same reason the diametral conductor on the same side as the active comb is somewhat detrimental to the efficacy of the machine. It is, however, indispensable to prevent reversal, and it suffices for this, although there are two moving plates. There is, in fact, a closed conductor on the second plate in which reversal can consequently never occur spontaneously; consequently only one diametral conductor is required, and that in front of the plate before which the combs are placed.

The most rational form of the Wimshurst machine would thus be provided with the two existing diametral conductors, and two straight combs facing the same plate instead of the horse-shoe combs. The best results will be obtained when the diametral conductors are 60deg. apart and 60deg. from the combs, and not at right angles to each other, and 45deg. from the combs as at present. This follows from the evidence brought forward as to the part played by the diametral conductors. In ordinary working the active combs must be as far as possible from the active conductor,

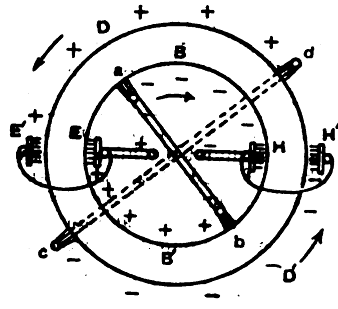

Fig. 3.

and in case of tendency to reverse, the two conductors must be as far as possible from each other in order not to interfere with each other.

Let me add one observation for the benefit of those who wish to repeat this investigation. The phenomena I have just described are only easily observed on the machine with separated combs. When the combs are joined, or when an ordinary machine is used, the appearances are somewhat different, but they in no way invalidate the interpretation just given.

I have stated that the active circuits are always those in which the movement of the electricity is the most easy. Now, the diametral conductors are usually keyed directly on to the iron spindle of the apparatus, and this spindle does not offer a sufficient resistance to prevent easy communication between the two conductors. In many machines—and this was the case with the two machines of which I had the disposal—it thus happens that the easiest circuit is that of the two halves of the diametral conductor united by the spindle, combined with that of the two combs placed the one in front of the first plate and the other in front of the second. In this way, for example, the distribution shown in Fig. 4 is obtained. The changes of sign take place at E′, *a*, *d* and H, as is easily seen in the dark.

All that has been said assumes the electrodes to be closed (or at any rate one pair when there are two). With the electrodes open the two circuits which perform the function of diametral conductors (two combs and one conductor) also become active and give a flux of the same sign as that of the neighbouring parts. Then all the combs and all the brushes situated on the left of the vertical diameter of symmetry of the machine have, let us say, a positive charge, all those on the right a negative charge. These phenomena fall in perfectly in my explanation, since the precise object of diametral conductors is to supplement the action of the combs when the resistance of that circuit is too great by reason of the opening of the exciter.

To check all these conclusions I removed the combs and the conductors which I found to be useless. The nature of the flux in the remaining parts was in no way altered. Further, I compared the output of the machine in the three following ways:—First I joined the combs so as to have an ordinary Wimshurst machine, then I suppressed the combs in front of one of the plates, whilst leaving the two diametral conductors in their places; lastly, I removed the combs in front of one of the plates and the diametral conductor in front of the opposite plate. The following are the figures obtained

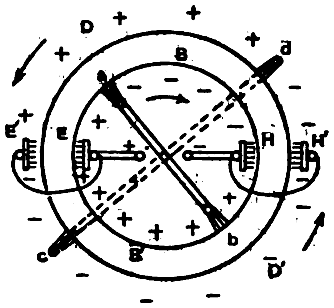

Fig. 4.

in one of my series of experiments, *n* being the number of revolutions per minute of the machine handle and *e* the number of sparks in the same time to the Lane bottle:—

	n	*e*		*n*	*e*		*n*	*e*
First arrangement.	43 44	132 140	Second arrangement.	45 43 41	137 131 129	Third arrangement.	45 47 49 47	145 151 152 147

These results, it is true, have no very precise value, owing to the impossibility with the apparatus at my disposal of maintaining a constant speed, of preventing the slipping of the belts, and, finally, of counting fractions of turns. Nevertheless, they clearly show that the quantity of electricity set in motion at equal speeds is sensibly the same in all three arrangements.

The new theory is therefore in perfect agreement in experiment. It leads, further, to a very important consequence, which it is easy to verify, and which points to a genuine improvement to be made.* According to my view, there is in every Wimshurst machine a closed diametral conductor (or two halves of a conductor connected by the spindle) in which all the movements of the charges of the corresponding plate take place. It is obvious that all the electricity thus developed is lost, so far as the useful output of the machine is concerned, since the conductor does not communicate with the electrodes. If we cut this conductor, and put it into connection with them, we ought to obtain twice the output of the ordinary machine,† with the exception, perhaps, of a certain reduction due to the fact that the induction would be less easy. Experiment shows these expectations to be quite correct. The machine, however, very easily reverses for somewhat long sparking distances. This is to be expected, since, after all, all that has been done has been to accurately reproduce the arrangements of a Holtz machine of the second order, which, as everyone knows, very easily reverses. This reversal may be prevented by means of two diametral conductors; one will not suffice, since the reversal may take place on either of the two plates.

* *Comptes Rendus*, Vol. CXIX., page 536, September 24, 1894.

* *Comptes Rendus*, Vol. CXIX., p. 536.

† If we assume that the U-shaped combs (*peignes à machoires*) have no other function except that of discharging the plates, as was formerly assumed (and, as I have already said, that explanation is plausible in the case of an absolutely symmetrical machine), the same conclusion is arrived at; in fact, if the combs, after having neutralised the glass, themselves recharge it, it is clear that they would give out twice as much electricity.

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In Fig. 5 is shown the arrangement I have finally adopted. The plates are the same as in the ordinary Wimshurst machine. At the end of a horizontal diameter, in front of one of the plates, are two insulated combs, E′ and H′, somewhat longer than the sectors of the plates, and provided with a brush which rubs against the knobs of the sectors. In front of the other plate, along a diameter making an angle of about 60deg. with the horizontal, are two similar combs, E and H, each of which is connected with the nearest comb of the first plate, and each pair thus formed is connected with one of the electrodes. The plates should be made to revolve in such a direction that before reaching the comb which discharges them they pass in front of the other comb connected to the same electrode. In that case the two combs of each electrode give the same electricity, and the knob is charged with the contrary sign; in the other case the two combs would give opposite fluxes and the knobs would remain neutral. This mode of working is absolutely identical with that of the second Holtz machine.

The chief difficulty was to find a suitable arrangement of diametral conductors. On investigating the action of these parts in single-plate machines, it is seen that they ought to be placed a little beyond the combs in the direction of rotation, and secondly, under the influence of the inductor which acts on the same comb. Let us apply this principle to each of our two plates. The diametral conductors must not first of all be within the quadrants included by the combined combs. In the other quadrants they would replace in the working of the machine a set of combs on one of the plates, or even both, and the useful output would be diminished or extinguished. To fulfil the second condition let me point out that here the inductors are the charges on the plates and that the demarcation of these charges when reversal tends to occur is displaced towards the diametral conductor. Let us consider the conductor *a b*, which should supplement the action of the combs E H in case the sparking distance is too great. The conductor

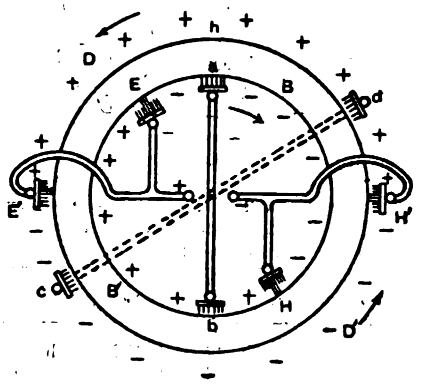

FIG. 5.

should be exposed to the influence of a positive charge on the plate D; consequently, to make sure of proper working, plate D must not be liable to reversal opposite it. Hence in the case of this plate the diametral conductor should be passed before the point *h* is reached. The second conductors should be placed at *c d*. The angular distance from *a b* to *c d*, that is to say, between the lines of sign change on the plates when the electrodes are too far apart, should be sufficiently great to make sure that in front of the combs the region of useful induction on the plate in front is enough to bring about the change of sign. In the contrary event the conductors are powerless to prevent reversal. On the other hand the conductors should not be too close to the combs under pain of diminishing the effect; 30deg. at least is the best distance off. In order to give oneself enough latitude, and to ensure constancy of sign, it is therefore necessary to provide the diametral conductors with discharging parts capable of very rapidly reversing the charge of the plates. I employed first of all the ordinary brush conductors of the Wimshurst machine, but did not allow them to touch the knobs. With this arrangement the flow of electricity was too slow. With combs on the two conductors the action was quite satisfactory. If brushes are employed on the diametral conductors, these brushes must not touch the plates under pain of immediate extinction of the action. In the Voss machine, as is well known, the diametral conductor is provided with brushes which touch the knobs on the plates. This is no defect, since the fixed inductors support the charges of opposite sign, which would, without them, rush to meet each other viâ the diametral conductor. But in the Wimshurst machine there are no fixed inductors, and each of the charges which acts as an inductor would at the same moment find itself in communication with a charge of opposite sign. Complete extinction would, therefore, necessarily be the result. The machine also stops if the combs are provided with contact brushes, though only when the electrodes are closed. With the electrodes open it works well this way. This eccentric behaviour is explained by the same principles. In the electrode circuit, as in the case of the Voss machine, I put combs in order to ensure an easy flow and to make use of a large surface of plate, and brushes to obtain spontaneous excitation. This latter seems to me to be brought about in much the same way as in the ordinary pattern—that is to say, as is well known, somewhat less perfectly than in the Voss. I should say, however, that I have not been able to assure myself yet that the machine is really and truly self-exciting. Throughout the whole course of my experiments the atmospheric conditions were persistently unfavourable, and the ordinary Wimshurst machine did not excite itself better than mine. However this may be, once excited the new machine keeps its charge exceedingly well, and in this respect, and in respect of ease of excitation, it is undoubtedly far superior to the Holtz machine.

To sum up, this is how I have arranged my apparatus: In front of one of the plates two combs on a horizontal diameter; before the other two combs 60deg. from the former; the two left-hand combs being united to one electrode, the two right-hand combs to the other. These combs are provided with contact brushes. At a distance of from 30deg. to 35deg. from the combs in the direction of rotation of each plate there is a diametral conductor carrying combs without brushes. The distance between the two conductors is about 50deg.

The following are the comparative tests of this machine made with the aid of the Lane bottle:—

—	*n*	*e*
Entirely new pattern	25·5	180
	26·0	189
	25·5	186
Pattern with a single diametral conductor	27·0	207
Pattern without conductors	25·5	203
Ordinary Wimshurst	25·0	90
	27·5	99
	27·0	101

The output is therefore twice that of the old pattern.

As is well known, Mr. Bonetti has recently considerably improved the Wimshurst machine from the point of view of output by giving it ebonite or glass plates without sectors and by increasing the number of the brushes on the conductors. It is evident that these modifications in no way alter my theory of the apparatus; every experiment, on the contrary, establishes it. All I have said as to the action of the ordinary machine is applicable to this new pattern. First of all, we must frankly renounce the horse-shoe shaped combs, as the following results prove:—

—	*n*	*e*
Entirely new pattern	51	104
	51	96
	51	100
Two straight combs and two diametral conductors	48	98
	53	108
Two straight combs and one conductor	53	100
	54	107
	55	118

If, now, I transform the Bonetti machine in the same way as I have transformed the Wimshurst machine, we shall have in Fig. 5, in place of the combs at E′ and E and at H and H′, the rows of brushes which M. Bonetti mounts on his diametral conductors, and on these I put combs without brushes similar to those employed in Fig. 5. The useful output is again doubled, as the following table shows:—

—	*n*	*e*
Ordinary Bonetti machine	74	79
	75	80
	77	81
Altered Bonetti machine	60	163
	64	173
	66	167

These figures, I repeat, have nothing absolute about them in view of the imperfection of my apparatus, but they leave no doubt as to the attainment of an increase in the output, in exact accordance with the provisions of theory.

It is therefore permissible to hope that the Wimshurst type of machine, which has been so greatly appreciated ever since its first appearance, on account of the ease with which it can be excited and on account of its constancy, will now become equally valuable on account of its output. Up to the present it has been markedly inferior in this respect to the Holtz and Voss machines. In the future it may be compared not disadvantageously with these machines.

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ELECTRICAL TRANSMISSION OF POWER, WITH SPECIAL REFERENCE TO MINING OPERATIONS.*

BY H. T. HAWS.

In electrical transmission of power there are two cases to be considered, *i.e.* :—

(1.) Transmission over distances measured by the foot or yard.
(2.) Transmission over distances measured by the mile.

In this Paper I intend to deal principally with the latter.

Broadly speaking, there are two ways in which you can transmit energy from one point to another. Let us assume that the primary source of energy is coal, and the energy is not required at the pit's mouth, but at some works one mile away ; then in this case you could convey the coal by cart from the pit's mouth to the works where it is required, or else you could burn the coal under a boiler at the pit's mouth, use the boiler to drive an engine, and transmit your energy to the works by wire rope, or in some other mechanical way. The first is obviously the more economical of the two, even if the distance is short, but the two cases are utterly different—on the one hand you transmit the substance from which you obtain your energy, while on the other you transmit the energy itself—you transmit energy, first, in the stored form, second, in the live form, if I may be allowed to call it so.

The most important sources of power in Nature are corn, coal, and falling water. By the term corn I mean energy obtained from vegetable food stuffs by means of horses and other animal engines ; by coal I mean energy derived from coal, &c., by means of some heat engine. Energy derived from corn and coal is generally transmitted in the stored form ; while energy derived from water is generally transmitted in the live form. Now, in electrical transmission of power you can obviously transmit it in the stored and in the live form ; you could (to go back to the example of the coal pit and the works) use the engine which is being fed at the pit's mouth by your boiler to drive a dynamo, which in its turn charged some accumulators ; these you could transmit by some vehicle to your works, and there set them to drive a motor, or you could convey the current direct to your motor by means of insulated wires. The former would be a case of stored transmission, while the latter would be a case of live transmission ; this latter is what is generally meant by "electrical transmission of power."

Before entering upon electrical transmission of power in the "live" form, I will stop to investigate the capabilities of electrical transmission in the "stored" form. You could transmit energy in the stored form, first by carrying coal, and second by carrying secondary batteries. Now, it is a well-known fact that a sack of coal contains much more stored energy in it than a secondary battery of equal size and weight ; it is much cheaper, its carriage is less expensive, and it requires less care in transmission. Thus we see that if the primary source of power is coal it would be more economical to convey the energy in the form of coal to your works, and there turn it into useful power by boiler and steam engine, than to convey the energy in the form of secondary batteries and turn it into useful power by a motor, not only because of the saving in carriage, but also on account of the smaller capital outlay and the loss of energy in the battery itself. But when the primary source of power is not coal, but falling water, it is easy to prove that electric transmission in the stored form is the best and most economical way of transmitting your power (that is, in the stored form) to any distance ; the only method that can be compared with it is compressed air, as largely used in France on the "Popp" system ; but, looking at the efficiency of the Popp system as compared with the efficiency obtainable by using electrical transmission in the stored form, we find the total efficiency of the Popp system to be 26.7 per cent., as compared with 56 per cent. given by electrical storage, or nearly twice as great (these figures are obtained from a Paper of Prof. Kennedy's, read before the British Association's Meeting at Cardiff in 1889). Thus we see that if power has to be transmitted from a waterfall to a distance in the stored form electricity is the only agent that need be considered.

The system of power transmission, or to be more correct, power distribution by storage batteries, is in use in this country. I mean the working of tramcars by accumulators which are charged at a central depot and distribute power when it is required for the propulsion of the cars. Touching the transmission of stored energy from one place to another other than by batteries, there are two cases to be considered, namely, carriage of coal and corn, both combined with proper appliances for converting stored energy into live power at the end of the line of transmission. Mr. Kapp, in his renowned Cantor lectures, proves pretty conclusively that these two methods are greatly superior to electrical transmission of power by storage batteries, provided the primary source of power is coal or corn, and he goes very deeply into this subject. In fact, taking batteries as they are at present, their use as agents in the transmission of power is only justifiable where the direct transmission by means of wires cannot be employed. The only case of electrical transmission of stored power which as yet has attained to practical importance is the use of secondary batteries for locomotive purposes, but you have heard enough on this subject at the Institution's meetings on "Electric Traction."

* Paper read before students' meeting of the Institution of Electrical Engineers.

ELECTRICAL TRANSMISSION OF LIVE POWER BY MEANS OF INSULATED CONDUCTORS.

The Line.—It is a well-known fact that overhead conductors are much cheaper to construct than conductors placed underground, and the longer the distance of transmission the greater is the discrepancy between them, as the following table will show :—

Transmission Plant for 5 H.P.

Distance.	Annual cost per h.p. delivered.		Difference.
	Overhead.	Underground.	
Miles.	£	£	£
1	22·8	33·6	10·8
2	25·6	47·2	21·6
3	28·0	60·0	32·0
4	30·6	74·0	43·4
5	33·0	87·0	54·0

All other things being equal.

But some people object to overhead conductors—and so do I—in a town ; but where the transmission takes place across country, as it probably would in conveying energy from a waterfall to drive a mining plant or a mill, &c. I should certainly advise carrying the conductors on poles—in fact, it would be waste of money to bury the conductors. Now, in long-distance transmission the line is the most important factor in the cost of construction, but for ordinary workshop transmission the line is not so important so in the former case it is advisable to have the leads as small as possible.

In designing large power stations that are, say, worked by a waterfall and have to supply power some miles away, there are some important points to be remembered. Both generators and motors should be multipolar, as this gets over any side drag which would occur in a two-pole machine, also magnetic leakage is minimised, and for a given speed you can obtain a greater E.M.F., which is essential to efficient working ; also for a given power multipolar machines are lighter than two-pole machines. As a rule, a good dynamo will make a good motor if you give the dynamo brushes a forward lead and the motor brushes a backward one. For efficient working what we require is high voltage at the generating end of the line, so that the leads may be small, and a large torque combined with a certain speed at the motor end of the line ; and if we were only to consider the electrical efficiency of the distribution, the higher the voltage we worked at the greater the efficiency. But there are other things to be taken into account, viz., insulation, &c.

Now, before going into the special branches of electrical transmission of power, I will say a word or two about the controlling and regulating of motors. What we want in practice is a constant speed, no matter how the load alters. This is what a steam engine is supposed to give. There are two cases to be considered : (1) When you work your motor off the electric light mains at constant pressure ; (2) when the supply of current is obtained from a generator erected especially for the purpose at constant or variable pressure (the regulation of current and pressure being automatic), as in long-distance electrical transmission from a waterfall. You all know that for regulative purposes a series-wound motor is no good, as when the load is increased the speed is slightly decreased, and current increases ; this strengthens field and raises counter E.M.F. ; this will check the current, and a further drop of speed will ensue until a stable condition of affairs is obtained at a lower speed. The same thing occurs if we take off some load, but in the opposite direction, *i.e.*, the motors tend to race ; but, on the other hand, a shunt motor is almost a self-regulating machine. This fact was first pointed out by Mr. Mordey in an article in the *Philosophical Magazine* of January, 1886. The only drawback to shunt motors is that at starting you must insert a resistance in the armature of the machine. This is done in very many different ways in practice ; it can be done automatically by placing a resistance permanently in the armature circuit, and causing it to be short-circuited by means of a centrifugal regulator fixed to the armature shaft, and so arranged that when the speed has obtained a certain value the balls fly out and release a spring which closes a switch. This centrifugal regulator will also serve to prevent your using too much current, as the speed will drop slightly and the resistance will be automatically reinserted. But if you are taking current, not from the electric light mains, but from a plant erected specially for the purpose, you can have perfect regulation of speed with either series shunt or compound machines; so in the first case

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you can only get good regulation with a shunt machine, but in the latter you can get good regulation with any machines the generators are constructed to work.

A few words about the supply of power in small parcels from central station supplies. Electromotors are not very largely used in London or suburbs, notwithstanding the enticement electric light companies offer by charging less for the current used for power during the daytime than if used for lighting purposes.

The St. Pancras Vestry have about 22 motors on their mains, aggregating about 70 H.P. The Bradford Electric Light Company have something like 40 motors, and they had great trouble at first with starting arrangements; but I believe they now use a liquid resistance combined with an automatic time starter. The Norwich Electric Light Company have mostly shunt motors, the special starting arrangements of which I will sketch on the board (Fig. 1). The other companies in London and district have comparatively few motors on their circuits; in fact, I was very much struck when visiting some of the central stations last year at the little power they supply for motive purposes, but I have no doubt that in five or six years this will have altered, and I should not mind saying that in eight or ten years the electric light companies in London will work at full load day and night.

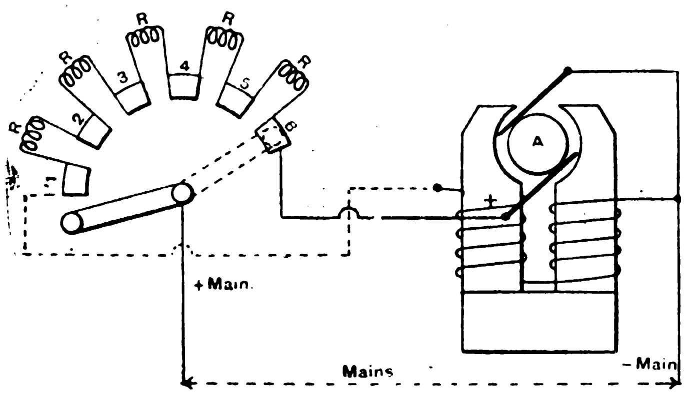

Fig. 1.

Electrical Transmission of Power in Large Engineering and other Workshops.

All practical electrical engineers must acknowledge that they have a rival in the distribution of small parcels of power, even if its merits are poor. I mean gas and oil engines. What brought the gas engine up to its present state of efficiency? Why, the competition of electrical engineers. Now, according to Mr. Crompton, the power obtained from an electric motor costs one-third the price of that obtained from a gas engine, while it is always at hand, requires no pulling round of heavy flywheels, lighting up, turning cocks, lubricating and the hundred and one things required to be done before a gas engine will start. Its speed is very regular and does not jump up and down with the characteristic jerk of a gas engine besides you can turn a motor on and off as much as you please, while it does not pay to keep stopping and starting a gas engine.

The advantages of the electric motor for working cranes, lifts, &c., over hydraulic power is at once evident. The electric motor demands power from the source of supply in proportion to the work it is called upon to perform, while if you make an hydraulic crane lift a weight smaller than its maximum, the amount of water supplied and pressure, provided the elevation is the same, is the same as that required for maximum load, and I believe you can get a dead loss of 80 per cent. by using hydraulic cranes below their maximum load; hence the advantage of using an electric motor on the crane which will hoist, slew, and propel the crane simultaneously or separately.

In large engineering works electrical power has many advantages over steam power, and I fail to see any important advantages the steam engine has over the electric motor. There can be no doubt that it is much more efficient to have one or two large steam engines directly coupled to dynamos, the former fed by a boiler working at high pressure, and transmit your energy to different motors placed in the various shops, than to have a small steam engine and boiler (necessarily inefficient) working an enormous amount of countershafting placed in every shop. Countershafting means a large percentage loss of power, due to overcoming friction, heating of bearings, besides a certain amount of danger, putting aside such minor inconveniences as noise, smoke, dirt, &c.; and what can be done and is done in large works is the abolition of a large amount of countershafting, by directly coupling a motor to each large machine which may be required to work intermittently, and using as many motors as possible, because now small motors can be made with comparatively large efficiencies, much more so than you can make small steam engines efficient as compared with large on s. The only works in which I have seen electrical power used very largely are Messrs. Siemens' works at Woolwich; there they have some large Willans engines directly coupled to continous-current dynamos at their central station, and this supplies the different shops with power by overhead conductors. In the india-rubber shop there are four machines, each one directly coupled to a 40-H.P. motor; but I have no doubt nearly all of you have been over Messrs. Siemens' works; if any of you have not, I would strongly advise you to take the first opportunity of doing so.

Electricity in Mining Operations.

The rest of this Paper I have devoted to electrical mining operations. In electrical transmission of power to mines, either from a waterfall near by or from a generating station, there are some difficulties to be overcome which do not occur in any other case. They are: (1) Falls of earth, &c., from roofs and walls and creeping of the floors; (2) water; (3) explosive gases. These require different methods to overcome them, and only an engineer experienced in this kind of work can do so successfully, *i.e.*, a man possessing a thorough technical knowledge of electrical subjects, and also a practical knowledge of mining. Strange to say, there are very few men in England possessing these necessary qualifications. There are plenty of men possessing the one, and thinking they possess the other, but I am of opinion that the number of good electrical mining engineers in England can be counted on both hands; this is perhaps one of the reasons why electrical mining has not made as rapid strides as you might have expected it to do. Much defective work has been done in this branch of power transmission, largely owing to that great bugbear in electrical as well as in civil and mechanical engineering. I mean accepting the lowest tender, no matter who tenders for the job, whether he is the local plumber or gasfitter, as long as he sets it to work, and it passes the fire insurance inspector or Board of Directors.

In mining work it is common to have the generating plant above the ground and the dynamo driven by a separate engine (in cases where steam engines are used for other purposes), and in English collieries, sad to say, electric plant plays a very small part in the main machinery; very often they do not have even a separate dynamo house.

Mining engineers have now begun to see the large saving in fuel and steam by using high-pressure boilers to drive quick-running engines; but I think the Lancashire boiler is used mostly, and I should feel inclined to say it was preferable to the water-tube and locomotive boilers, which seem the rage just now, because, although the water-tube and locomotive boilers are very superior in raising steam quickly, yet they are more difficult to clean, and require more skilful labour to repair them, whereas a good Lancashire boiler with cross tubes, and working at a pressure of but 80lb. to 120lb. per square inch, is fairly efficient, requires little attention, especially if fed with coal (which in a colliery is never of the best and is mostly dust) by mechanical stokers, and can easily be repaired.

Now, with regard to generators, I take it for granted direct driving is chosen for reasons which were put so admirably before you in our secretary's Paper of last November. Shall we have an open or closed type of engine? There are various opinions on the subject; but I think, taking into account the probable nature of the engine house, the closed type engine is the best (such as Messrs. Willans and Robinson's), as although it is more difficult to get at it cannot get dirty, and there is less risk of accidents.

The question of system employed, and also the pressure the generators must work at, depends on how far the engine house is from the mine and on local conditions. If it is a case of long distance transmission, as from a waterfall a mile away, then perhaps it would be more economical to use high-tension continuous current with transformers; with short distance transmission 500 volts is a very common pressure, but it must be remembered that it is not safe to work portable coal cutters with a greater voltage than 50 volts, especially if they are worked by non-electrical miners, so it is common to transform your current down again before using it to drive coal cutters, drills, &c.

I regret to say that owing to shortness of time I am unable to say much about the polyphase system of distribution; but it has been used very little, if at all, in this country.

Conductors.—In mining operations there are very many classes of cables which are suitable, and they differ mostly in the insulation employed and the means used to protect them from water and injury; also in the methods employed to prevent the cable sparking if it is severed or injured. The best two kinds of insulation used are vulcanised fibre and bitumen compounds: the former is the most expensive and is better for small leads, while the latter is cheaper, and is, therefore, best for large trunk mains; but as bitumen loses its insulating properties considerably if it gets wet, it is always necessary to cover it with lead, which is generally again armoured with iron or steel wire. This form of bitumen cable is nearly always made concentric. It is found advisable to use a duplicate system of mains in mines, connected in parallel to omnibus bars, and also to use small conductors limited to 19/14 S.W.G., as in mining it is often a matter of impossibility to make repairs during the drawing of coal. Thus, if one cable broke down, the other one could supply the current until the

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fault was located and put right. This would obviously prevent the occurrence of any sparking. Another advantage of using small mains over large ones is that the former are relatively lighter, and are therefore easier handled and fixed in position. Further, the cost of repairs to the smaller cables is generally much less than to larger ones, owing to the greater ease with which the joints can be made, &c. Bare return concentric cables are largely used; they are cheap, and prevent to a certain extent external sparking, and if armoured are very strong.

Safety Cables.—These are generally made of two conductors in parallel, insulated from one another, and one of the conductors breaking before the other actuates a magnetic cut-out which opens the main circuit before it is actually broken in the mine, thus preventing sparking occurring in the mine itself.

The Atkinson Safety Mining Cable.—This consists of two conductors in parallel insulated from one another except at the ends, the inner one being in the form of a spiral which, when a stone falls on the outer conductor, and breaks it (owing to the resistance it offers), stretches out, and is not fractured, but all the current going through this thin wire blows a magnetic cut-out in the engine room, and thus prevents sparking in the mine. The efficient working of this cable depends on (1) perfect insulation between the two conductors, (2) the continuity of fine-wire circuit being preserved during fall. I think the practical use of these cables may be doubted.

There are very many safety devices used to prevent sparking, some employing elaborate systems of magnetic cut-outs, &c.; but, taking it all round, none of them offer greater security from external sparking than an armoured concentric cable, such as I have here, either buried in the ground or hung very loosely with plenty of slack from the roof or sides of the mine. If a stone or lump of coal falls on it, it will either bury the conductor in the ground or else cut through the outer conductor; but the other side of the outer conductor remaining, the magnetic cut-outs will probably go before any harm occurs; success lies in hanging the conductors loosely, so as to prevent instantaneous cutting of the cable. As far as I am aware, there has never occurred an authenticated case of coal gas having been fired by the severing of a concentric cable, although the possibility of its occurring is evident.

Safety Motors.—Various methods have been devised for constructing a good safety continuous-current motor. The first method was to enclose the whole motor entirely in a metal case, but it was found that the quantity of air enclosed was too large to be safely fired. The next course was to only enclose the commutator and brushes, and Messrs. Easton, Anderson and Goolden have constructed an excellent safety mining motor on this plan, which I have not time to fully describe. The main objection to enclosing the brushes is that the design of the brush gear is complicated, and therefore the adjustment of the brushes is rendered difficult, especially to unskilled hands. The only real safeguard against explosions from sparking at the brushes and commutator is to get rid of them altogether, and this can be easily done by using polyphase motors.

The polyphase system, there is no doubt, is the system of the future, and it will outdo all others, especially in mining work. The advantages of the polyphase system over any others are:—

(1st.) Sparking is impossible.

(2nd.) Racing is impossible, since speed of rotor can never exceed that of synchronism with generator.

(3rd.) Speed regulation can be accomplished by means of impedance coils in a small space without any fear of sparking, as no part of the circuit need be opened or shunted, as is the case with ordinary regulative resistances.

The sole advantage continuous-current motors have over polyphase motors is in regard to their starting torque. From this point of view the series-wound motor is the most efficient motor that can be built, as a polyphase motor has to have a starting resistance in the rotor circuit.

A few words with reference to electric coal cutters and drills. One of the difficulties of electric coal cutting seems to me to be that they cut the coal too quickly, and the coal cannot be removed fast enough from the workings, and so the cutter is not used continuously; but this obviously can be got over by constructing smaller coal cutters, say to cut five to ten yards per hour instead of from 20 to 40, as they sometimes do. It may be remarked that one of the best electric coal cutters, with two men to work it, will hew as much coal per hour as 20 or 30 men could; and as the number of accidents in a mine is directly proportional to the number of men employed, the introduction of electrical coal-cutting machinery would obviously largely decrease the loss of life from accidents.

Electrical coal cutters may be divided into two classes—(*a*) bar cutters, (*b*) rotary wheel or disc cutters. Under the first head are included all machines which have a cutter bar revolving either at right angles or parallel to the face of the coal. This type has proved by far the most successful in this country and America, the best-known being (1) the Goolden-Atkinson bar cutter, (2) the Jeffrey machine, of American origin. In the former the cutter bar is usually geared to the armature shaft by a pair of cast-steel double helical wheels running in oil, and makes from 300 to 400 revolutions per minute, and the motor is nearly always series-wound; the latter is different from any machine of English origin, being made to suit the American coal seams. Under the second head may be mentioned the Yorkshire Engine Company's side-wheel cutters and the Thomson-Houston coal cutter; but, owing to the great success of these machines when driven by compressed air, practically no difference has been made when worked electrically.

I will now describe some mines in particular which are worked either wholly or partly by electricity in England.

Abercanaid Colliery.—The generating plant here consists of a Marshall's engine, compound, 13 by 21, steam pressure 140lb., flywheel 12ft. diameter; a Crompton dynamo, 180 amperes at 500

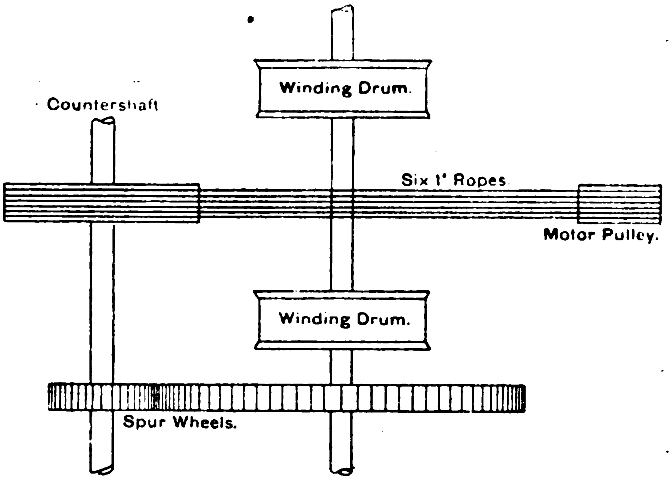

FIG. 2.

volts, 550 revolutions per minute. The current is carried by cables down the shaft and through the workings 1ft. underground to a point three-quarters of a mile from the generating plant; here is the hauling engine, motor, and plant. The system is the main tail and rope haulage. Two drums, 3ft. 6in. diameter and 1ft. broad; the drum shaft is driven by spur gearing from a countershaft, which is driven by a Crompton motor by six 1in. ropes. I will here sketch the arrangement (Fig. 2). The motor will work at 100 H.P.; it is a series machine. The cable used for transmission of power is 3,200 yards of 37/14 S.W.G. copper, insulated with vulcanised bitumen; it is armoured heavily with a double sheath of No. 8 steel wire; external diameter, 2·15in.

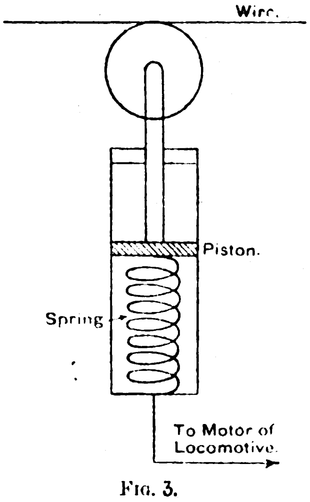

FIG. 3.

Greenside Silver Lead Mines.—The generating plant consists of a 100 B.H.P. "Vortex" turbine, driving an Immisch compound dynamo four-pole type, 100 amperes, 600 volts, 500 revolutions. Water is taken 360 yards to dynamo house by 15in. pipe. Length of transmission 1¼ miles. Here is an Immisch motor driving winding drum hoisting 10 cwt. at 360ft. per minute; 350 yards further on is another motor driving a three-throw horizontal pump. Midway between these two motors a constant-current transformer is placed to transform down to 200 volts for working an electric locomotive (Fig. 3). Length of line, three-quarters of a mile: average load, twelve tons; speed, five miles an hour; contractors, Acme and Immisch Electric Works Company.

East Hull Colliery.—Generating plant consists of vertical high-speed steam engine driving a Crompton continuous-current dynamo. Length of transmission, 1·7 miles. There are three motors in the mine driving pumps.

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The Electrician.

The Oldest Electrical Journal, 1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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INFLUENCE MACHINES.

Three articles which we print to-day in our columns on the topic of Influence Machines are evidence of the continued attention which is being given by electricians to this class of apparatus. One is from the veteran Professor HOLTZ, whose pioneering researches of 1866 have never really ceased; another from our own Mr. WIMSHURST, who has done so much to give to the influence machine the qualities of reliability and efficiency which is so sorely needed; while the third is from the pen of Father SCHAFFERS.

With the question of priorities in invention that incidentally peeps out we need not concern ourselves much. No one in this country grudges to HOLTZ the reputation won by his patient and protracted labours any more than such recognition would be grudged to his contemporaries TOEPLER and VARLEY for their contributions to the subject. Mr. WIMSHURST's single-hearted and disinterested enthusiasm is known to all electrical men; they appreciate the entire honesty and originality of his work. To have produced machines which neither lose nor reverse their charges in action, and which never fail in their excitation, is no small achievement, and one not to be belittled by saying that self-excitation is a secondary detail. The answer to the detractor is to be found in the thousands of influence machines that are in use to-day, and would never have existed but for the work of WIMSHURST.

The main point raised now by the Papers of Father SCHAFFERS and Prof. HOLTZ is the operation of that part of the machine which is connected to the pair of discharging knobs, or, as Father SCHAFFERS terms them, the electrodes. It were to be wished, indeed, that in both Papers the phraseology were a little more strict. Prof. HOLTZ uses the term "intensity" of output apparently as a synonym for maximum length of spark, or, perhaps, for the electromotive force that is concerned in the maximum length. Father SCHAFFERS starts off by a reference to the "combs" which discharge the sectors, meaning thereby, as it appears, the horseshoe-shaped combs which communicate with the discharging knobs; and he speaks of the "flux," not meaning (as might have been supposed by analogy with the magnetic flux) the total number

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of lines in the electrostatic field, but as meaning the current which the machine sets up. Father SCHAFFERS seems to imply that there is something wrong in the usual method of describing the elementary action of the influence machine as well as in its construction. When carefully examined, his argument amounts to the following contention. The discharging part of the machine, usually consisting of two horseshoe-shaped combs connected to a pair of discharge knobs, does not act simply as a discharging apparatus; it also acts at the same time as a neutralising conductor, aiding or replacing for the time being in the exercise of that function one of the two oblique diametral conductors. Here he is undoubtedly right: it does so aid in addition to acting as discharger. But that is no reason for not calling it after its principal function rather than after its incidental operation. Many years ago Mr. WIMSHURST demonstrated that this discharging apparatus is no necessary part of the machine. He constructed and presented to the Royal Institution a simple pair of discs furnished only with the two oblique diametral conductors and the axis for revolution, which nevertheless excited itself and constituted a perfect machine. All else is merely accessory. He traced out the operations in the revolution of the discs and described the currents in the two conductors; the mutual repulsions in two of the opposite pairs of quadrants, and the mutual attraction in the other two, just as we know them to-day. The older Holtz machine used these currents directly, the operation of procuring the spark discharge consisting in opening a gap between two knobs inserted (and closed together at starting) in one of the two neutralising paths. Prof. SILVANUS THOMPSON pointed out ten years ago that there was the same difference between putting the discharging gap into one of these two neutralising circuits and putting it into a special discharging circuit as there is in dynamos between putting the lamp in series with the magnetising coils and putting it in parallel to them as a shunt. The series dynamo does not excite itself when the circuit is open, and is liable to reverse its polarity. The shunt dynamo keeps its polarity without reversing; excites itself best on open circuit, and loses its charge when short-circuited. A clear hold on this useful analogy would help both Father SCHAFFERS and Prof. HOLTZ to explain exactly what they are striving for. Father SCHAFFERS' contention that one of the diametral conductors is superfluous and harmful, as diverting current from the useful path of discharge, leads him to remove it altogether. Suppose we had a compound dynamo having a badly-designed shunt winding which diverted too much current from the lamps, we might justly say, Let us remove the shunt, and we shall increase the output of the machine. We remove it, and lo! we find we have got a series machine, with its inability to excite itself on open circuit, or, unless we add something, to perform the function formerly performed by the shunt. That the two branches of the horseshoe-shaped combs of the discharging apparatus do not act equally has long been known. To remove half of them and put straight combs opposite one face only of the machine may remedy this "defect." Mr. WIMSHURST long ago found that a better course was to build the combs so that the front comb was a little in advance of the back comb at one side and a little in retard at the other side of the machine. If we remember rightly, this construction was actually used in the large machine with 7ft. plates which Mr. WIMSHURST built for the national collection at Kensington.

In the article by Mr. WIMSHURST we have a criticism of and a rejoinder to the comments of Prof. HOLTZ. Mr. WIMSHURST's remark that the metal carriers or "sectors" are necessary evils is one that we entirely endorse. Their presence is inevitable in a climate such as ours, otherwise the machine relapses into that state of unreliable action from which it is Mr. WIMSHURST's great merit to have effectually rescued it. Though Mr. WIMSHURST does not reply specifically to Father SCHAFFERS, there is one point of curious difference as to fact between them. Father SCHAFFERS lays great stress on the alleged circumstance that the carriers, after having passed under a comb, are found to be over-neutralised—that is to say, actually charged with charges of reversed sign, which alleged fact he attributes to the influence exerted laterally by the charges upon the neighbouring undischarged parts of the plate. Mr. WIMSHURST passes the alleged fact in silence; and in his diagram represents the effect of passing a brush not as over-neutralising, nor as even quite neutralising the sector.

Mr. WIMSHURST's closing remarks for the encouragement of other workers meet with our entire approbation. Much as he has himself accomplished there is room for the efforts of future aspirants to fame. Probably a good deal remains to do in finding the most satisfactory disposition of details. It is now well recognised that the length of spark is limited by the internal insulation of the machine, and that the quantity of the output is proportional to speed and to the amount of surface charged and discharged in each revolution. The point that is yet not properly appreciated is that the operation of charging any sector or carrier and making it impart its charge to another part of the apparatus really consists in charging a condenser of a certain small capacity up to a certain potential, and then in artificially raising that potential by pulling apart the dielectric that lies between the charged carrier and the oppositely charged body with which it was previously in proximity. We shall not be able to increase the output of a machine of given size at a given speed until we understand how to increase the mutual capacity of the two parts when brought into proximity, or how to increase the degree of electrification of them without causing wasteful internal discharges in the operation of charging them and then separating them from one another. The contributions of Prof. HOLTZ and of Father SCHAFFERS may both aid to this end; but there are other recent workers whose efforts are also well worthy of consideration.

NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(Continued from page 360.)

§ **47. Capacity Tests** (*continued*).—The Silvertown testing key designed by Mr. Rymer-Jones, illustrated in Fig. 142, is largely used in capacity or insulation tests. There are three ebonite pillars, two of which support horizontal contact levers movable about the point of support and provided with ebonite handles. The levers can be moved independently, but one of the handles carries a distance piece (seen in Fig. 143) which prevents them both touching the back contact bar at the same time. The back bar is fixed on the third pillar, and is curved or channel shaped, so as to present two contact surfaces—one for each lever. The contact surfaces have springs pressing in an upward direction, so that as the levers move on to the surface of the springs good contact is made. The ends of the levers are tipped with gold, and the springs are of platinum, these metals having been found to wear best and keep a perfectly clean surface. The high insulation obtained by the pillars, the accessibility of all the parts, the good contacts made by the levers, and the adaptability of the key for different tests are its chief advantages. In one form, as in Fig. 142, a central contact bar *a* can be moved up into position when the key is required as a reversing key, or moved away when the

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key is in ordinary use. The key, as arranged for reversing and discharge, is shown in plan in Fig. 143. By moving the handles of the key apart, and so pointing the levers towards each other, the two levers can be entirely insulated from the back contacts and from each other.

For Gott's capacity test it is convenient to use two of these keys as in Fig. 144, one for charging or earthing the condenser and the other for connecting galvanometer to slides or taking the absorption discharge. Another is also shown connected to the battery as a reversing key.

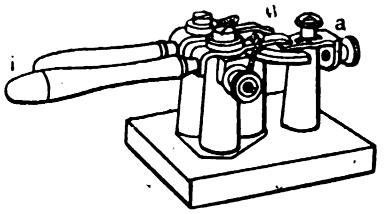

Fig. 142.—Rymer-Jones Key.

So arranged, the test is started by putting the levers of both keys to the right, thus earthing the condenser and cable and getting rid of all residual charge. This is done between each successive trial to balance. The balance key is then insulated and galvanometer key opened. The charge is then applied for

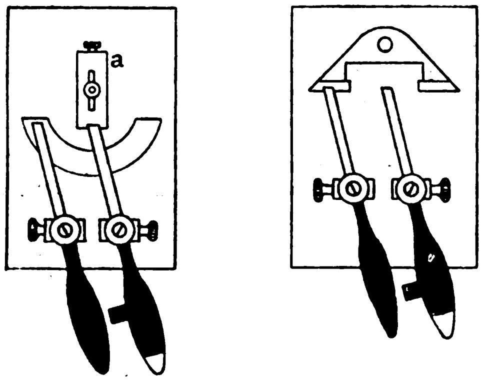

Fig. 143.—Rymer-Jones Reversing and Discharge Keys.

a given number of seconds by putting charge key to the left. Galvanometer is then connected to slides by putting balance key to the left. If there is a deflection the slides are readjusted until, on repeating the charge, the deflection is *nil* or nearly so. Want of balance is corrected afterwards by the absorption discharge, so that it is not necessary to obtain a perfect balance on slides.

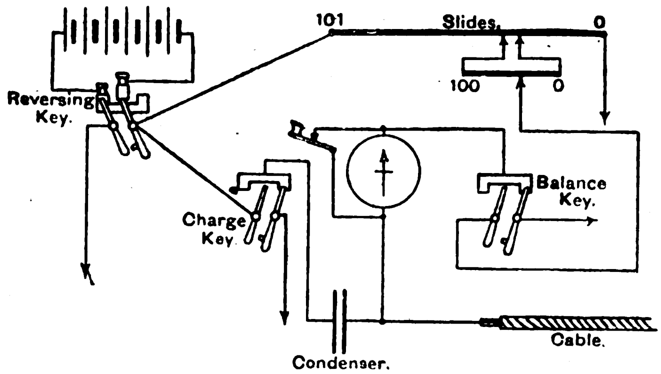

Fig. 144.—Gotts' Test with Rymer-Jones Keys.

The absorption discharge is now obtained by first insulating the balance key, opening galvanometer key and charging the condenser and cable again for the same period of time as before (slide index being at position for balance). Immediately after the period of charge the charge key is put over to the right, thus earthing the condenser, and after an interval of 3 seconds (the earthing period) the balance key is put over to the right, thus earthing the galvanometer and producing the absorption discharge deflection. A shunt may be required on the galvanometer for this deflection, and if so the same shunt for convenience should be used when getting the equivalent deflection on the slides. The slide index is moved to a position near the zero or earth end, and the balance key put to the left, thus connecting galvanometer to slides. The slide reading equivalent to the absorption discharge is then calculated and added to or subtracted from the original slide reading, as described above, and the capacity of the cable worked out by the formula given.

This key is in use in the General Post Office, and a full description of it is given in Kempe's "Handbook of Electrical Testing." The Silvertown Company also use a pair of these keys mounted on one board for testing the insulation resistance and inductive capacity of cables, the permanent connections being those shown in Fig. 145.

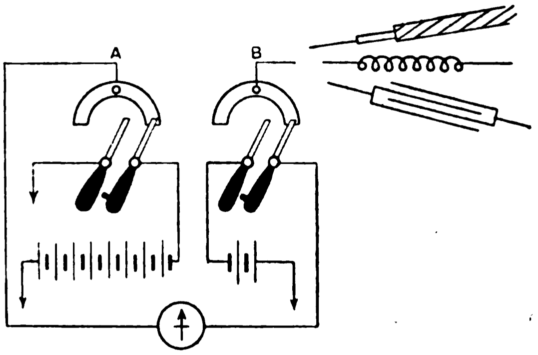

Fig. 145.—Combination Testing Set.

48. Calibrating the Slides.—The slides afford a most convenient means of measuring any potential or difference of potential direct in volts, answering the same purpose in fact as a potentiometer. A fairly large battery is connected to the extreme ends 0 and 101 of the slides (Fig. 146), and a standard cell, galvanometer and key are joined between the travelling contact *c* and the terminal 0 of the left-hand box. The battery and standard cell are joined so that their E.M.F.'s are in opposition. Balance is obtained in the usual way by

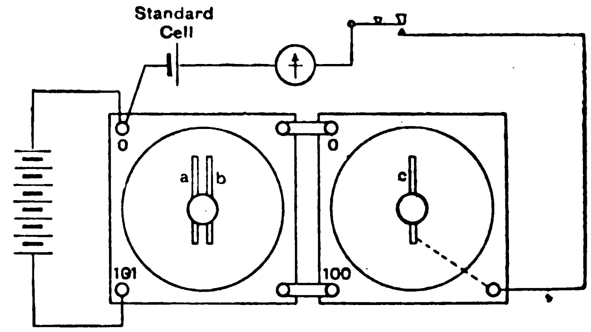

Fig. 146.

moving the contact arms (first the arms *a* and *b*, and then the single arm *c*), meanwhile tapping the key at intervals until a position of the arms is found at which no current passes through the galvanometer when the key is closed. At the particular point of contact on the slides so determined the potential is equal to the E.M.F. of the standard cell. This will be clear from Figs. 147 and 148, which represent the same connections as Fig. 146, but in a theoretical form.

In Fig. 147 the thick horizontal lines marked 0 to 101 and 0 to 100 represent respectively the resistances in the two boxes of the slides. As previously explained, the arms *a* and *b* are insulated from each other and move together, always enclosing two of the 1,000 ohm coils between them.

The single contact *c* moves over a resistance divided into 100 parts, the whole of which is equal to the resistance of the two coils enclosed between *a* and *b* (viz., 2,000 ohms). These two coils are, therefore, equivalent to one coil only, and the difference of potential at the ends of this equivalent of a single coil

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is subdivided into 100 parts. We have therefore 100 coils, each of which is 1,000 ohms resistance, and capable of subdivision into 100 equal parts. The total resistance is therefore 100,000 ohms, but it is scarcely ever necessary to take into account the actual resistance. All that is necessary to consider is that we have 100 coils of equal resistance, each of which can be divided into 100 equal parts, making therefore 10,000 equal parts or divisions. We may therefore still further simplify the diagram by a single line representing 10,000 equal resistances (as in Fig. 148), over which the potential falls uniformly. One travelling contact c moving over such a set of 10,000 equal coils amounts to exactly the same thing as the two sets of coils and travelling contacts in the slides.

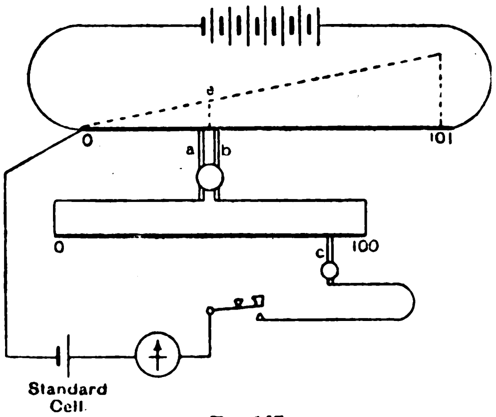

Fig. 147.

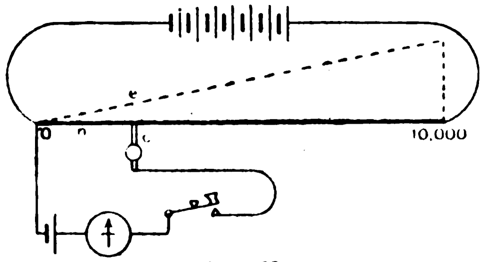

Fig. 148.

Suppose now that the slide reading is n divisions when the standard cell is balanced. We then have a direct calibration of the slides in volts, the difference of potential per division being equal to

$$\frac{e}{n} \text{ volts.}$$

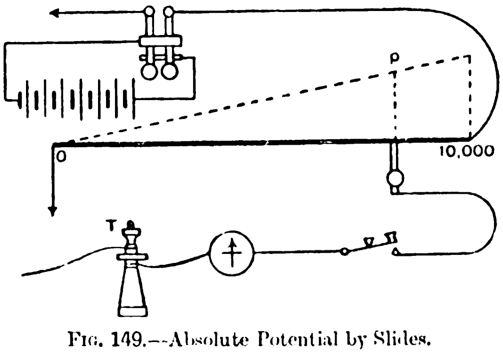

Fig. 149.—Absolute Potential by Slides.

For example, say the slide reading at balance is 967, with a standard cell of 1·45 volts; then the potential corresponding to each one of the 10,000 slide divisions is equal to

$$\frac{1{\cdot}45}{967} \text{ volts,}$$

and any other potential which it is desired to measure can be obtained in volts by multiplying the corresponding slide reading by the above ratio. For example, say we have a connection at the terminal T (Fig. 149) to a point in some circuit, the potential (p) of which is required. The battery on the slides (the same as used when calibrating) is connected to a reversing key, so that the right direction of current can be put on to oppose the potential p. Balance being obtained, say with a slide reading of 2,667, we have at once a direct measurement of this potential in volts, viz. :—

$$\frac{1{\cdot}45}{967} \times 2{,}667 = 4 \text{ volts.}$$

For the purpose of this test, the E.M.F. of the battery connected to the slides need not be known, but it must exceed any potentials that are to be measured on the slides, and, if altered at any time, a fresh calibration reading with the standard cell will be necessary.

(To be continued.)

ENGLISH INTERNATIONALISM.*

BY E. HOSPITALIER.

Our readers may reassure themselves. The subject of this article has nothing to do with Foreign Policy nor the Egyptian Question, provisionally settled by the "J'y suis, j'y reste" of our good friends across the Channel, who would like to make it eternal. The subject we propose to deal with is purely scientific. We propose to consider English internationalism from the point of view of the service which it may render to the cause of the unification of the symbols, notations and units of physical science. We have devoted ourselves for the past 12 years to this cause, in which we have up to the present met with more rebuffs than successes, and though we have often met with indifference, and sometimes with hostility, nowhere has this hostility been so keen as in England, the country whose marvellous system of units secures for it the compassionate admiration of all civilised nations.

After the Electrical Congress held in Chicago in 1893, a table of notations, abbreviations and symbols, which had been recommended by the Committee on Units, was printed and distributed in America by the *Electrical World*, and in France by *L'Industrie Electrique*. These symbols are slowly spreading. They have made their mark, and with time will end by imposing themselves. The establishment of a system of international symbols is not an easy thing, and it was necessary to compromise by taking letters representing quantities, some from one country and some from another, and here the truly international character of our neighbours shows itself. They have accepted without demur P as the symbol of power and W as the symbol of energy or work, but they will not hear of I for current, which they persist in denoting by the letter C, and as C was chosen for capacity, they substitute for this the letter K, thus, rather than change their custom in the slightest degree, destroying the economy of letters practised in the original plan. To accept the concessions of others, but to make none themselves, is characteristic of English internationalism. This was also recently shown in *The Electrician* of May 31, 1895, in connection with the symbols denoting magnetic quantities, and in connections with the names provisionally adopted last year by the American Institute of Electrical Engineers. This is the way in which our contemporary rejects the one and the other :—"Every individual is, of course, entitled to have his own opinion as to the relative merits of 'block' and 'black' letters ; but the use of 'block' letters having become well established in this country, where modern magnetism took its growth, we may be pardoned for refusing to countenance any further this anarchic tendency of every new writer on magnetic subjects to employ whatever symbols and terms seem good in his own eyes. The strange names which Messrs. Houston and Kennelly employ for the numerous magnetic units they refer to are quite unnecessary additions to the jargon of science, already sufficiently irritating, and they possess neither the sanction of authoritative nor of international usage, notwithstanding their adoption by the American Institute of Electrical Engineers. The hasty introduction of superfluous names and terms cannot be too strongly deprecated, both in the interest of science and of sense."

In its misoneism, as excessive as it is national, our contemporary falls into a double error, both with regard to the symbols of physical quantities and with regard to the units. This we will proceed to prove.

Modern magnetism has received its development in England. This declaration lacks modesty, but it is correct, and it affords us an argument in favour of "ronde" [German text] type. It was the Papers presented to the Royal Society in 1885 by Dr. Hopkin-

* From *L'Industrie Electrique.*

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son and Prof. J. Ewing, which specially contributed to this development. Now as we write this article we have under our eyes extracts from the *Philosophical Transactions* of the Royal Society, and we assert that the symbols used to denote the magnetic quantities, $\mathfrak{B}$, $\mathfrak{H}$ and $\mathfrak{I}$ are in "ronde" letters. It was from the English Papers of Ewing and Hopkinson that we borrowed the symbols which figured in the table recommended by the Committee on Units of the Chicago Congress, and it is the English to-day who most oppose the use of "ronde" letters which were also employed by Clerk-Maxwell in his celebrated treatise !

We think we have found the reason for this hostility and for the change in symbols. "Ronde" letters at the time, about 1885, that the new contributions to magnetism appeared, were only to be found in a small number of printing offices, and they were replaced by Gothic letters, almost illegible, and ugly to look upon. The idea then occurred to an economical printer—"business is business"—to replace Gothic letters by the block letters which the English will not to-day let go. Should so much of the commercial spirit be allowed to enter the minds of men of science, and would it not be simpler to render homage to Maxwell, Ewing and Hopkinson by adopting "ronde" letters,* and abolish these horrible block letters, which disfigure a book and take an enormous time to write on the blackboard.

As to the employment of one and the same unit, the "gauss," to express the magnitude of the magnetic field $\mathfrak{H}$, and the magnetic induction $\mathfrak{B}$, nothing is more natural. In the electromagnetic system, these two physical quantities have the relation $\mathfrak{B}=\mu\mathfrak{H}$ on the fundamental hypothesis that μ is an abstract number—a simple numerical ratio. So long as the absolute dimensions of magnetic permeability have not been determined in terms of L M T, it will be logical and rational to measure $\mathfrak{H}$ and $\mathfrak{B}$ by means of the same unit; in the same way as the same unit, the centimetre, is used to measure lengths, breadths, heights, thicknesses, coefficients of induction in the electromagnetic system, and capacities in the electrostatic system. In all the Papers of Lord Kelvin, an indisputable authority in England and the entire world, are not resistances even expressed in centimetres? Does not Dr. Hopkinson express couples (torque) in joules in his investigations on tramways. Lord Kelvin, however, knows that a resistance is not a velocity, and Dr. Hopkinson that a couple is not work. Nevertheless, they make use of these units, and with good reason, since they are the result of logical hypotheses made with a view of establishing as coherent and simple a system as possible. On the day that a more advanced state of science permits of the suppression of these hypotheses, and of the establishment of the absolute dimensions of physical quantities, and on that day only, everything may be begun afresh, and new names created in great numbers, since it will no longer be legitimate to measure all quantities not having the same dimensions in terms of the same unit. But in the actual state of science, and in view of the fundamental hypothesis which serves as the basis of the electromagnetic system—an hypothesis which makes magnetic permeability a simple numerical ratio—it is coherent, logical and rational to measure $\mathfrak{B}$ and $\mathfrak{H}$ in terms of one and the same unit. It is more logical and rational, then, to express "resistivities," as our contemporary often does, either in ohms or ohms per cubic centimetre, a "resistivity" not being either a resistance nor the quotient of a resistance into a volume.

As to the utility of the names upon which *The Electrician* throws doubt, we must be allowed to inform our contemporary that there is no doubt about it, and that at any rate for educational purposes these names render the greatest service. They have the advantage of giving a concrete idea of the quantity measured and of indicating its nature by the mere enunciation of the name of the unit in which the quantity is measured.

As to the reproach that the magnetic units have not the sanction of international usage, "C'est une vérité de la Palice." These units date from hardly a year ago, and have not yet spread, and it is not the systematic hostility of *The Electrician* which will contribute to that end. But their use will extend in spite of it, as the metric system has spread all over the world in spite of the opposition of England.

* For the edification of our readers we reproduce below the four symbols most employed in magnetism, printed in the different types still in use:—

Italic capitals	*B*	*H*	*I*	*R*
German text	$\mathfrak{B}$	$\mathfrak{H}$	$\mathfrak{I}$	$\mathfrak{R}$
Block	**B**	**H**	**I**	**R**
Gothic	𝕭	𝕳	𝕴	𝕽

This table shows that gothic letters are neither legible nor easy to write. Block letters are too black, and it has been proposed to reserve them for photometric quantities, which are but little used. Italic capitals are partly employed for other quantities. "Ronde" letters, therefore, are specially suitable for magnetism.

The utility of international symbolism needs no further demonstration. Since 1893 "reactance" and "impedance" have made their scientific journey, and as an agreement has not yet been arrived at as to the symbols for these quantities, the divergences of writers in this respect are exceedingly curious. M. Blondel employed K and Z, Steinmetz *s* and *u*, MM. Bedell and Crehore K and J, &c. One can imagine the perplexity of unfortunate men who, wishing to study a subject, are first obliged to study the symbols adopted by different authors, symbols which they would be sure to confuse when comparing results. But in this matter of symbols we are amused to see the English denying, after ten years time, their scientific gods in order to save the expense of new type. What thinkest thou of thy fellow-countrymen, O shade of Maxwell?

LONDON COUNTY COUNCIL.

ELECTRIC LIGHTING LOANS.

At the weekly meeting of the London County Council, held at the County Hall, Spring-gardens, on Tuesday, Mr. Alfred Hoare moved the adoption of the Finance Committee's report, which recommended, amongst other matters, the following loans:—£7,000 to the Vestry of Hammersmith for the purchase of freehold land in Fulham Palace-road, to the extent of 3½ acres, one half of which is required for the electric lighting station; £850 to the Vestry of Rotherhithe for electric light installation, engine, boilers, &c., at their wharf in Rotherhithe-street; and £687 to the Vestry of Shoreditch for the enlargement of electric lighting station.—The recommendations were agreed to.

TRANSFORMER CHAMBERS.

The Highways Committee reported that the County of London and Brush Provincial Lighting Company had asked the Board of Trade to give a definite decision upon the appeals of the Company, which were the subject of an inquiry by the Board in December last. In February the Committee reported that the Board had intimated that it was not prepared to hold that sufficient reasons had been advanced, either on the ground of public safety or a want of Parliamentary sanction, to justify the Board in refusing to approve of a system of supply involving the use of transformer chambers in the public streets, and that the Board hoped that that decision on the general question would render unnecessary any further action on the appeals lodged by the Company. The Board afterwards approved a description of the supply under the County of London (North) Order, 1892, which contained the following words:—"The converting stations will be street boxes of sufficient size and suitable construction to contain several transformers, room being also provided to enable a man to enter the box and conveniently examine the transformer and controlling apparatus." The Council on April 9th and May 28th disapproved two notices given by the Company, each for the construction of the same 42 of these large chambers in St. Luke's and Clerkenwell, and doubtless that disapproval was the reason for the Company's request to the Board of Trade. The House-to-House Electric Light Supply Company had also appealed to the Board against the Council's disapproval on the Company's notice of the construction of one of these large chambers in Kensington. The Board of Trade had decided to hold a further inquiry into the matter, and the Committee recommended: "That the Highways Committee be authorised to take all necessary measures for making known at the Board of Trade inquiry the Council's objections to the transformer chambers being placed under the public streets, and for this purpose to employ counsel."

The recommendation was agreed to.

ELECTRIC LIGHTING FOR THE THAMES EMBANKMENT AND BRIDGES.

The report of the Highways Committee on the scheme for the lighting of the Victoria Embankment and the Waterloo and Westminster Bridges, which appeared in last week's *Electrician*, again came up for discussion.

Mr. Westacott said that, as they had all other matters to attend to, he would move that the matter be deferred.

This was seconded by Major Probyn, and carried.

The following notices of amendment have been given:—By Mr. Thornton, seconded by the Earl of Onslow: "That the Highways Committee be instructed to obtain reports from the engineer and the chemist upon the question whether the lighting of the Victoria Embankment and the bridges could be improved by the substitution of incandescent burners for those in use." By Mr. E. White: "That the recommendation be referred back to the Committee, with instructions to ascertain and report what is the cost of the present lighting, what would be the cost of incandescent gas lighting, and what would be the cost of electricity supplied by a company.

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PHYSICAL SOCIETY.

At the ordinary meeting of this Society on June 28th, Dr. Gladstone (Vice-President) in the chair, Mr. BOWDEN read a Note on

"An Electromagnetic Effect."

A long glass tube containing mercury and fitted with a small standpipe to indicate the hydrostatic pressure, is passed between the poles of an electro-magnet. On passing a current of about 30 amperes through the mercury in this tube, the standpipe being turned so as to indicate the pressure either perpendicular or parallel to the lines of force of the field of the electro-magnet, movements of the mercury in the standpipe take place. When the standpipe is perpendicular to the lines of force of the field, the mercury rises or falls according to the direction of the current. When the standpipe, however, is parallel to the lines of force, the mercury always rises, whatever the direction of the current.

Prof. S. P. THOMPSON said there appeared to be three unexplained effects, one proportional to the current and the field and reversible, another independent of the direction of the current or of the field, and a third which only occurred while the current was changing in strength. In addition there might be a fourth effect which up to now had not been noticed. The motion of the mercury column was in the opposite direction to that of the drag on a conductor carrying the current. An apparent rise in the pressure might be due to a decrease in the density of the mercury, due to the heat developed by the current.

Mr. BLAKESLEY asked if the author had noticed any changes in level in the mercury reservoirs at the ends of the tube.

The AUTHOR, in his reply, said the reservoirs at the ends were so large that no changes of level were appreciable.

Mr. Rhodes read a Paper on

"The Armature Reaction in a Single-Phase Alternating-Current Machine.

In this Paper the author gives the investigations that were the subject of a verbal addendum to a Paper read before the Society on a previous occasion. He investigates the lag or lead of the E M.F.'s over the current, and applies the results to examine whether the field-excitation of the generator or the motor is strengthened or weakened by the reaction of the armature currents.

Mr. BLAKESLEY said that the conclusion of the author that "either of two alternate-current machines may be driven as a motor by the other, irrespective of their E.M.F.'s," was not invariably correct. The facts of the case were these : The E.M.F. of the motor might exceed that of the other machine to a certain extent, but that E.M.F., multiplied by the cosine of the angle of the electric lag, must yield a product not greater than the E.M.F. of the generator—*i.e.*, using Mr. Rhodes's symbols, $e \cos \theta$ must not be greater than E. Mr. Blakesley gave a geometrical proof of this, but the same proposition had been given by him some ten years ago in the course of investigating the subject generally. This was at a time when Dr. John Hopkinson was, with less than his usual perspicuity, teaching that synchronous alternate-current machines could not be run in series with stability, both doing work. Referring to the author's diagrams, Mr. Blakesley said that in a problem involving so many elements as that under consideration it was impossible, with the limited dimensions of space, to represent the results with the complete generality of a formula. Some elements had to be taken as the independent, others as the dependent variables. The author had considered the power transmitted to the motor, the E.M.F. of the generator and the angle of electric lag as independent. The E.M.F. of the motor was dependent. In Mr. Blakesley's original diagrams the E.M.F.'s were both considered independent, as well as the electric lag, and the powers applied or transmitted as dependent variables. In any case the formulæ properly derived from such diagrams became perfectly general, and it did not appear to him that the change of method indicated could properly be called a new theory on the subject. As a matter of fact, diagrams based on the independence of the E.M.F.'s and the electric lag would furnish a better means of discussing the question of the stability of the motion than Mr. Rhodes's plan, and this might account for the entire omission from the Paper of this important matter.

Prof. S. P. THOMPSON said it was impossible to discuss the question of stability till the subject of armature reaction had been thoroughly investigated. The terms, lag and lead, had been used by Mr. Rhodes in a consistent manner, but this was not always done, and he recommended that the phase of the current which was common to both generator and motor be taken as the standard.

The AUTHOR, in his reply, said he agreed with Mr. Blakesley that there was a limit to the extent to which the motor might be excited, and this upper limit could easily be obtained from the figure given in the Paper. The question of armature reaction was, however, most important, as it might excite the field two or three times more than the original excitation. Since motors were designed to do a certain amount of work, and not the work to fit the motor, it was most natural to take the output of the motor as fixed.

Mr. SHELFORD BIDWELL read a Paper on

'The Electrical Properties of Selenium.'

The author has continued his investigations on this subject, and has come to the following conclusions:—(1) The conductivity of crystalline selenium appears to depend principally on the impurities which it contains in the form of metallic selenides. It may be that the selenides conduct electrolytically, and that the influence of light in increasing the conductivity is to be attributed to its property of facilitating the combination of selenium with metals in contact with it. (2) A selenium cell having platinum electrodes, and made with selenium, to which about 3 per cent. of cuprous selenide has been added, is, even though unannealed, greatly superior, both in conductivity and sensitiveness, to a similar cell made with ordinary selenium and annealed for several hours. (3) Red selenium in contact with copper or brass is quickly darkened by the actions of light, owing, it is suggested, to the formation of a selenide. (4) Crystalline selenium is porous, and absorbs moisture from the air, and it is this moisture that causes the polarisation of selenium after the passage of a current. (5) The presence of moisture is not essential to sensitiveness, but appears to be in a slight degree favourable to it. (6) If cuprous selenide is made the cathode in an electrolytic cell, and a strip of platinum the anode in water, red selenium, mixed with detached particles of the selenide, is deposited in the water. (7) The photo-electric currents, sometimes set up when light falls upon selenium, are dependent upon the presence of moisture, and are no doubt of voltaic origin. (8) Perfectly dry selenium is below platinum in the thermo-electric series.

Prof. MINCHIN [communicated] suggested that selenium "cell" should be called a selenium "resistance." A grid having one terminal made of aluminium and the other of copper might form a true cell, and might generate an E.M.F. when light fell on it. He (Prof. Minchin) would like to know if the author had tried any such cell in which light simply and solely generated an E.M.F. He could not argue that chemical action must necessarily follow the action of light in a cell; for take the case of the oldest photo-electric cell, the thermopile, what chemical action can we show there for all the energy of the incident heat ? Chemical action, due to light, may or may not occur, according to the nature of the cell.

Mr. APPLEYARD asked whether the author had submitted these selenium resistances to the action of electric oscillations. Prof. Minchin's "impulsion" cells were greatly influenced by electric oscillations. The great variation in the resistance with time of the author's cells pointed rather to an effect of contact between the selenium and the electrodes than to an elementary change in the structure or composition. He (Mr. Appleyard) had recently tried to crystallise a supersaturated solution of sodium sulphate by electric oscillations, as well as by direct sparks, and by currents of several amperes, but no crystals could be induced to form. Change of contact, rather than change of structure, appeared to him to be the most promising direction in which to look for an adequate theory of selenium resistances.

Prof. RAMSEY said the quantity of selenium liberated in the electrolytic experiment was much too great to be accounted for by oxygen dissolved in the water. The study of selenium was very interesting, for this substance was in the borderland between those bodies in which the electric conduction was metallic and those in which it was known to be electrolytic.

The AUTHOR, in his reply, said he agreed that the name "selenium cell" was not an appropriate one. He had not tried the effect of electric oscillations.

The Society then adjourned till the autumn.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *July 6, 1895.*

The Niagara Plant.—The first public exhibition of the machinery of the Niagara electrical transmission plant was given last week before the members of the American Institute of Electrical Engineers in attendance at the annual general meeting of that body at Niagara Falls, and the opinion of the 150 or more engineers was unanimous that the plant is an unqualified success. One of the 5,000 H.P. units was in operation, and was run from no load to 5,300 H.P., and the load rapidly varied by large amounts without the slightest noticeable change in performance. The steel field cylinder surrounding the armature weighs, with its magnets, 40 tons, and revolves at 250 revolutions per minute, giving a peripheral velocity of over 9,000ft. per minute. So excellent has been the mechanical execution that at a short distance the machine appears to be at rest, and no tremor is noticeable upon close inspection when large variations in load are rapidly occurring. One of the most interesting parts of the apparatus is the hydraulic governor, furnished with the turbines by Messrs. Faesch and Piccard, of Geneva. During the time of the visiting engineers in the power house the loads were constantly varied, and the operation of this beautiful piece of machinery was watched with the most lively interest. The vertical shafting, 140ft. in length, also attracted much attention. As your readers are doubtless aware, this shafting consists of hollow steel cylinders or tubes, 38in. in diameter, with short lengths

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of solid shafting 11in. in diameter at the three bearings, and so well has it been constructed and aligned that the cylindrical portion was frequently mistaken for the turbine flumes, which, however, are 7ft. in diameter. Visitors to the turbine pit were almost deafened by the intensely shrill noise, which was, presumably, caused by the impact of the water on the buckets of the turbine; the note was extremely disagreeable and penetrating, and rendered the hearing of speech in the pit almost impossible. While no tests have yet been made public, it is said that the efficiency of the turbine approaches 79 per cent. Not a hitch has occurred in the operation of the dynamo, which has been run experimentally at frequent intervals for some time, and on the last day of the meeting 2,000 H.P. were transmitted to the rotary transformer plant of the Pittsburgh Reduction Company, whose performance was similarly satisfactory. In an address delivered before the Institute at Niagara, Mr. Coleman Sellers stated that from the inception of the enterprise no mistake worth mentioning had occurred, and while the extremely conservative policy of those at the helm had much to do with the signal success achieved, yet the engineers who designed and carried out the work might well be proud of what perhaps may be considered one of the most admirable engineering achievements of the age.

The Niagara Meeting of the American Institute of Electrical Engineers.—The twelfth annual meeting of this Institute was the most successful one in its history, the attendance of the members and guests being over 200. Of the 16 Papers read the inaugural address of the President, Dr. Duncan, easily takes first rank, and is besides a contribution of most timely importance in view of the vague notions at present held as to the probable scope of electric traction. The conclusions of Dr. Duncan on this point are that it would not be advisable to substitute electricity for steam in moving heavy freight, nor on tracks over which widely-varying classes of traffic pass. The address was considered rather conservative by some of the more enthusiastic electrical engineers, but the arguments were apparently so well founded that no one attempted any material criticism. Mr. C. P. Steinmetz read two strong Papers; in one the mathematical theory is developed of what is called a general alternating current transformer, which includes the stationary transformer and induction motor as special cases. In another Paper a review of the work done in the last several years in alternating currents is given, and a new system of nomenclature proposed for alternating currents. It is suggested that the name of "polycyclic" be given to other than simple alternating systems, and that a factor be applied to the different systems to designate the balance; according to this the "monocyclic" system would be a "polycyclic" system with a balance factor of zero, and a three-phased system with both sides equally loaded a "polycyclic" system with a balance factor of one. It is interesting to know in this connection that a patent has recently been issued to Mr. Steinmetz for a "polycyclic" system. Prof. F. B. Crocker read a Paper on the application of electric power in factories and mills, giving a large quantity of data giving the amount of power required to drive all the usual machine tools. In a Paper by Mr. Franklin L. Pope an account is given of the transformation at a very moderate expense of an unprofitable town lighting system into a dividend-paying property with the latest types of apparatus. The 10,000 volt Pomona, Cal., plant was described by Mr. G. H. Winslow. This consists of two 120-kilowatt alternators, the energy of which is transmitted to two towns at distances of 13¾ and 28¾ miles, respectively, over No. 7 copper wire. The regulation is accomplished at the generating station; at the two sub-stations, from which the current is distributed, the plant is started up in the afternoon by a clerk and the stations then locked up until the next morning. The plant has been in operation three years and no difficulty whatever has been experienced. An excellent Paper was read by Mr. C. E. Emery giving the yearly cost of steam power in units of 20,000 H.P. He finds that with coal at $2.24 per ton, and for a consumption of 1·25lb. of coal per indicated horse-power per hour, the cost of steam power would be $23.13 for 10 hours on a basis of 20,000 H.P. delivered continuously with 10 per cent. on original cost of plant charged for dividends, and $0.75 per horse-power added for general business expenses.

The English Westinghouse Company.—In the report of the Westinghouse Electric and Manufacturing Company, just issued, it is announced that the parent Company during the past year sold additional patent rights to the English Westinghouse Electric Company (Limited), and with the proceeds purchased Preferred and Common Stock of English holders, so that it now holds $782,500 Preferred Stock, and $1,307,400 Common Stock out of $2,322,750 outstanding, and the parent Company will hereafter direct all of its affairs. All apparatus sold by the London Company has been purchased from the parent Company, it is stated, at profitable rates, and the business of the former has always been profitable; last year it netted, the report states, nearly 5 per cent. on a valuation of $1,000,000. The report adds that the management intends to continue to push business in Great Britain, Continental Europe, and the various Colonies, in order to increase sales of Westinghouse apparatus, and that it is believed that the new prices which will be made to the London Company will enable it to largely extend its sales, and give a permanent value to all of the stock now held by the parent Company.

CORRESPONDENCE.

AMERICAN PRIORITY IN TELEGRAPHING WITHOUT WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The above is the heading under which Prof. Dolbear's letter, which you reproduced in *The Electrician* of June 21st, appeared in the *Electrical Engineer* of New York, U.S.A. May I beg of you to afford me the opportunity of saying a word or two about it?

Nearly fifty years ago, and thirty years before Prof. Trowbridge "made original researches between the Observatory at Cambridge and the City of Boston," your humble servant, the writer of these lines, had also researched on the same subject, and a year or two later published the results of his investigations in an English periodical—the *Mining Journal* of March 31, 1849—under the heading "Telegraph communication between England and France." In that letter, after going into the subject very much like the American Professor in 1880, there will be found my explanation—also not differing much from the Professor's—as to how the thing was to be done; except that, in my case, I proposed a new and delicate form of galvanometer or telegraph instrument for the purpose, while he made use of the well-known telephone. I suggested the erection of lengths of telegraph wires on the English and French coasts, with terminals dipping into the earth or sea, and as near parallel as possible to one another; and I suggested a form of telegraph consisting of "coils of finest wire, of best conductibility," with magnets to deflect them, on the passage of a current of electricity through them, which I expected would take place on the discharge of electricity through the circuits on either side of the water; anticipating, of course, that a portion of the current would flow from the one pair of earth-plates—terminals of one circuit—to the other pair of terminals on the opposite shore. This appears to me to be just about what Prof. Trowbridge proposed to effect, and which Prof. Dolbear says "covers the ground of doing telegraph work by means of earth conduction." If I should be mistaken, would Prof. Dolbear please show me where I missed it? and, as I am proposing to contend for its English origin, I don't see why I should not at the same time claim for myself "whatever of merit or utility there may be in this method of telegraphy without wires"—especially as Prof. Dolbear also says that "it is a discovery, and an important one too," which I now am induced to believe—seeing that he says it is so.

But, Mr. Editor, after all, I don't value at one finger-snap the circumstance that I happened, so early as the year 1849, to suggest a possible mode of telegraphing without wires, and of which, most likely, Prof. Dolbear was ignorant; it is only the apparatus by which I obtained the signals in experiments I made to this end, to which I attach the least importance. In

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a footnote to my letter which appeared in the *Mining Journal* it will be seen that I laid "claim" to a conjunction of coils of wire to convey electricity, with magnets, for the purpose of deflecting them as an original form of "telegraph" working with "the least amount of current and resistance," and "depending much upon the power of the magnets," as a "design or invention of my own." Later on, I will show why I attach importance to the above.

It may interest your readers, perhaps, if I tell them how I came to think that "telegraphy without wires" was a possibility, and that it should have appeared to me to have some value at a time when gutta-percha as an insulator was not imagined, or the ghost of a proposition for a submarine wire existed. At that time, too, it was with the utmost difficulty that efficient insulation could be maintained in elevated wires if they happened to be subject to a damp atmosphere.

It was in the year 1845, and refers to the one only long line of telegraph then existing in England—London to Gosport—which induced me to refuse the accepted theory that currents of electricity discharged into the earth at each end of a line of telegraph sped in a direct course—instinctively, so to say—through the intervening mass of ground to meet a current or find a corresponding "earth-plate" at the other end of it to "*complete the circuit.*" I could only bring myself to think that the earth acted as a reservoir or condenser—in fact, receiving and distributing electricity almost superficially for some certain or uncertain distance around the terminal "earths," and that according to circumstances only. A year later, while occupied with the installation of telegraphs for Messrs. Cooke and Wheatstone (afterwards the Electric Telegraph Company), a good opportunity offered of testing this matter practically upon lengths of wire erected on both sides of a railway. To succeed in my experiment, and detect the very small amount of electricity likely to be available in such a case, I evidently required the aid of a very sensitive galvanometer, much more so indeed than the long pair of astatic needles and coil of the Cooke and Wheatstone telegraph, which was then in universal use as a "detector." The influence of magnetism upon a wire conveying an electric current at once suggested itself to me, and I constructed a most sensitive instrument on this principle, by which I succeeded in obtaining actual signals between lengths of elevated wires about 120ft. apart. This, however, suggested nothing more at the moment than that the current discharged from the "earth-plates" of one line found its way into the "earth-plates" of another and adjacent circuit, through the earth. Later on, I had other opportunities of verifying this matter with greater distances between the lines of wire, and ultimately an instance in which the wires were a *considerable distance apart*, and with no very near approach to parallelism in their situation. Then it was that it entered my head that "telegraphing without wires" *might be a possibility.*

However, to cut a long story short—whether this sort of telegraphy depended upon the earth passage or induction through the atmosphere Prof. Dolbear seems to think the discovery of it to be "meritorious," and I think it is only fair that I should ask for "whatever merit" happens to belong to it—by reason of "*priority.*"

There is just one other item connected with it all which I may be pardoned for introducing now, and that is: In the year 1849 I published, and claimed as a "design or invention of my own," a certain form of instrument which I actually made and used, not only in England, but in North America, in the year 1851, in the interest of a Mr. Henry O'Rielly and others, and which turns out to be the only thing applicable or possible to be availed of in the accomplishment of recording signals in ocean telegraphy—even at the present day.

With reference to the rather significant suggestion of Prof. Dolbear that Prof. Trowbridge's efforts in the direction of "telegraphy without wires" have been "forgotten or ignored," what might I not now retort? But it is not to be expected that everyone shall get to know what everyone else has done in any particular direction, especially when so many years have elapsed, and perhaps before they were born, or could read for themselves or ever were in a position to see the accounts of what others had done in print. This holds good, too, with reference to the form of instrument I claimed in the *Mining Journal* of 1849, when I know for certain that the same design has been patented at least twice in the United States, the last time within a year or two, and illustrated and described as a new invention in the pages of the *Electrical Engineer* of New York. How was that last patentee, or the patent officials at Washington, to know that the *invention* under consideration was common property, and was well known to scores of persons in the United States near half-a-century ago?

Fifty years ago, Mr. Editor, I took charge of the telegraph on the Northampton and Peterboro' Railway on the opening of that line, July 1, 1845. I had then been under the personal training of Mr. W. F. Cooke for three months in the establishment of Robert Reid, the original maker of telegraphs; and I don't think I need be ashamed of suggesting that I may possibly be—if not the oldest—at least the *first* in this country who ever qualified, by a course of practical and theoretical instruction, under competent teachers (of all that was to be acquired at that day), with the object of following the profession of electric telegraph engineer.

Trusting you may insert this letter, although it is very long, and that it may come to be seen that "priority in telegraphy without wires" belongs to this side of the Atlantic and not the other, if no more, and I shall be quite satisfied with the result.—I am, &c.,

J. W. WILKINS.

ARC LAMP GLOBES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On p. 345 of your last issue you refer to a case in which the carbons of an arc lamp were burnt through when used in connection with a spherical silvered globe. It may perhaps be of interest to some of your readers to hear that the use of silvered globes is not at all necessary to produce this effect.

About two years ago, during the trial of a large installation of arc lamps, several of the negative carbons burnt through about an inch above the holder. Egg-shaped opalescent globes were used, and these being elliptical at the top gave such well-defined foci that in some cases I was able in a few seconds to blacken a splinter of wood introduced through the bottom of the globe.

By increasing the size of the negative carbon the C^2R losses were diminished, and the temperature of the carbon sufficiently reduced to prevent its burning.—Yours, &c.,

Chelmsford, July 16, 1895. E. A. N. POCHIN.

LEGAL INTELLIGENCE.

Direct Spanish Telegraph Company (Limited) v. the Owners of the "Caloric."

This action came before the Appeal Court (the Master of the Rolls and Lords Justices Kay and A. L. Smith), with nautical assessors, on Monday last, being the appeal of the plaintiffs against the judgment of Mr. Justice Day in March last. It will be remembered that the case for the plaintiffs was that in November, 1894, the "Caloric," while on a voyage to Bilbao, improperly anchored in a place where the plaintiff Company's submarine telegraph cable was lawfully lying; that she neglected to move therefrom; and refused to take the assistance of a pilot, in contravention of the rules and regulations of the port and harbour of Bilbao, and allowed her anchor to foul and become entangled with the cable; that the defendants' servants negligently or unnecessarily caused the cable to be cut and damaged, and that thereby the plaintiffs suffered loss. The defendants denied that the plaintiffs suffered damage as alleged, and alternatively they said that if the "Caloric" fouled the cable, such fouling was occasioned by the "Caloric" while properly lying at anchor in a proper anchorage ground, encountering a gale of exceptional violence accompanied by terrific squalls, whereby she was driven across the track of the cable; that the cable was not properly buoyed or marked; and that the defendants' servants had no knowledge of and no reason to anticipate the presence of the cable at or about the place of the ship's anchorage. Though the question of whether the captain of the "Caloric" anchored in the right place was the first one in dispute, much of the argument in the original action turned on the point whether the captain ought not to have slipped his anchor when he found that the vessel was entangled in the cables, of which there were two in his place of anchorage. One of these broke through the strain, and the other was cut to get the vessel free from entanglement. The plaintiffs' nautical witnesses said that the

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captain ought to have slipped his anchor; but he and other nautical witnesses for the defendants said that he took the proper course to get rid of the cables. One of the subjects in dispute was which cable he cut. Of the two cables, one—the new one—belonged to the plaintiffs. The old one was the property of the Spanish Government. The contention of the plaintiffs was that theirs was the one cut, that of the defendants that it was the old one which was cut. Defendants' counsel maintained that plaintiffs had not suffered any damage through the action of the defendants' employés. Mr. Justice Day, after consulting with the assessors, came to the conclusion that there was no negligence, and further, was not satisfied that the plaintiffs' cable was cut in the way suggested. Judgment was therefore given for the defendants with costs. The plaintiffs now appealed.

Mr. A. COHEN, Q.C., for the plaintiffs, said the injury was done to the cable by reason of the steamer fouling the cable.

The MASTER of the ROLLS (to Mr. Cohen): Do you say that an accidental fouling of a telegraph cable by a ship is actionable?—Certainly not. But in this case it was seen for at least half an hour that this ship was really hanging on to this cable with its anchor.

Lord Justice SMITH: Then do I understand that the first foul would be accidental, and that it was the hanging on that was negligent?—Yes.

The MASTER of the ROLLS: What is the ground of the appeal? Do you say that the Trinity Masters advised the Judge wrongly on the question of seamanship? They advised him that the captain acted as a prudent and reasonable man would have done. You say that they advised the Judge wrongly.

Mr. COHEN submitted that the advice of the Trinity Masters was inconsistent with the facts and the evidence.

The MASTER of the ROLLS called attention to a portion of Mr. Justice Day's judgment, which ran: "The course taken by the captain was a reasonable course, and the captain was quite justified, as a matter of seamanship, in endeavouring first of all for a reasonable time to get the cables clear without slipping his anchor." His Lordship also referred to another portion of the judgment: "The master acted prudently, and not negligently."

Mr. COHEN submitted that the cable was lawfully there, and that the master was negligent in allowing his vessel to hang on to the cable for half an hour.

The MASTER of the ROLLS said the master did not know he was hanging on to a cable. He did not know where this beastly serpent was!

Lord Justice SMITH added that the Judge had said that there was no reason to doubt the accuracy of the master's statement that he (the master) was not aware of the existence of a submarine cable.

Mr. COHEN was referring to the Submarine Telegraph Act, 1885, when the Master of the Rolls interposed with the remark: "A master of a ship does not know anything about Acts of Parliament, and he is not bound to sit down and read Acts of Parliament."

Mr. COHEN: If he violates the provisions of an Act of Parliament his owners are liable. The master ought to have taken care not to injure the property of others.

The MASTER of the ROLLS: How can he take care if he does not know of its existence? If the master had slipped his anchor it would have gone down to the bottom and been entangled in the cable just the same as before. This telegraph cable was lying there without anything being put there to give notice of its whereabouts.

Without calling upon respondents' counsel, the MASTER of the ROLLS said the appeal must be dismissed. Here the captain found himself, it must be admitted, in a difficult position. It was all very well to say that the captain ought to have sacrificed his owner's property in order to save the property of somebody else. The only question here was, Did the captain do anything which a captain by ordinary care and skill would not have done, and did he omit to do anything which a captain by ordinary care and skill would have done? The learned Judge in the Court below was advised by his nautical advisers that neither of these propositions could be made out against the captain, and the gentlemen who advised them (the Appeal Judges) were of the same opinion. Therefore, although the case was very well put by the plaintiffs' counsel, both Courts were of the opinion that there was nothing like negligence of any kind, and of course if that were so the action could not lie.

Lords Justices KAY and SMITH concurred, and the appeal was accordingly dismissed, with costs.

Corporation of Portsmouth v. Edwards.

This action, which was decided last week at the Portsmouth County Court, was for the recovery of £5 for electric current supplied by the Portsmouth Corporation to a local tradesman. The defence was that the meter which registered the consumption was unreliable, and that the number of units consumed was not so great as recorded. After hearing evidence, the Judge held that the expert evidence favoured the defendant's contention, and he gave judgment for him.—Mr. King (on behalf of the plaintiffs) asked for an adjournment, in order that he might apply for leave to appeal, as the finding was a serious matter for the Corporation.—Mr. Burbidge (for the defendant) argued that Mr. King could not appeal on a question of fact, and in this view his Honour concurred, but said that of course the Corporation would move for a new trial.

Muirhead v. The National Electric Supply Company (Limited).

Lords Justices LINDLEY, LOPES and RIGBY, in the Court of Appeal on Wednesday last, directed that there should be a new trial in the case of Muirhead v. the National Electric Supply Company (Limited), which was tried before Mr. Justice Day in the Queen's Bench Division on May 25th last.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s.

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"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson, price 6s. 6d., post free.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d. post free (abroad 11s.).

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

TENDERS INVITED.—The Corporation of Brighton require tenders for the supply and erection, at their electricity works, North-road, of evaporative brass tube surface condensers, electrically-driven air pumps, and exhaust and condenser pipings. The specification can be seen at the office of Mr. F. J. Tillstone, Town Clerk, Town Hall, Brighton, to whom tenders must be sent before 10 o'clock on Saturday, August 10th.

——— The Salford School Board invite tenders for the installation of the electric light in their new offices in Chapel-street, Salford. Plans and specifications may be obtained from Mr. S. V. Clirehugh, Temple Chambers, Brazenose-street, Manchester, on and after Tuesday next, the 23rd inst. Tenders, addressed to the Chairman of the Board, must be in by 12 o'clock on Wednesday, July 31st. Additional particulars may be obtained from our advertisement columns.

——— The Crown Agents for the Colonies require tenders, to be delivered by 11 a.m. on Thursday, August 1st, for the supply of materials in connection with the installation of the electric light in the Civil and War Department buildings at Malta. The materials required comprise cables and wires, tools, &c., fittings, fixtures, &c., and sundries.

——— Tenders are invited by the Vestry of Hammersmith, London, W., for complete schemes for public and private lighting, and for the supply of motor power in the compulsory area of the

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Vestry's Provisional Order. Some particulars are given in our advertisement columns, and all further information can be obtained of Mr. H. Moir, Surveyor to the Vestry. Tenders have to be sent in by 6:30 p.m. of Wednesday, September 4th.

Tenders Invited.—The Electric Committee of the Belfast Corporation invite tenders for the construction of street culverts, supply of cast-iron pipes and frames, insulators, insulated cable, copper strips, &c., required by the department for one year. Tenders, addressed to the Town Clerk (Sir Samuel Black), Town Hall, Belfast, must be in by Wednesday next, the 24th inst. Our advertisement columns contain additional information.

——— Tenders are invited by the municipal authorities of Biar, Spain, for the concession for lighting the public streets by electricity for five years. Tenders to the Secretaria del Ayuntamiento, Biar (Alicante), Spain.

——— Tenders are required by the 26th inst. by the Dutch Minister of Waterways, Commerce and Industry for (1) the erection of and repairs to telegraph lines between Haarlem and Rotterdam, and (2) in Brabant, Limburg and Gelderland. Tenders to the Minister, at the Hague.

——— The Shropshire Iron Company (Limited), Wellington, Salop, require tenders for a complete electric lighting plant for their works lighting.

——— The Town Council of Whitehaven require tenders for electrical fittings, incandescent lamps, &c., for the year ending July 31, 1896. Tenders must be sent in to the Town Clerk, Whitehaven, by the 26th inst.

——— The District Council of Cowes (Isle of Wight) require tenders for the erection of electrical plant. The tenders have to be sent in to Mr. Damant, High-street, Cowes, before August 27th.

Tender Accepted.—The Hanley Town Council have accepted the tender of Mr. Cornes for the erection of additional buildings required at the electricity works.

Plant for Sale.—The Woolwich District Electric Light Company have two Davey Paxman boilers, two "Bennis" mechanical stokers, with shafting, pulleys, &c., and a 3 h.p. electric motor for disposal. Applications should be sent to Mr. G. E. B. Pritchett, 31, Soho-square, London, W. Further particulars appear in our advertisement columns.

Appointments Vacant.—The Tunbridge Wells Borough Council are prepared to receive applications for the appointment of an assistant electrical engineer. Salary £100 per annum. Applications must be in by the 24th instant. Our advertisement columns contain additional particulars.

——— From our advertisement columns it will be seen that the St. Pancras Vestry (London, N.W.) require two assistant electricians for their electricity and refuse destructor works at King's-road. Salary £100 per annum. Applications, addressed to Mr. Albert E. Pycraft, Chief Clerk, Electricity and Public Lighting Department, Vestry Hall, Pancras-road, N.W., must be in by Tuesday next, the 23rd instant.

——— The Governing Body of the Northampton Institute, Clerkenwell, E.C., are prepared to receive applications for the appointment of a principal. The salary attached to the office has been fixed at £600 per annum, and the duties will commence on January 1st next. Applications must be sent in, before 10 a.m. on September 4th, to the Clerk (*pro tem.*), Mr. J. J. Lambert, 8, Dowgate-hill, Cannon-street, London, E.C. Some further particulars appear in our advertisement columns.

——— The University College of South Wales and Monmouthshire require an assistant lecturer and demonstrator in engineering. Applications should be sent to the Registrar and Secretary (Mr. J. A. Jenkins, B.A.) by August 31st next. Further information is given in our advertisement columns.

Appointment.—Mr. O. V. Thomas, who was for some years at Singapore, some time back joined the Eastern Extension Telegraph Company's service, and was lent by that Company to the Government of British North Borneo. Mr. Thomas has now been gazetted Superintendent of Telegraphs to the British North Borneo Government.

Personal.—It will be seen from the report of the Directors of the National Telephone Company that Lord Balfour of Burleigh (Cabinet Minister in Lord Salisbury's administration) and Col. R. R. Jackson (owing to ill-health) have resigned their seats at the Board of the National Telephone Company.

Bankruptcies.—A meeting of creditors under the failure of J. Torr Todman, electrician, late of 11, Queen Victoria-street, and 36, Bermondsey-street, London, was held last week. The insolvency is attributed to liability on accounts guaranteed by the bankrupt as managing director of a company, and on accommodation bills for which he received no consideration. A proposal was before the meeting to pay a composition of 7s. 6d. in the pound by three instalments of 2s. 6d., the cash to pay the first to be deposited with the official receiver before the Court was applied to for its approval of the arrangement, and the second and third instalments, payable at six and nine months from the date of approval, to be secured by the joint and several promissory notes of the debtor and his mother. The offer was not accepted, the case being left in the hands of the official receiver.

Bankruptcies.—A Receiving Order has been made against the estate of Ronald A. Scott, described as an electrical engineer, The Elms, Acton Hill, Middlesex.

Catalogue.—We have received from Messrs. H. M. Salmony and Co., of Charing Cross-road, London, W.C., a very complete catalogue of electrical sundries. Amongst other items we note silvered-reflector glow lamps which are claimed to be far less liable to peel than the ordinary run of silvered bulbs; cut-outs with diverging contact plates, which thus allow the use of longer fuses than do other cut-outs of the same size, and a simple gravity-action pattern arc lamp. Messrs. Salmony also sell arc lamps and battery carbons, a special style of carbon brush, Arnoux-Chauvin ammeters and voltmeters, dry batteries, &c.

Journalistic Enterprise.—We have to acknowledge the receipt of another summer number of the *Western Weekly News*. Mr. Ernest Croft, the energetic manager of the *News*, is to be congratulated upon his latest attempt to cater for the holiday public. The illustrated description of Western holiday haunts should prove an excellent advertisement for these beautifully-located health resorts.

A Successful Experiment.—"We (*Sheffield Daily Telegraph*) have just completed an interesting experiment, and, as the results may be of use to our readers, we have pleasure in giving details. Owing to the number of engines in and about our basement, we were troubled with great heat, which non-conducting material, electric ventilating fans, and open windows failed to diminish. Much of this heat proceeded from pipes conveying steam from the boilers to the various engines. As we have a dynamo running night and day for lighting purposes, we decided to try electric motors instead of engines, and shut off the steam entirely from all steam pipes. Two motors have been running for the last eight weeks, and the temperature has been greatly reduced. The motors are also an improvement on steam engines, as they are cleaner and noiseless in working. The most satisfactory feature, however, is the economy of electricity. We have most carefully examined our coal consumption, and have had the figures checked, as we did not expect any saving, but the fact remains that we are burning six loads per week less than before the motors were introduced." The *Sheffield Daily Telegraph* offices are amongst the finest blocks of newspaper premises in this country, and such testimony to the suitability of electric motors for newspaper printing work is of the very highest value. The avoidance of noise is in itself no mean recommendation, and the large printing works in the neighbourhood of Fleet-street, London, should prove eager customers for electric motor plant.

British North Borneo.—In reference to the appointment of Mr. O. V. Thomas, mentioned elsewhere, the telegraph line now being constructed for the Government of British North Borneo by Mr. Thomas is overland from the main land opposite Labuan to Sandakan, which country is unexplored, but Mr. Thomas has hopes that the line will be completed within a year.

Fires.—We regret to announce that the works of the General Electric Company, at Chapel-street, Salford, were destroyed by fire on Friday night last. The whole of the five-storey building was gutted. The fire originated on the ground floor, and was difficult of access, and, as a strong wind was blowing, fears were entertained that, notwithstanding the heroic efforts of the firemen, the fire would not be confined to the General Electric Company's premises. Ultimately, however, success attended the firemen's efforts, and little other damage was done. The loss is variously estimated at from £20,000 to £30,000! We are asked to state that the General Electric Company's business will be in no way interfered with, and that orders will be executed with the usual promptitude from heavy stocks in London, Manchester, and Glasgow, as well as from the manufacturing facilities that the Company possess at their various works and shops at Hammersmith, Clerkenwell, Thames-street, &c. New works have been taken at Adelphi, Salford, for which plant, machinery, and tools are now being prepared, and which, when completed, will enable the Company to increase their output considerably.

——— Singularly, another fire broke out on Saturday at Messrs. W. T. Glover and Co.'s works, Springfield-lane, Salford. The fire was discovered in one of the large sheds, and is supposed to have been caused by the overflow of one of the tanks containing composition for cable covering. Owing to a plentiful supply of water being available, the firemen experienced little difficulty in dealing with the conflagration. In this case it is estimated that £1,000 will cover the damage, and the many friends and customers of Messrs. Glover and Co. will be pleased to learn that only one department of the business is affected by the fire, and that all work

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is being carried on as usual and without any delay. The citizens of Salford are certainly to be congratulated upon the efficiency of the fire brigade, as at both these fires property of great value was in jeopardy, and was only saved from destruction by the energetic and successful efforts of the brigade.

CALCUTTA.—An interesting article in a Calcutta exchange points out that, notwithstanding that the City claims to rank fifth in importance amongst the cities of the world, and can at any rate claim to be one of the hottest, the streets, offices and residences of the citizens are still lighted by gas or paraffin, and the electric light is practically unknown. The journal asks why, in the name of all that is practical, economical and progressive, is not the electric light in general use in Calcutta.

CARDIFF.—At the meeting of the Electric Lighting Committee, on Tuesday last, it was agreed that, as the estimated cost of the electric works and plant (£32,500) had been exceeded by £5,000, an additional £7,500 should be borrowed to meet that and other extra expenditure. At the same meeting the borough engineer submitted an estimate of the working expenses of the lighting department (including gas and electricity) for the next six months, the total amount being £5,380. 10s., against £5,580 for the previous half-year.

DOUGLAS (ISLE OF MAN).—The Isle of Man Tramways and Electric Power Bill has been the subject of a petition from the Douglas Town Commissioners to the Tynwald Court Committee. Two schemes are before the Isle of Man authorities, one for the erection of a cable line, and the other for an extension of the present electric tramways. A very liberal offer has been made by the Tramways and Electric Power Company to pay a minimum of £1,500 a year, or 15 per cent. on the gross takings, for the extension of the lease of the shore line for 20 years, and they undertake to construct and work a tramway to Upper Douglas. Some opposition to both schemes was presented, and the Committee adjourned to further consider the matter.

DUBLIN.—A meeting of the Dublin United Tramways Company was held on Tuesday, at which, after declaring a dividend of 5 per cent., the Chairman referred to the subject of electric traction for their lines. The Company's Bill before Parliament was supported by the Town Commissioners of Clontarf, Drumcondra, and Kilmainham, as well as by other important interests in the districts through which their tramways pass, but opposition was offered by the Dublin Corporation and the Commissioners of several of the districts, which necessitated their omitting Dublin City and the townships of Rathmines and Pembroke from the operations of the Bill. The Chairman pointed out that the opposition of the Dublin Corporation was, he thought, owing to a misunderstanding, as the Company were most desirous to meet the Corporation, and to maintain friendly relations. The Company proposed to proceed to construct the line from Dollymount to the boundary of the city, and to be ready by next spring. As evidence of the strong local wish for the electric line the Company had secured signatures from 370 out of a possible 385 frontages on both sides of the line.

EDINBURGH.—The Cleaning and Lighting Committee of the Town Council have decided to recommend that George-street and the various side streets therefrom to Princes-street be lighted by electricity.

FULHAM (LONDON, S.W.).—The Electric Lighting Committee have presented a further report on the lighting of the district by electricity, which states that there are reasonable grounds for supposing that a combined electric lighting and dust destructor scheme could be installed and worked at a profit to the ratepayers. Messrs. Kincaid, Waller and Manville have therefore been asked to prepare a report at a fee of £50. The Capital and Counties Electricity Supply Company have given the Vestry notice of their intention to apply for an electric lighting Provisional Order. The Committee recommend that the application be opposed.

HALIFAX.—Major F. H. Tulloch, M.I.C.E., will hold an official inquiry to-day (Friday) into the application of the Corporation for sanction to borrow £10,000 for electric lighting purposes.

HARROGATE.—At the last meeting of the Town Council it was resolved to wire the Montpellier Baths for the electric light.

HARROW.—Some time back the Electric Lighting Provisional Order obtained by the District Council was transferred to Messrs. Crompton and Hawtayne, who have now notified the Council that they have named the Harrow Electric Light and Power Company (Limited) as their nominees, under the agreement between the old Local Board and themselves. Opposition to the transfer was shown at the last meeting, when it was proposed that the Council should notify Messrs. Crompton and Hawtayne that they were not prepared to go on with the contract. Only two members supported this proposal, and therefore the agreement will in due course be submitted to the Board of Trade for approval.

HENDON (MIDDLESEX).—The District Council are considering the advisability of applying for a Provisional Order for lighting the district by electricity. The Council have under consideration a proposal for lighting the district electrically by the Parfitt system.

ILFRACOMBE.—At a special meeting of the District Council last week called to discuss the electric lighting question, a motion that any further consideration of the matter should be deferred until September next, was approved on the grounds that it would be necessary to obtain expert opinion regarding the proposed purchase of the gasworks, and that, therefore, the electric lighting question should be shelved, at least for the present.

ISLINGTON (LONDON, N.).—At the last meeting of the Vestry a report from the Finance Committee, as to the properties acquired in Burnand-place for future extension of the electric generating station for £5,150, was presented. The Committee recommend that application be made to the London County Council to sanction a loan for this amount for 55 years. The report was agreed to.

KEYNSHAM.—Tenders for the extension of the public lighting in this district were discussed at the last meeting of the Parish Council, when the offer of the Western Electric Power and Light Company to light 77 lamps for £137 per annum, and to supply extra lamps at £2. 5s. each, was accepted.

LUTON.—A junction telephone line between Luton and St. Albans, where trunk line communication with London is now complete, has been erected by the National Company. The Luton town rate of subscription has been fixed at £10. 10s. per annum.

MANSION LIGHTING.—The contract for the electric lighting of Sir Richard Quain's London house has been entrusted to Messrs. Drake and Gorham. About 120 lights will be fixed.

MARYLEBONE (LONDON, W.).—The Vestry have appointed a committee to consider and report on the question of lighting the parish electrically.

MARGATE.—Messrs. Harrap, Hewitt and Duffield, of Queen-street, London, E.C., have been instructed to prepare a preliminary report on the proposed electric lighting of the borough by the Margate Town Council. They are further to advise on the Provisional Order which is to be promoted by the Council in the next Session of Parliament. The fee for these services has been fixed at 25 guineas.

MUSIC HALL LIGHTING.—The Star Music Hall, Dublin, which is said to be one of the largest music halls outside London, is to be lighted electrically.

OSSETT.—No considerable enthusiasm was manifested by the Town Council in a motion discussed last week to purchase the local gasworks. Several speakers pointed to the fact that the establishment of electric lighting works, either by the Council or by a local company, would have the effect of seriously depreciating the value of the gasworks property, and might ultimately leave them with £80,000 worth of gas works on their hands and by the casting vote of the Mayor a proposal to prepare a Bill authorising the Ossett and Aubrey gasworks undertaking, and also to establish an electric lighting works, was approved.

PANAMA.—Advices from Paris state that amongst the many difficulties experienced by the new company which is endeavouring to complete this unfortunate enterprise is the collapse of the Electric Lighting Company, and the imminent failure of the Electric Tramroad Company. About 900 men are employed on the Panama Works.

PORTSMOUTH.—The Town Council have obtained the formal sanction of the Local Government Board to the borrowing of £21,000 for electric lighting extensions.

PROVISIONAL ORDERS.—The Barmouth Electricity Supply Company have notified the District Council of their intention to apply for a Provisional Order to light the district electrically.——The Capital and Counties Electricity Supply Company have given the Wandsworth Board of Works (London, S.W.) notice of their intention to apply for a Provisional Order to supply electric current in the district.——The Brush Provincial Company have notified the Broadstairs and St. Peter's District Council (Kent) of their intention to apply for a Provisional Order for supplying electric current within the district.——At the last meeting of the Ryde (Isle of Wight) Town Council a notification was recevied from the Great Western Electric Light and Power Company that they intend to apply for a Provisional Order to supply electricity to the district. The Council decided to oppose the application.——The Guildford Electricity Supply Company have notified the Dorking District Council of their intention to apply for a Provisional Order to supply the district with electric current. It has been decided to oppose the application.——The Capital and Counties Electricity Supply Company have notified the Clerkenwell Vestry (London, E.C.) of their intention to apply for a Provisional Order to supply the district with electric current.——The Capital and Counties Electricity Supply Company have notified the Poplar District Board of Works of their intention to apply for a Provisional Order to supply electric current to the district.——The Capital and Counties Electric Supply Company have given the Surbiton District Council notice that they intend to apply for a Provisional Order to supply

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electric current within the district. The Clerk was directed to inform the Company that the Council intended to carry out the electric lighting of the district themselves, under the Order which they have already obtained, and it was agreed that at least six firms be invited to send in plans and specifications for an electric lighting scheme.

RICHMOND (SURREY).—The Town Council have decided to sanction some further extensions of the electric light company's mains.

STAFFORD.—The Electric Lighting Committee's report to the Town Council recommends some further extensions of the mains, and the recommendations have received the approval of the Council.

TELEGRAPH WIRE EXPORTS.—Although the export trade of this country in telegraph wire and apparatus connected therewith was slightly more active last month than in May, the aggregate is far below that of last year. Exports increased from £26,942 in May to £99,572 in June, as compared with £341,646 in June last year. The returns for the first half of the year show that exports have amounted to £226,260, compared with £883,741 in the corresponding period of 1894, and £479,195 in the first half of 1893.

THEATRE LIGHTING.—The New Empire Theatre of Varieties, Blackpool, is lighted throughout by electricity. A system of electric heating for the dressing rooms has also been adopted. The work has been carried out by Messrs. Lowcock, Hill and Co.

THE BERNE VOCABULARY.—The members of the important New York Coffee Exchange have recently met and effectively pulled to pieces the new Berne Vocabulary. The citizens of New York are never anything unless they are thorough, and they bring no less than five important objections against the compulsory use of the new vocabulary. They have forwarded these objections to the managers of the international cable companies in New York, with a request that the objections may be laid before the International Telegraph Congress, which meets next year at Buda-Pest.

THE EUROPEAN GAS COMPANY AND THE ELECTRIC LIGHT.—The annual general meeting of the European Gas Company was held on Monday, Mr. J. Blacket Gill in the chair. In their report the Directors stated that one of the causes of the decrease in the rental was that the Company had now, with one exception, to contend with the electric light at all its stations. "The Directors have in many cases been able to meet this competition by introducing incandescent gas burners, and by making special concessions in price to large consumers, but in spite of these measures they have to acknowledge that their efforts are not entirely successful, and that where the cost of lighting is not a consideration they frequently lose good customers." The Chairman, in subsequently addressing the shareholders, stated that the general manager and he had visited their works this year, and had found everything in a satisfactory condition as far as the works were concerned. They could not, however, help being struck with the great inroads electricity had already made among their consumers, because there were rarely shops of any standing at all that had not the electric light. The café proprietors informed them that their customers almost insisted on having the electric light, not matter at what cost. The Company had therefore found it very difficult to compete with it.

WINDSOR.—A question as to how far the subject of producing electric current by water power for the use of this town was considered at the last meeting of the District Council. Mr. Alderman Dewe said the matter was in the hands of Mr. F. H. Medhurst, and the Electric Light Committee were awaiting his report. Particulars which had been required by Mr. Medhurst had been supplied by the Committee, and Mr. Medhurst is in his report to deal not only with the question of the best means of supplying the electric light, but also the addition of a refuse destructor. Some dissatisfaction was expressed at the delay in the settlement of the electric lighting matter, particularly as the Council possess an Electric Lighting Order.

WITHINGTON.—The Manchester Suburban Electric Supply Company have given the Withington District Council notice of their intention to apply for a Provisional Order to supply electric current within the district. After considerable discussion it was resolved at the last meeting that the Council withhold their consent to the proposal for the present, and a motion "that a sub committee be appointed to consider and report as to the desirability of obtaining powers to light by electricity the more populous portions of the district, and that they be empowered to retain the services of an electrical engineer for the purpose," was rejected by eight to four. The matter is to be further considered later.

WOLVERHAMPTON.—The Town Council have adopted the recommendation of the Lighting Committee (referred to in our issue of the 5th inst.) as to electric lighting extensions, at a cost of £5,000.

ANNUAL OUTING.—The employés of the Electrical Company of Charing Cross-road, and of the British Agency of the Calmon Asbestos and Rubber Works, of the same address, with a number of guests, held their second annual outing on Tuesday. A dinner was served on an electric launch, under the presidency of Mr. F. T. Eggers, the Managing Director. The numerous party enjoyed a pleasant holiday.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification a companies application an asterisk is suffixed.*

June 29, 1895.

12,596. A. G. NEW and A. J. MAYNE. London. Improvements in apparatus for automatically governing electric transformers.

12,613. J. G. LORRAIN. London. Improvements in or connected with electric railways or electric transport. (F. C. Esmond, United States.)

12,614. J. G. LORRAIN. London. Improvements in or connected with electric railways or electric transport. (F. C. Esmond, United States.)

12,615. J. G. LORRAIN. London. Improvements in or connected with electric railways or electric transport. (F. C. Esmond, United States.)

12,616. J. G. LORRAIN. London. Improvements in or connected with electric railways or electric transport. (F. C. Esmond, United States.)

12,617. J. G. LORRAIN. London. Improvements in or connected with electric railways or electric transport. (F. C. Esmond, United States.)

12,622. A. MÜLLER. London. Improvements in secondary or accumulator cells.*

July 1, 1895.

12,651. R. HEATHERFIELD and W. S. RAWSON. London. Improvements in electrolytical apparatus.

12,683. T. BERDELL. London. Improvements in or relating to telephone transmitters.

12,690. C. BRAULT and C. JEANTAUD London. Improved means for regulating the speed of electrically propelled vehicles.

12,697. A. HANSEN and H. H. FRIMAND. London. An automatic electric fire alarum and indicator of heavy air in a room or other enclosed space.

July 2, 1895.

12,711. J. A. LONDON and H. P. BAILEY. Newcastle-on-Tyne. Improvements in or connected with the insulation of copper conductors for electric light wires, cables, telephones, all electrical work and other purposes.

12,717. J. COCKING. Sheffield. An instrument for acquiring the art of telegraphy.

12,719. J. ESTRADE. Glasgow. An improved filament for incandescent electric lamps.

12,772. L. G. ROWAND. London. Improvements in automatic safety devices for electric circuits.*

12,773. J. A. KINGDON. London. Improvements in or relating to the generation of electricity and the mode of operating steam dynamos and the like, and in apparatus therefor.

July 3, 1895.

12,824. J. W. GIBBS. Liverpool. Improvements in or relating to engines for ventilating fans, dynamos, steam launches, and other purposes where economy of space is required.

12,836. C. M. DORMAN and R. A. SMITH. Salford. Improvements in automatic electric cut-outs.*

12,869. J. L. JACK, Jun. London. Improvements in or relating to automatic electric time calls.

12,871. C. A. MCEVOY. London. Improvements in electrical circuit closers.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

5,537. HEATHERFIELD and RAWSON. Electrical deposition of zinc, &c.

7,205. GOMESS. Electro-deposition of aluminium, &c.

12,552. NISBETT. Protecting electric cables.

12,707. VERITY. Electric lampholders, &c.

13,148. HARRISON. Electrical measuring and recording instruments.

21,330. HÜBNER galvanic batteries.

1895.

52. BIDDLE. Electric lighting apparatus for railway cars.

4,120. MEEK. Electric heaters.

5,259. REED. Battery plates.

5,313. CRAWLEY and SOAMES. Ohmmeters, &c.

5,701. MACINTIRE. Arc lamps.

9,056. SIEMENS BROS. AND CO. (Siemens and Halske). Safety appliances for electric circuits.

9,095. BUCHWALD. Cutting-out appliances.

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COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Company (Limited).

The following report is issued by the Directors of this Company for the half-year ended March 31st last, and will be presented to the forty-sixth half-yearly ordinary general meeting to be held at Winchester House, 50, Old Broad-street, E.C., on Thursday next, the 25th inst., at one o'clock:—

The revenue for the period amounted to £420,526, from which are deducted £98,060. 4s. 8d. for the ordinary expenses and £52,730. 0s. 2d. for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £3,222. 19s. for depreciation of spare cable, £1,813. 5s. due to revaluation of currency assets, and £5,812. 4s. 7d. for income tax, there remains a balance of £258,887. 6s. 7d., to which is added £59,175. 16s. 6d. brought from the preceding half-year, making a total available balance of £318,063. 3s. 1d. From this balance there have been paid—

	£	s.	d.
Interest on Debentures and Debenture stock	27,514	12	8
Dividend on Preference shares	20,296	6	8
An interim dividend of 2s. 6d. per share on the Ordinary shares	50,000	0	0
	£97,810	19	4

Leaving a balance of £220,252. 3s. 9d., out of which the Directors have placed £9,000 to the reserve fund for maintenance ships and £100,000 to the general reserve fund.

The Directors now recommend the declaration of a final dividend for the year ended March 31st of 2s. 6d. per share and a bonus of 3s. per share, amounting together to £110,000, both payable on the 25th instant, free of income tax, and making, with the three previous payments on account, a total distribution of 13s. per share or 6½ per cent. for the year on the Ordinary shares. The balance of £1,252. 3s. 9d. is proposed to be carried forward to the next half-year. The revenue includes £32,914. 10s. dividends and bonus for the half-year upon the Company's investments in the Eastern and South African, the Black Sea, the Direct Spanish, and the African Direct Telegraph Companies.

Anglo-American Telegraph Company (Limited).

The report of the Directors of this Company, to be presented at the ordinary general half-yearly meeting to be held at Winchester House, Old Broad-street, E.C., on Friday next, at 2 o'clock, is as follows:—

The total receipts from January 1st to June 30th last, including balance of £485. 6s. 2d. brought forward, amounted to £141,715. 4s. 11d., which is subject to revision, as the financial result of the judgment given in favour of this Company against the Paris and New York Telegraph Company cannot yet be determined. The traffic receipts show an increase of £9,382, compared with the corresponding period of last year. The total expenses of the half-year, including the repair of cables, &c., were £55,384. 2s. 4d., a decrease of £332. 13s. 2d. The Directors have, before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £74,331. 2s. 7d. One quarterly interim dividend of 10s. per cent. on the Ordinary stock, and of £1 per cent. on the Preferred stock, was paid on May 1st last, absorbing £35,000, and a second quarterly dividend of 11s. per cent. on the Ordinary stock, and £1. 2s. per cent. on the Preferred stock, amounting to £38,500, will be paid on August 1st, leaving a balance of £831. 2s. 7d. to be carried forward.

The Company's repairing s.s. "Minia" has been employed during the past half-year in the repair of the 1874 cable, broken off the coast of Ireland, and of two of the cables connecting Newfoundland with Cape Breton. She has also been employed by the Direct United States Cable Company for the repair of a cable belonging to that Company, the payment for which appears in the revenue statement.

West African Telegraph Company (Limited).

The following report of the Directors of this Company for the year ended December 31st last will be presented to the general meeting to be held at Winchester House, Old Broad-street, London, E.C., on Thursday next, at 2:30 o'clock:—

The revenue for the twelve months amounted to £64,761. 5s., against which £17,286. 18s. 6d. is charged for ordinary expenses and £13,473. 9s. 2d. for expenditure relating to repairs of cables, &c. After providing £916. 5s. 3d. for income tax and £26. 11s. 3d. due to re-valuation of currency assets, there remains a balance of £33,058. 0s. 10d. From this balance there have been deducted £11,900. 5s. 10d. for interest on debentures, and £11,766. 13. 4d. for sinking fund, leaving £9,391. 1s. 8d., which has been carried to the general reserve fund.

The Directors record, with regret, the decease of their colleague, Mr. Thomas Fuller, and notify that the vacancy on the Board has been filled by the election of the Hon. A. G. Brodrick. The Directors who retire by rotation are Mr. Robert Kaye Gray and the Hon. A. G. Brodrick, who offer themselves for re-election, as do the auditors, Messrs. Deloitte, Dever, Griffiths and Co.

Accompanying the report, a circular announces that the sum of £9,391 net revenue on the year's working, which has been placed to the credit of the reserve fund, is simply replacing the amount taken from this fund last year on account of heavy repairs. With respect to the year 1895, the result of the first six months' working justifies the Directors in paying an interim dividend of 2s. per share, which is at the rate of 2 per cent. per annum, and will be payable on the 26th instant.

National Telephone Company (Limited).

The report of the Directors of this Company for the half-year ended June 30th last, to be presented to the shareholders at the meeting to be held at the Cannon-street Hotel, London, E.C., on Friday, the 26th instant, at 1 o'clock, states that the income accrued in respect of the business of the half-year amounts to £393,855. 5s. 8d., compared with £359,891 12s. 6d. for the corresponding period of 1894, an increase of £33,963 13s. 2d. The working expenses for the half-year amount to £206,888 10s. 6d., compared with £187,089. 4s. 4d. for 1894, an increase of £19,799 6s. 2d. The net result (after deducting Post Office Royalties amounting to £35,263. 14s. 10d.) is a profit balance of £151,703. 0s. 4d., compared with £140,533. 11s. 2d. for 1894, or an increase of £11,169. 9s. 2d. The rentals carried forward for unexpired terms of running contracts amount to £390,978 3s. 4d., against £345,358. 18s. 5d. at the corresponding period of 1894, an increase of £45,619. 4s. 11d. Out of an available balance of £122,767 13s. 7d. the Board recommend the payment of a dividend at the rate of 6 per cent. per annum, less income tax, on the First and Second Preference shares, 5 per cent. per annum, less income tax, on the Third Preference shares, and 5 per cent. per annum, free of income tax, on the Ordinary shares; and also to transfer £35,000 to the reserve fund, carrying forward the balance of £3,288. 16s. 1d.

The draft of the formal agreement with the Post Office for the acquisition of the Company's trunk lines, having been laid upon the table of the House of Commons in accordance with the promise of the Postmaster-General, the preliminary agreement requisite to give effect to the arrangements was executed on March 15th last. The difficult and somewhat complicated details connected with the transfer of the Company's trunk lines are approaching completion, and payment of the purchase money, now in process of being ascertained, may be expected shortly.

A Parliamentary Committee on telephone questions has had during the past Session many sittings and taken much evidence, but has not made a final report. The inquiry stands over till the new Parliament assembles, when it may be hoped the questions submitted to the Committee will be speedily determined.

The Board, to their great regret, have to announce the resignation of his seat by Lord Balfour of Burleigh, who has taken office as a Cabinet Minister in the recently-formed Administration. During the period Lord Balfour of Burleigh has been a Director, his experience, counsel, and constant devotion to the interests of the Company have been invaluable. His withdrawal is a serious loss to the shareholders, and especially so to his colleagues, who will always retain the highest opinion of his ability, and the warmest feeling of personal regard towards himself. At the general meeting four Directors retire, viz., Mr. James Staats Forbes, Mr. Eli Heyworth, Mr. Samuel Herrick Sands and Col. Robert Raynsford Jackson. The three first named offer themselves for re-election, but Col. Jackson, owing to ill health, is compelled to sever his official connection with the Company, in the foundation and growth of which he has been so long and closely concerned. The auditors (Messrs. Welton, Jones and Co.) also seek re-election.

Chili Telephone Company (Limited).

The report of the Directors of this Company to March 31st last, which is to be submitted to the general meeting at Winchester House, London, E.C., on Tuesday, the 30th inst., at noon, states that a small addition to the tariff made in October caused some subscribers to withdraw, but others have been connected, making the aggregate number at all centres 4,015 at the end of the year, as compared with 3,987 at the beginning, or a gain of 28 for the year. The gross revenue from all sources for the past year compares favourably with that of the previous one: in 1894-5 it was $555,551, and in 1893-4 $504,188, an increase of $51,363. Owing to the additional expense incurred by reconstructing some of the trunk lines which were in bad condition, the expenditure in Chili shows an increase of $39,941.

The net income in Chili from all sources was: in 1894-5 $191,074, and in 1893-4 $179,652, or an increase of $11 422. The average rate of exchange was 13·61d., compared with 13·96d., a fall of 0·35d. Converted into sterling at these rates, the income was: in 1894-5 £10,835, and in 1893-4 £10,448, an increase of £387.

The liquid assets and liabilities in Chili on March 31st last were valued at 16⅞d., the current rate of exchange on that day, compared with 13d. on the corresponding date of the previous year. This increase represents £2,751, which has been carried to the reserve fund, raising it to £11,852. London expenditure is £116 less than in the previous year.

The net profit for the year of the whole business was £6,013, against £3,528 in 1894, and the Directors recommend the payment of a dividend of 2s. 6d. per share, being at the rate of 2½ per cent. per annum, free of income tax, leaving £513. 6s. 11d. to be carried forward.

Capital outlay during the year in sterling was £3,845, and the total mileage was:

	Miles.	Yards.
On March 31, 1895	6,420	80
„ „ 1894	6,169	432
An increase of	250	1,408

The General Manager in Chili reports that the prospects of the Company are encouraging, and that affairs are improving in every direction.

Owing to the death of Mr. Thomas Greenwood, Mr. George Keith has joined the Board and has been elected its Chairman. Mr. F. W. Jones offers himself for re-election as a Director, as does the auditor, Mr. Thomas A. Welton.

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NEW COMPANIES, STATUTORY RETURNS, &c.

"BEST" MINERS' SAFETY LAMP COMPANY (LIMITED).—This Company was registered on July 11th, with a capital of £25,000, in shares of £10 each, to enter into an agreement made between W. Ackroyd, of Birkenshaw, and W. Best, mechanical engineer, of Morley (trading as Ackroyd and Best), W. M. Rennie, J. Graham and Harry Chapman, electrical engineers, of Morley, near Leeds (trading as Graham, Chapman and Co.), to purchase and generally deal with certain patents, and to carry on the business of manufacturers of and dealers in lamps of every description. The subscribers, with one share each, are: W. Ackroyd, A. Ackroyd, G. L. Pitt, W. Best, J. Graham, H. Chapman, and J. C. Best. Registered office: 48, Albion-street, Leeds.

GALLOWAYS (LIMITED).—This Company was registered on July 12th, with a capital of £115,000, in £100 shares, to take over as a going concern the business carried on by a company of the same name, incorporated in April, 1889, at Ardwick, Manchester, to enter into an agreement between the old Company and J. W. Pollitt (its liquidator) and the new Company, and to carry on the business of engineers, boiler makers, founders, tool makers, metal workers, electricians, suppliers of electricity for the purposes of light, heat and motive power, &c. The subscribers, with one share each, are: C. J. Galloway, E. N. Galloway, A. W. Galloway, J. H. Beckwith, H. Bowman, W. E. Norbury, R. Mottram and C. Rought. The first Directors are: J. Galloway, W. E. Norbury, C. Rought, C. J. Galloway, E. N. Galloway, A. W. Galloway and J. H. Beckwith—the four last-named to be Managing Directors.

CANTERBURY ELECTRICITY SUPPLY COMPANY (LIMITED).—The statutory return to October 30, 1894, was recently filed. Out of a nominal capital of £50,000, in £5 shares, only the seven subscribers' shares have been taken up, and no calls have as yet been made.

CHATHAM, ROCHESTER AND DISTRICT ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return to June 12th has been filed. The nominal capital is £50,000, in £5 shares. 3,890 shares have been taken up, of which 1,863 have been issued as fully paid. The full amount has been called on 2,000, and £2 per share have been paid on the remaining 27 shares.

CHINA AND JAPAN TELEPHONE COMPANY (LIMITED).—The annual return to May 28th has been filed. The capital is £20,000, in £1 shares, of which 14,761 have been taken up, and all issued as fully paid.

CUTTRISS, WALLIS AND CO. (LIMITED).—The annual return to May 10th has been filed. The nominal capital is £10,000, in £5 shares; of these 651 have been taken up, and 300 have been issued as fully paid. The full amount has been called on the remaining 351 shares; 120 shares have been cancelled.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The annual return to May 15th has been filed. Out of a capital of £3,000,000, in shares of £10 each, 250,000 have been taken up. The full amount has been called and paid on each of these shares.

ELECTRIC WIRE AND FITTINGS COMPANY (LIMITED).—The annual return to January 24th last was filed on June 27th. The nominal capital is £5,000, in £1 shares, of which 1,382 have been subscribed for and allotted, and the full amount has been called and paid thereon.

EVERED AND CO. (LIMITED).—The annual return has been filed. Out of a nominal capital of £200,000, in £10 shares, 16,496 have been allotted. The full amount has been called on 6,744, and £7 per share on the remaining 9,752.

GENERAL ELECTRIC TRAMWAYS COMPANY (LIMITED).—The statutory return to July 4th has been filed. The nominal capital is £50,000, in £1 shares, of which 5,007 have been allotted. The full amount has been called and paid. Of these shares, 5,000 are held by The Electric Construction Company (Limited).

NORWICH ELECTRICITY COMPANY (LIMITED).—The annual return to May 8th has been filed. The nominal capital is £50,000, in £10 shares, of which 2,695 have been taken up. The full amount per share has been called and paid.

CITY NOTES.

AMAZON TELEGRAPH COMPANY (LIMITED).—Letters of allotment in the recent issue of this Company's capital have been posted.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).—The Directors of this Company, after placing the sum of £6,000 to the credit of the renewal fund, have declared an interim dividend for the quarter ended June 30th of 11s. per cent. on the Ordinary stock, and £1. 2s. per cent. on the Preferred stock, less income tax, payable on August 1st.

CITY AND SOUTH LONDON RAILWAY (LIMITED).—The accounts of this Company for the half-year ended June 30th show a balance, after providing for debenture interest and the full dividend on the Five per Cent. Preference shares, sufficient to allow the payment of a dividend on the consolidated Ordinary stock at the rate of 1½ per cent., carrying forward a balance of £965 to the new account. The dividend for the corresponding period last year was 1 per cent., the balance carried forward being £1,336. The traffic returns for the week ended July 14th were £848, as against £882 in the corresponding period of 1894, a decrease of £34. The total receipts for the half-year, 1895, amount to £1,763, against £1,761 in the corresponding period of 1894, an increase of £2.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The Directors of this Company have resolved to recommend a final dividend of 2s. per share, free of income tax. With the interim dividends already paid this represents a distribution of 2 per cent. for the year. £7,000 is placed to the reserve fund account, and £1,410. 0s. 9d. is carried forward.

EDISON ELECTRIC ILLUMINATING COMPANY OF BROOKLYN.—At a recent special stockholders' meeting of this Company the capital stock was increased $750,000, to $3,750,000. The Directors were authorised to issue additional bonds to the amount of $500,000 for the purpose of purchasing the capital stock of the Citizens' Electric Illuminating Company and for extensions of the combined plants.

ELECTRIC ORGAN COMPANY (LIMITED).—Letters of allotment in the recent issue of the capital of this Company have, it is stated, been posted.

INTERNATIONALE ELEKTRICITATS-GESELLSCHAFT (VIENNA).—At the recent annual general meeting of this Company it was reported that during the past year there were applications for current equivalent to 28,000 16-c.p. lamps, which brings the total up to 110,000 lamps. In the same period the number of arc lamps rose from 1,059 to 1,536. The total capacity of the station is at present 5,400 H.P., but extensions are already in progress which will increase this output to 7,200 H.P. The Company has declared a dividend at the rate of 7 per cent. for the past year, against 6 per cent. in 1893.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 14th inst. amounted to £1,186. The amount for the corresponding week last year was £905; increase, £281.

LYNN AND BOSTON RAILROAD COMPANY.—This is a street railway company, incorporated in 1859, in the State of Massachusetts, U.S.A., and applications have been invited for $2,500,000 Five per Cent. First Mortgage Thirty-year Gold Bonds of $1,000 each, payable to bearer. The price of issue is 108 per cent., equal to £216 per bond. The issue is made through the Bank of Montreal. The bonds are secured by an indenture of mortgage, in virtue of which the total issue of 5,379,000 bonds (of which the present issue forms a part) are a first lien on the Company's property. The Company's system comprises 150 miles of track, all but seven of which are operated by electricity, the number of passengers carried in 1894 being 22,548,576. Since 1880 8 per cent. per annum has been paid on the capital stock of the Company, whose present capital amounts to $1,000,000, fully paid. The gross earnings of the Company have steadily increased from 1885 to 1894 from $368,670 to $1,238,410, with surplus profits of $36,210 and $113,078 respectively. Recent improvements and additions have resulted in an immense saving in the cost of producing power. The list for subscription opens on Monday next, and closes not later than four p.m. on the same day. The London address of the Bank of Montreal is 22, Abchurch-lane, E.C., and prospectuses can also be obtained from Messrs. J. and A. Scrimgeour, 18, Old Broad-street, London, E.C.

SMOKE AND FUMES ANNIHILATOR COMPANY, LIMITED (in liquidation).—A meeting of the shareholders in this failure was held on Monday last, when the liquidator, Mr. J. Satchell Hopkins, was authorised to deduct and retain 4s. per share to meet the expenses of liquidation, and the balance paid by subscribers to the Company's capital is to be returned to them. This was the scheme by which Mr. Samuel Elliott, of Newbury, proposed to consume smoke from all descriptions of chimneys, but which has itself ended in smoke, causing serious loss to the shareholders in the Company and bankruptcy to Mr. Elliott himself.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend at the rate of 7 per cent. per annum on the Preference, and 4 per cent. per annum on the Ordinary, shares for the past half-year. The sale of electric current for the quarter ended June 24th last, at 6d. per unit, amounted to £8,593, as against £7,380 at the same rate for the corresponding period of 1894.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have ordered the following securities to be quoted in the Official List:—Further issue of £200,000 Five per Cent. Debenture Stock of the City of London Electric Lighting Company (Limited), in lieu of the provisional certificates now quoted; and 15,000 Preference shares (Nos. 1 to 15,000) of the Tramways Electrical Traction Company (Limited), in lieu of the shares of the Tramways Company of France (Limited) now quoted.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—As announced in our last issue, an interim dividend of 12s. per share will be paid by this Company, and the transfer books will be closed from the 15th to the 23rd inst. inclusive.

WATERLOO AND CITY RAILWAY COMPANY.—The third half-yearly general meeting of the shareholders of this Company takes place at Waterloo Station, London, S.E., on August 8th, at 2:30 o'clock. The transfer books will be closed from July 25th to August 8th inclusive.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended July 12th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,356.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the fortnight ended the 15th inst. were £1,658, as compared with £2,009 for the corresponding period of last year. The March receipts estimated at £5,902 realised £5,891.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY (LIMITED).—To provide funds for the extension of this Company's electricity works subscriptions are invited from the present shareholders of the Company for 9,900 Ordinary shares of £5 each. The prospectus states that the extension of the works is necessitated by the increasing demand for electric current in the city of Leeds. It is proposed to erect a new engine and boiler house on the remaining land which the Company has, and to instal plant equal to 1,000 I.H.P. Should any of the shares now issued remain unapplied for, the Directors take power to dispose of them as they determine.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, July 10.		Price Wednesday, July 17.		Rate per Cent. Yielded.	Dividend Due.	Business Done during Week ending July 17. Highest	Lowest
			TELEGRAPHS					£ s. d.		Highest	Lowest
£1,012,880	Stock	10/0	Anglo-American	47	49	47	49	4 1 8	Jan., Apr., July, Oct.	..	..
£2,993,560	Stock	20/0	Do. Preferred	88	89	88½	89½	4 9 8	,, ,,	89¼	88
£2,993,560	Stock	5/0	Do. Deferred	8¼	8¾	8½	8¾	..			..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 16 2	January and July	103¾	..
130,000	£10	3/0	Brazilian Submarine	13¼	13¾	13½	14	4 12 10	Mar., June, Oct., Dec.	13 13/16	13⅝
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	110	114	111	115	4 6 11	June and December	..	..
10,000,000	$100	1¾%	Commercial Cable Capital Stock	160	165	160	165	4 4 10	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	,, ,,	..	..
12,931	5	2/0	Direct Spanish (fully paid)	3½	4½	3½	4½	4 8 11	April and October	4⅛	..
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10¼	9¾	10¼	4 7 7	,, ,,	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	,, ,,	..	—
60,710	20	2/0	Direct United States Cable, 1877	9¼	9¾	9¼	9¾	4 0 5	Jan., Apr., July, Oct.	9⅜	9¼
400,000	10	2/6	Eastern	16⅝	16⅞	16¾	17	3 16 6	,, ,,	16 15/16	16⅝
70,000	10	6%	Do. 6 per Cent. Preference	17½	18	17½	18	3 6 8	,, ,,	17⅞	17⅝
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	124	127	125	128	3 2 6	May and November	126½	125
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	107	110	107	110	4 12 10	February & August	..	..
250,000	10	6/6	Eastern Extension xd	17¼	17½	17¼	17½	4 0 0	Jan., Apr., July, Oct.	17⅝	17¼
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	124	127	126	129	3 2 0	February & August	126½	126
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	106	102	106	4 14 4	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	106	102	106	4 14 4	,, ,,	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	107	110	107	110	3 13 11	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	111%	114%	112%	115%	3 10 0	May and November	..	..
180,227	10	2/3	Globe Telegraph and Trust	10⅜	10⅝	10⅜	10⅝	4 7 0	Jan., Apr., July, Oct.	10 9/16	10½
180,042	10	6%	Do. 6 per Cent. Preference	17	17½	17	17½	3 9 7	,, ,,	17 1/16	—
150,000	10	5/0	Great Northern	21¾	22¼	21¾	22¼	3 16 3	Jan., April, and July	22⅛	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	..	..
17,000	25	37/6	Indo-European	49	52	49	52	4 13 2	May and November	51½	50
37,548	10	2/6	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	106	110	107	111	5 10 1	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	106	109	107	110	3 12 9	..	107½	..
11,839	8	4/0	Reuter's	3½	4½	3½	4½	..	April and October	..	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	124	129	123	128	4 13 9	,, ,,	126¼	125
15,609	10	5/0	West African Telegraph	4½	6½	6¼	6¾	..	January and July	..	—
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	103	105	104	107	4 15 9	March & September	105½	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	103	99	104	7 13 10	June and December	101	..
88,321	10	6d.	West India and Panama	¾	1	¾	1	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	9¾	10¼	10	10½	5 14 3	May and November	10 5/16	10¼
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	6 13 4	,, ,,	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	109	112	110	113	4 8 6	June and December	..	..
64,242	15	6/0	Western and Brazilian	11	11½	10¾	11¼	4 0 0	May and November	..	..
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½	6¾	6½	7	..	—	6⅞	6⅞
33,129	7½	1/6	Do. 5 per Cent. Deferred	4½	5	4½	5	..	..	4 11/16	4¾
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	104	108	104	108	5 14 0	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	104	108	104	108	5 14 0	,, ,,	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	6 0 4	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 17 8	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	—	..	—	..
224,850	10/0	1½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	—	May and November	..	—
171,504	£1	8·125d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	..	..
484,597	5	2/6	National	5¾	6	5¾	6	4 3 4	June and December	6⅛	5 15/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	16	17	16	17	3 10 7	,, ,,	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14½	15½	15	16	3 15 0	,, ,,	15⅜	15¼
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅞	6⅛	5⅞	6⅛	4 1 8	—	..	6⅛
1,000,000	Stock	3¾%	* Do. Debenture Stock, 4½% (red.)	105	107	105	107	3 5 5	January and July	105¾	105
58,000	5	3/0	United River Plate xd	2½	3	2½	3	..	,, ,,	2 ½	2 7/16
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	92	97	92	97	5 3 1	,, ,,	93¾	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	15	16	14½	15½	1 12 2	—	15⅛	15
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	16	17	16	17	3 10 7	—	16⅜	..
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	131	134	131	134	3 12 9	June and December	132½	132
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	—	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	—		..		..	—	..	..
8,322	£5	..	House-to-House Electric	—		—		..	—	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	—		..		..	—	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	..	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7¾	7⅞	7⅝	7¾	..	—	..	..
111,000	5	..	London Electric Supply	..		..		..	—	..	—
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	10½	11	10½	11	2 14 7	..	10⅞	10 11/16
£150,000	Stock	4½%	* Do. 4½% Debs.	115	117	116	119	3 15 8	June and December	116½	..
6,452	£10	2/0	Notting Hill Electric	8¼	8¾	8¼	8¾	..	—	..	—
19,980	£5	4/6	St. James and Pall Mall	8¼	8¾	8	8½	..	—	..	..
20,000	£5	7%	Do. 7 per Cent. Preference	9	9½	9	9½	3 13 8	—	9⅛	..
59,900	5	5%	Westminster Electric Supply (fully paid)	7¾	8	7¾	8	3 2 6	—	..	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2¼	2½	2¼	2½	6 0 1	—	—	..
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	—	2 3/16	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	112	115	112	115	3 19 8	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2	2½	2	2½	..	January and July	..	—
12,139	5	..	Edison and Swan United	1¾	2¼	1¾	2¼		..	..	—
£100,000	Stock	4%	Do. 4% Mortgage Debenture Stock	104	107	104	107	4 1 1	..	..	..
£90,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		—		..	..	—	..
120,000	2	..	Electric Construction	¾	1	⅝	⅞	..	..	⅞	—
12,845	2	1/9⅝	Do. 7 per Cent. Cumulative Pref.	1¾	2¼	2	2½	..	..	2 1/16	1⅞
91,195	2	10/0	Elmore's Patent Copper Depositing	1	1¼	⅞	1¼	..	..	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	¼	¾	¼	¾	..	..	..	..
50,000	10	25/0	India Rubber, Gutta Percha, &c., Works xd	20	22	19	21	4 15 3	February & August	20⅜	19⅞
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 7 2	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..	—	..	..
16,000	£10	..	Do. 8 per Cent. Preference	..		—		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)		⅛		⅛	..	..	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	43	45	43	45	5 6 8	March and July	44⅞	43½
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	4 13 6	January and July	..	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,570	10	12/0	W. T. Henley's Telegraph Works Ordinary	10½	11½	10½	11½	5 4 4	..	..	..
£30,000	10	7%	Do. 7 per Cent. Preference	14	15	14	15	4 13 4	..	..	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock	104	107	104	107	4 4 1	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1¼%	City and South London Railway	42	44	42	44	2 16 10	May and November	43	42½
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14	15	3 6 8	..	..	—
£67,130	Stock	4%	Do. 4% Perpetual Debenture	133	135	133	135	2 19 3	May and November	—	..
37,500	£10	2%	Liverpool Overhead Railway	9 15/16	10 1/16	10 1/16	10 9/16	1 13 1	—	..	..
6,295	10	5%	Do. 5% Preference	14½	15½	14½	15½	3 5 7	..	..	..
125,000	Stock	4%	Do. 4% Debenture	110	112	110	112	3 11 5	January and July	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 897. [No. 13. Vol. XXXV.] FRIDAY, JULY 26, 1895. PRICE SIXPENCE.

NOTES.

OUR readers, we feel sure, will share our own pleasure in the resumption this week of Mrs. AYRTON's instructive series of articles on "The Electric Arc." The four months that have elapsed since the publication of the last batch of Mrs. AYRTON's experimental results have been devoted to an exceedingly laborious investigation, and the net result is an equation which represents with surpassing accuracy the connection between volts, amperes and length of arc. The time and labour required to attain this end may be gauged by the fact that with small currents the carbons require from one to two hours to properly form, and that no reliable potential difference reading can be taken before this. Again, almost every point in Fig. 33 represents the mean of several results obtained at different times with different pairs of carbons. In her next article Mrs. AYRTON proposes to discuss previously published equations; these, whilst having an attractively simple appearance, and possessed of apparent generality, scarcely fit the facts so well as the equation deduced by Mrs. AYRTON, and were not, we venture to say, so firmly based on solid experimental work.

WE publish in this number an article by Dr. BEHN-ESCHENBURG, which comes at an opportune moment. At a recent meeting of the Physical Society, in the course of the discussion of a communication from Mr. W. G. RHODES on the running of synchronous alternator motors, Prof. SILVANUS THOMPSON remarked that before the question of stable running could be decided the whole question of the armature reaction in alternators needed investigation. Dr. BEHN-ESCHENBURG's article is a contribution to the subject. His method may be briefly described thus: Having first determined the characteristic curve on open circuit, he determines also for the same range of field excitation what is the electromotive force, and the phase of the same, required to drive the current through the alternator armature itself. From this he determines by use of vector diagrams the magnitudes and phases of the components, depending on the coefficient of self-induction, the armature resistance and the demagnetising action of the armature coils, and eddy currents. Having once determined these components, then for any field excitation and load, and any phase difference between the electromotive force at the terminals and the current, he determines by other vector diagrams the relation between the full electromotive force of the armature and the potential difference at the terminals. Unfortunately, the method is an analytical one only, and difficult to use in designing because some of the important elements have to be determined experimentally; but as indicating the method of attacking the problem the article is very suggestive.

WE cannot, however, agree with Dr. BEHN-ESCHENBURG's contention, that the factor which determines the efficiency and "quality" of an alternator is the fall of potential from open circuit to full load, because this must depend on the purpose for which the machine is designed. Some alternators, principally by American manufacturers, are specially designed, so that on short-circuit the current will not much exceed the full-load current. Specifications have been issued in England recently requiring the current on short-circuit not to exceed by 100 per cent. the normal full-load current. Such alternators could hardly be used if the work to be done was largely motor work, but beyond requiring additional regulation there is little objection to their use for lighting. But, besides this, it is possible to design an alternator so that the phase of the current always leads on the phase of the electromotive force at the terminals, and thus the armature reaction raises the electromotive force. The efficiency and "quality" of such a dynamo would exceed 100 per cent. were Dr. ESCHENBURG's view a correct one.

IN another column will be found a contribution to the controversy respecting the chemical reactions which take place in lead secondary batteries at present being carried on between M. DARRIEUS and various opponents. We could wish that Messrs. ELBS and SCHÖNHERR had followed up their experiments on the electrolytic formation of persulphuric acid by experiments on various cells in actual commercial use, as was done by Mr. ROBERTSON, who first suggested that an important part was played by the reactions occurring in the acid. The latter observer found hydrogen peroxide the principal oxidation product in cells containing acid of density 1·18, while persulphuric acid was the chief constituent in those containing acid of density 1·2, and though a large number of cells engaged on different work were examined, oxidised bodies were found in the acid in every case. Messrs. ELBS and SCHÖNHERR point out that with acid of density of 1·15, and a current density of 4,000 amperes per square metre, and using a platinum anode, no persulphuric acid at all was found. It would be interesting to know

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whether, with the same current-density, and using a lead anode, any peroxide of lead would be formed, as Messrs. Gladstone and Tribe found that with low-current density lead sulphate was the sole product on the positive plate, while by diminishing the strength of the acid, keeping the current constant, the formation of lead peroxide nearly ceased, and a white substance, supposed to be a basic sulphate, took its place. It may well be that, though both persulphuric acid and peroxide of lead depend for their formation on the strength of the acid as well as on the current-density employed, there is no real relationship between them, and that they may be produced independently of each other; but the elucidation of this point would go far to clear up the doubts concerning the chemistry of the lead cell.

Just a year ago we referred in our leading columns to the risk run by modern science of being buried beneath its own accumulations, and to the proposal of the Royal Society to avert this danger by the compilation of an international catalogue of scientific Papers. In another column will be found an abstract of the Report of the International Catalogue Committee, from which it will be seen that the scheme, as was to be anticipated, has met with warm support, and that the net step is to be the calling together in July, 1896, of an International Conference to discuss and settle details. It is to be regretted that replies have only been received from some 50 per cent. of those to whom the Royal Society's circular-letter was sent. On the other, hand it is a matter for congratulation that in no single case was any doubt expressed as to the extreme value of the proposed undertaking, although, unfortunately, no precise information was forthcoming as to what the scheme might be expected to cost, where the money is to come from, and on what lines the idea is to be carried out. We note with satisfaction that English is the language most generally favoured. To our thinking the one factor essential to the success of this vast undertaking is that the actual labour of indexing shall be done by men who have actually read and *digested* the papers to be indexed, and that it shall not be relegated to mere index makers, however clever and conscientious. A central bureau will, of course, be required to collate and correct and publish; but to entrust the actual compilation of the catalogue to a body of individuals without any occupation in life other than this deadening one will result in failure. An index compiled by an army of human machines can serve no useful purpose. The outside co-operation of experts can alone ensure success.

The motion for an injunction against the County of London and Brush Provincial Electric Lighting Company which the Wandsworth District Board of Works brings to-day before Mr. Justice Stirling raises a somewhat important issue. From the beginning, the Wandsworth Board of Works has objected to the construction of transformer-pits under the pavements, and acting in conjunction with the London County Council endeavoured last year to persuade the Board of Trade to veto their use. The decision of the Board of Trade last December was, it will be remembered, in favour of properly constructed transformer-pits, the Board of Trade further holding that it had power under Clause 12 of the Electric Lighting Orders Confirmation (No. 5) Act, 1892, to authorise the transformer-pit system. The clause in question is indeed headed "Street Boxes," but as these may contain apparatus for the regulation and control of the supply of energy, it would appear that "street box" is an elastic term, and might without undue straining be stretched to include a transformer-pit. This is the point which Mr. Justice Stirling is called upon to settle.

After a lengthy and pertinent discussion the London County Council has decided to obtain further information with regard to the cost of the present system of lighting the Thames Embankment and bridges, and estimates of the cost of lighting by incandescent gas burners and by arc lamps supplied with current from a company's mains; the recommendation of the Highways Committee to erect a special municipal station for the sole purpose of this scheme not meeting with much support. Whatever may be the ultimate result of this set-back to the electric lighting of the Thames Embankment, the step taken by the Council is an unusually sensible one. For our own part, we do not fear an impartial investigation by experts of the relative merits of arc and Welsbach lamps for the illumination of main thoroughfares; but it is quite right to make perfectly sure that no mistake is being made in spending nearly £17,000 of the ratepayers' money. Further, it is even more desirable to ascertain whether the work cannot be done equally well and somewhat cheaper by taking the current required from the mains. An annual charge of £2,768, or £33 per arc lamp per annum, is excessive, even if we make allowance for the fact that the capital outlay, which also appears unduly large, has to be repaid in 42 years. We are not at all sure that small arcs placed in the existing handsome gas standards on the Embankment parapet, and supplied with current by a company, would not be found to be on the whole the best and most economical plan.

University College, Bristol.—The session of the Chemical Department of this College begins on October 3rd next.

Journal of the Society of Arts.—The new Index to the *Journal of the Society of Arts*, for Vols. XXXI. to XL. (1882-1892), is now ready.

Académie des Sciences.—Prof. Ramsay has been elected Foreign Correspondent of the Chemical Section of the Académie des Sciences in place of Prof. Frankland.

The Welsbach Light.—The report of the Directors of the Incandescent Gas Light Company for the year ended March 31, 1895, states that the sales of burners for the years ended March 31, 1893, 1894, and 1895, have been approximately 20,000, 105,000, and 300,000 respectively.

Cable Interruptions.—There are again no cable interruptions to notify this week. It is a remarkable fact that the Eastern Telegraph Company have no less than three of their cable steamers laid up in dock in London at the present time.

Purchase of the Liverpool Electric Supply Company's Undertaking.—The purchase by the Corporation of the undertaking of the Liverpool Electric Supply Company has been effected. The sum to be paid amounts to something like £400,000. At the meeting of the Lighting Committee on Monday it was decided that the Chairman, Alderman F. Smith, should draw up a report detailing what had been done, for the information of the Committee and also of the public.

Polyphase Currents.—Next week Messrs. E. and F. N. Spon will publish a new work on polyphase electric currents and

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alternate-current motors, by Prof. Silvanus Thompson. It runs to 250 pages, and has two plates and numerous cuts. At a moment when so much attention is being drawn in the engineering world to the uses of polyphase currents, at Niagara and elsewhere, the book is opportune. Those who are interested in such matters will be glad to know that Prof. Thompson does not omit to mention the two-phase generating station which was established in London so far back as 1883, and which has therefore been 12 years in successful operation.

Personal.—Mr. H. W. Ravenshaw, who has for the past eleven years been chief of the electrical staff of Messrs W. T. Goolden and Co., whose business is now merged with that of Messrs. Easton and Anderson, of Erith, has gone into partnership with Mr. Robert Booth, consulting engineer, of 110, Cannon-street, London, E.C. Mr. Ravenshaw's services have been retained by his old firm as consulting electrical engineer. We wish Mr. Ravenshaw every success in his new departure.

Deaths by Lightning.—On Friday last week at Pockleton, Leicestershire, a farmer in company of his son and nephew, took refuge from a thunderstorm under a hedge, when the lightning struck him and killed him on the spot. The two others escaped uninjured.—Dr. J. T. Reece, a medical practitioner at Ystradgynlais, Breconshire, when out riding on Friday last was killed by lightning, also his horse.—During a heavy thunderstorm on Tuesday last the Belle Vue Church, West Hartlepool, was struck by lightning, and the tower fell with a crash.

The Durability of "Asphalte" Cables.—Herr Görz, of St. Petersburg, writing in the *Elektrotechnische Zeitschrift* on the proposed German wiring rules, and proposing several amendments, refers to the question of the durability of insulated cables. He states that the whole underground network of the St. Petersburg Electric Supply Station consists of lead-covered "asphalte" Siemens-Halske cables, which have been working for the last six or seven years to entire satisfaction. The expenditure for repairs and renewals for the last year was only ½ per cent. of the total expenditure of 1,100,000 silver roubles on cables.

Artistic Designs for the Embankment Electric Lamps.—The following letter appeared in Wednesday's *Times*, over the initials "J. R. C.":—

SIR: Considerable interest attaches to the resolution of the Highways Committee on what, to some, may seem a small matter; I refer to its timely aim to employ artistic design for the electric lamps and standards to be adopted for the Victoria Embankment. On such ground it is devoutly to be hoped that the resolve in question may lead to commensurate results, "worthy," as the report puts it, "of the finest thoroughfare in London." The step is manifestly in the right direction, for it may spare us from further abominations in the character of our public gas lamps and standards, and promote the expression of artistic taste in such work. Nothing can be so art-promoting and potent in educational influence as the element of beauty in things of common public use. It is proposed to invoke the aid of the "art schools and classes" for the designs in question. I fear the said schools and classes have, as yet, made little or no impression in such directions. Better would it be to invite the wider scope of open competition by drawings, or, better still, models to small scale. Such invitations would, doubtless, induce artistic minds and hands, in this new departure, to deal a death-blow to the abortions which, in such form, have been hitherto inflicted on the metropolis. In Paris, how different! There the prominent contrast in every thoroughfare is seen in the common lamps and standards—admirable works of art, masterly in their elegant proportions, and beautiful in their refined detail. As an artist, my Continental studies have included sketches of the lamps and lamp-posts of Paris, in the art of which I have found fruitful study and extreme pleasure.

Iron Pipe Wiring.—We had the pleasure a few days ago of inspecting the wiring of the new premises of the Commercial Union Assurance Company in Cornhill, which, we believe, is the first large installation in London where the whole of the wiring has been carried out in iron pipes. The installation is in two parts, one for the main building and one for tenants. The total number of 16 c.p. lights will be about 800. The three-wire system is used throughout, alternate lights being in either circuit. On entering, after passing through main switches and fuses, the mains run to two chases built into the staircase well, running to the top of the building. The mains for the tenants are carried up one chase in an iron pipe, a cast-iron box being inserted at each floor, in which tappings are made for the services to different tenants, and in which the fuses for these services are placed. From these boxes service wires are run to a meter and distributing fuse-board fixed in the tenants' offices. The leads for the main building are carried direct up the other chase to the fifth floor, where a board is fixed from which leads run back to each floor, and on which switches and fuses controlling each floor separately are fixed. A distributing fuse-board is also fixed on each floor, from which three wire circuits branch out to the lights. All fuses, with the exception of those in the floor plugs, are grouped on these boards. The wires are everywhere run in wrought-iron pipes (coated with Argus Smith composition) buried in the floors and walls, specially designed cast-iron boxes being inserted wherever a sharp bend occurs. Similar boxes are inserted over all drop points, and all joints are made in them. The greater number of pipes are ¾in. and ½in., the main pipe up chase being 3½in. The wires are all Henley 2,000 megohm vulcanised rubber. The work has been carried out by Messrs. Hayward Tyler and Co. to the instructions of Messrs. Handcock and Dykes, who are so satisfied with the way in which the system works out, and so impressed with its advantages that they have introduced it also into the Guardian Fire Insurance Company's new premises and the Clydesdale Bank, Lombard-street, and also in certain provincial installations.

The International Catalogue of Scientific Papers.—The following is a brief abstract of the report of the International Catalogue Committee, presented to the President and Council of the Royal Society on July 5th. The recommendations were approved. The report will be found in full in *Nature* (July 18th). The first meeting of the Committee was held on February 8, 1894. A circular letter was prepared and issued; this letter was sent to 207 societies and institutions selected from the exchange list of the Royal Society, and to a few others. A special letter was addressed to the Smithsonian Institution. More than a hundred replies were received, several being reports of Committees specially appointed to consider the suggestions put forward. In no single case was any doubt expressed as to the extreme value of the work contemplated, and only two or three correspondents questioned whether it was possible to carry out such a work. The importance of having complete subject catalogues, and not mere transcripts of titles, was generally recognised. Some bodies and individuals took the matter up very warmly, and urged that steps should be taken forthwith to put the scheme into action, this being especially true of the replies received from the United States; others, while giving a general approval, dwelt upon the difficulties of carrying out the suggestions put forward; and others, again, asked for more details. Over and over again reference was made to the great value of the Royal Society's "Catalogue of Scientific Papers." There is abundant evidence that considerable use is made of this on the continent of Europe. And it is clear that a proposal to carry out a more comprehensive scheme initially under the direction of the Royal Society of London is likely to meet with general approval, owing to the fact that the Society is credited with having already carried out the most comprehensive work of the kind yet attempted. No very precise information as to the best mode of putting the scheme into operation was to be gathered from the replies as a whole. In no case was any attempt made to form any exact estimate of the cost. As regards language, over and over again the opinion was expressed that English should be the language of the subject catalogue. Some form of card catalogue appeared to be generally favoured, especially in America, as the basis of the scheme. From various sides it was urged that an International Congress should be held to discuss plans. Such being the tenour of the correspondence, the Committee stated they were convinced that initial steps of a definite nature in furtherance of the scheme ought to be taken. They accordingly requested the President and Council to take measures with the view of calling together, in July, 1896, an International Conference, at which representatives of the several nations engaged in scientific work should be invited to attend, with the view of discussing and settling a detailed scheme for the production by international co-operation of complete authors' and subject catalogues of scientific literature, a detailed scheme to be immediately prepared, to serve as a basis for discussion at the Conference.

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GAS ENGINE ELECTRIC SUPPLY STATIONS.—II.*

Belfast.

The latest development in gas-engine stations for electric supply is represented by the station recently put into operation by the Corporation of Belfast. As long ago as February, 1893, the plans for a system of supply to a limited area were laid before the City Council by Prof. A. B. W. Kennedy, and were accepted; these forming the scheme upon which the present works have been carried out. No doubt, on account of the experimental nature of the trial of gas power, as well as from the fact that it is a simpler matter to duplicate such stations than stations driven by steam power, it was decided to restrict the capacity of the station to 8,500 lamps, allowing that only 6,100 lamps will be alight simultaneously in the ordinary course.

System Adopted.—The system which was decided upon by the Corporation, on the recommendation of Prof. Kennedy, was as follows. Power was to be derived from the Corporation town gas mains, the gaseous fuel being used to drive gas engines; these engines were to be geared by ropes to continuous-current dynamos, which, in conjunction with a large storage battery, were to feed a network of 220-volt three-wire mains, consisting partly of bare copper strip and partly of covered cables, by means of feeders of copper strip and covered cable. Balancing dynamos and a suitable system of battery switching were to be employed for keeping the two 110-volt sections of the three-wire system properly regulated. The scheme included no provision for street lighting; but, as has been said, it made ample allowance for the supply of 6,100 glow lamps simultaneously. The estimated cost of the plant for the generation, storage, and distribution of power for this system of supply was £19,000, exclusive of land, buildings, and consumers' meters. Contracts were arranged with the following firms:—

Gas engine plant	Dick, Kerr and Co.
Dynamos	Siemens Bros. and Co.
Electric storage plant	The E.P.S. Co.
Switchboard	J. H. Holmes and Co.
Bare copper strip	Curtis and Sons.
Covered cables	Callender Bitumen Co. and British Insulated Wire Co.
Road work	Scott and Sellar.
Buildings	M'Laughlin and Harvey.
Cast ironwork	R. Maclaren and Co.

We understand that the actual cost of carrying out the works was considerably below the estimated figure, and that the utmost capacity of the generating plant is somewhat in excess of its specified power.

Generating Station.—The site selected for the generating station lies on the border of the present area supplied with power, as will be readily seen in the accompanying map (Fig. 1). It consists of a narrow strip of land, formerly the site of a tannery, between Marquis-street and Chapel-lane. The extreme length of this strip of land is 185ft., and the width is shown in Fig. 2, which shows a plan and sectional elevation of the engine and battery buildings. The whole of the buildings were constructed to the designs of Mr. C. S. Peach, of London. The general arrangements of the engine and battery rooms, and of the outlying offices, &c., may be learned from Fig. 2, by means of the key which accompanies that illustration. In every way these seem well adapted to the peculiarities of the system and to give efficient service. Fig. 3 is from a photograph of the interior of the engine room, looking in the direction of the switchboard. At the far end may be seen the 6-ton traveller, by Messrs. Marshall, Fleming and Jack, which can be run over the entire length of the engine room. The interior of the room is lit at night by arc lamps suspended from the roof and by a number of glow lamps placed on brackets along the walls.

The present equipment of the engine-room comprises altogether six sets of rope-geared gas engines and dynamos. Four of these sets are for the general supply through the feeders, and the remaining two—which are of smaller power —may be used either for this same purpose or for balancing the three-wire sections. The smaller dynamos are provided with special commutator arrangements—which will be described presently—to enable them to fulfil this double duty, being in the former case required to give 220 volts, and in the latter instance only half that pressure. Gas is metered into the station through two large meters, and passes along one large supply pipe, from which branch pipes convey the gas to the several engines. The Corporation makes a charge for gas at the rate of 2s. 3d. per 1,000 cubic ft. The charge to townsfolk for gas is at the rate of 2s. 9d. per 1,000 cubic ft., with discounts. The exhaust gases are conveyed away from the engine through pipes which Tee into one common exhaust main, and this main pipe conveys the gases to a suitable but simple silencer, and thence to an up-take, from which the discharge takes place slightly above the level of the roof. The silencer consists of a small cylindrical chamber, provided with an inlet at the bottom and an outlet at the top, and with a number of perforated baffle plates, to intercept the passage of the gases. It is found that when several engines are working the impulses tend to damp out all or nearly all the sudden rush of gas, which is the cause of the noise nuisance; while when only one engine is running the passage through the pipes is so ample, in proportion to the volume of gas discharged, that there is no great rush of gas, and consequently no serious noise. At any rate, the employment of one common exhaust main, in place of independent exhaust pipes and "silencers" which are used at Morecambe and in other places, is a great advance, and a step towards surmounting the noise nuisance in gas-engine stations. No less adequate are the provisions which have been made for jacketing the engines at Belfast with cold water. Besides a large cooling tank, seen in Fig. 2, by means of which the circulation of water may, with ordinary loads on the station, be maintained sufficiently cool, there are arrangements for running town water straight through the water jackets to the drains, or for admixing town water with the tank water in any proportion which may be required to cope with the waste heat from the engines. Each engine is also provided with a circulating pump, for driving water through the jackets. The town water is metered into the station, and the charge made is at a rate depending on the consumption. For only 100,000 gallons per annum a charge of 10d. per 1,000 gallons is made, while for over 1,000,000 gallons per annum the rate is

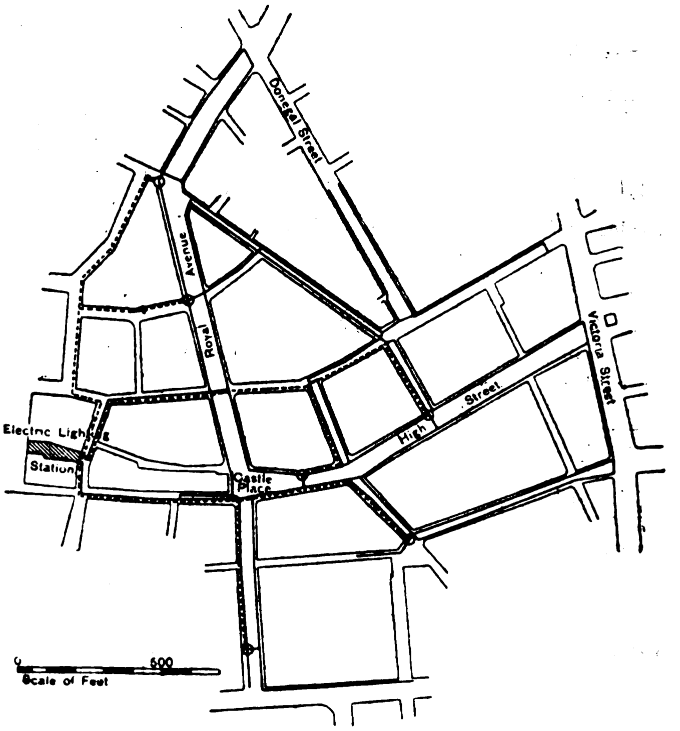

Fig. 1.—Map of Area of Supply, showing Feeders and Distributing Network, and Position of Generating Station.

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only 5½d. per 1,000 gallons. Pausing for a moment to comment on this, we may observe that the price of jacket water may become a serious item in a gas engine station, and that in towns, where high prices are charged, it may be cheaper to expend capital on a spacious cooling tank than to take water—except for evaporation make-up—from the mains. Such a system of cooling would also be more advantageous in a small station than in a large one.

Gas Engines.—As already has been stated, there are six gas engines now installed. These have been constructed to Prof. Kennedy's specifications by Messrs. Dick, Kerr and Co., of Kilmarnock. Four of these engines are capable of developing a maximum of 120 I.H.P., and are used for driving four Siemens 60-kilowatt dynamos. The remaining two engines are coupled to Siemens 26·5-kilowatt dynamos. The contractors have guaranteed that the consumption of Belfast gas by these engines, when at their rated load, shall not exceed 26 cubic ft. per electrical horse-power per hour, as measured at the dynamo terminals. We understand that by a six-hours' trial at the contractors' works, it was found that the consumption of Kilmarnock gas did not exceed 24 cubic ft. per electrical horse-power hour, under the specified conditions. The combined $\frac{\text{E.H.P.}}{\text{I.H.P.}}$ efficiency of the engines proved to be about 76 per cent. In regard to the quality of Belfast gas, we may state that, although we are not in a position to publish any analysis of this fuel, there are circumstances which make it probable that its calorific value suffers appreciable change from time to time. This gas is not simple coal gas; but consists of coal gas which has been largely admixed with enriched water gas; *i.e.*, carbon monoxide and the vapour of highly volatile hydro-carbons. We understand that the proportion of this enriched monoxide which is used varies with the relative price of gas coal and enriching oil, as well as with the amount of coke in stock at the gas works. The effort of the gas authorities to maintain a fairly constant illuminating power will have no effect in keeping the calorific power of the gas constant. Incidentally, while referring to the existence of large amounts of carbon monoxide in the town gas of Belfast and other cities, we may remark that it must be much safer to the public for such gas to be burned in public stations than in private houses; also, that if it is considered safe enough for water gas to be led into private houses, there ought not to be any serious danger in using it—*à la* Dowson gas—in an electric supply station. We understand that, at present, there is no Board of Trade regulation in respect to the proportion of poisonous monoxide which may be admixed with coal gas for town supply, and that in some towns so much as 30 per cent. of water gas is used.

Messrs. Dick, Kerr and Co. had already acquired some considerable experience in the matter of designing gas engines for electric supply stations when they commenced to build the Belfast engines, for it was that firm who were the makers of the Coatbridge engines. At Coatbridge they had introduced the double-acting type of engine, and had provided for an impulse every stroke by placing two cylinders on the same engine. But at that place the cylinders of each of the two-cylinder engines were cross-coupled, or arranged side by side. This involved the use of two cranks, two connecting rods, &c., and an engine of more than double width. In the Belfast type of engine—speaking now only of the larger engines, for these alone have two cylinders—a very important and useful modification has been introduced; for, while these engines have each two cylinders, both double-acting—and are thus capable of giving an impulse at each stroke—the two pistons are arranged on the same rod, there is only one crank, the cylinders are placed in tandem, and the width of the engine is no more than that of a single-cylinder engine of half the power. In order that this arrangement might not spoil by increased length the economy of space which resulted from decreased breadth, the method of backward driving was

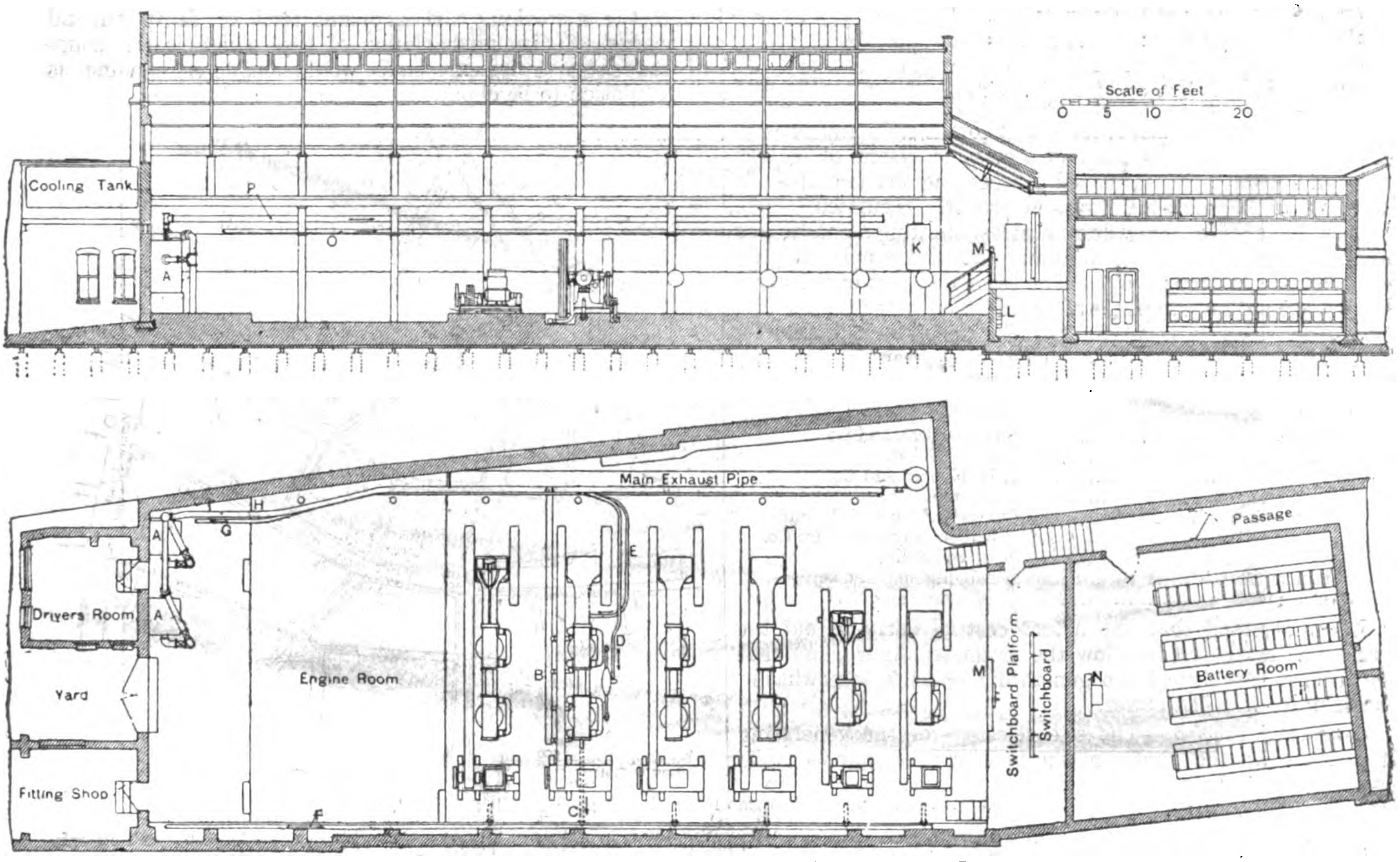

Fig. 2.—Plan and Sectional Elevation of the Engine and Battery Rooms.

A = Gas Meters (two).
B = Exhaust Pipe from Engines.
C = Water Pipe from Engine to pipe F.
D = Gas Pipe to Engine.
E = Water Pipe from Cooling Tank to Pump.
F = Water Pipe from Engines to Cooling Tank.
G = Water Pipe from Tank to Engines.
H = Main Gas Pipe.
K = Exhaust Silencer.
L = Resistance Frames.
M = Shunt Resistance Switches.
N = Battery Regulators.
O = Water from Cooling Tank.
P = Gas Main (same as H).

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adopted, the cylinders being located between the flywheel and the dynamo alongside of the rope-drive. Thus the amount of floor space covered by the plant is actually less than would be required by a forward-driving single-cylinder engine of equal power. Again, in order that backward driving should not put the ropes into slack tension at the bottom and tight tension at the top—a plan which would cause the ropes to lift off the pulley grooves except over a small arc, thus making the ropes slip—it became necessary to design the engine so that it would turn the flywheel in the reverse to the usual direction. That this method results in getting a compact engine room, a glance at the photograph (Fig. 3) will suffice to show. A set of scale drawings of one of the larger of the Belfast engines is shown in Fig. 4. The drawing on the left of the plan represents a section transversely through the valve box.

The cycle of operations which is carried on at each end of both cylinders is the well-known Otto cycle. The phase relations of the four cycles are adjusted so that, at full load, there is a quick succession of impulses; no two impulses in any one engine occurring at the same time. The explosions occur in the following order: first, there is an explosion in the back end of the back cylinder, then one in the front end of the front cylinder, then one in the back end of the front cylinder, and, finally, one in the front end of the back cylinder. The advantages of this system, from an electrical point of view, are enormous. Not only is there a more rapid succession of impulses, but the magnitude of each impulse is correspondingly reduced. The quick succession of impulses enables a flywheel of moderate inertia to suffice to store the fluctuating energy; and the fact that each impulse is only one-quarter of that which would arise were the whole power merged in one impulse reduces the amount of fluctuating energy to be stored. Thus, by the distribution of the load among four suitably arranged Otto cycles, it is probable that the tendency to fluctuation is reduced to one-sixteenth of the tendency in a single-acting single-cylinder engine of equal horse-power and flywheel inertia.

The engines are designed to run at constant speed—160 revolutions per minute—at all loads, accurate speeding-up being as yet practically impossible in gas engines. At full load there will therefore be 320 impulses per minute. It is not intended, as is done at Morecambe, to run the engines at full load during the whole time of working; but provision has been made for economically meeting the conditions of a varying load. Of course, for economical reasons, the load will always be kept as full as can be; but, what we mean is, that the engines will not be run without a governor, necessarily at full load whenever they are running, as is done at Morecambe. It was originally intended to arrange that at reduced loads the engines would systematically miss one or more of their 4-cycle explosions. The following is a detailed account of what would take place in such an arrangement. As the load falls from its full or normal value, the valves automatically reduce the proportion of gas and air admitted for each explosion, and this reduction goes on until a certain reduction of load is reached, at which point an entire explosion is missed. This point corresponds to about three-quarters of the rated indicated horse-power, and when it is reached only three of the Otto cycles come into action. If the load falls still further a further reduction of the proportion of gas and air is effected by the valves; and at half load two of the Otto cycles will have been cut out, and only one explosion in each cylinder will be taking place. Below a quarter load there will be only one explosion out of the four, and as the load still more is reduced the force of this single explosion will be diminished by the reduction of the amount of gas admitted for each charge. This fine gradation of explosive power and of the frequency of the explosions would enable a high degree of regulation to be obtained; but the plan of missing explosions has, we learn, not been finally adopted at Belfast, it being found to be preferable to arrange that the whole of the regulation by the governor shall be effected by varying the proportion of gas used in all four explosions. There is no doubt that the practice of retaining the full number of explosions at reduced loads must enhance the conditions of steady driving at those loads. It may be mentioned that great care has been taken to ensure good lubrication of the cylinders; the cylinder oil is admitted from the top of the cylinders by the suction exerted when the charging stroke is being made by the piston. An inward-opening oil valve is opened by the suction, and allows a small quantity of oil to be carried into the cylinder. The four large gas engines are each provided with 8ft. 5in. cast-iron grooved pulleys, which drive the large dynamos by means of eight ⅞in. ropes on each pulley. In addition to the grooved pulley each crank shaft carries a heavy cast-iron flywheel for giving greater steadiness in running.

The two smaller gas engines are of the single-cylinder double-acting type, and provide an explosion at every revolution when working at full load. So far as the distribution of the gas and air is concerned, and the cycle of operations at each end of the cylinder, the smaller engines differ in no respect from the larger ones. Regulation for reduced load is

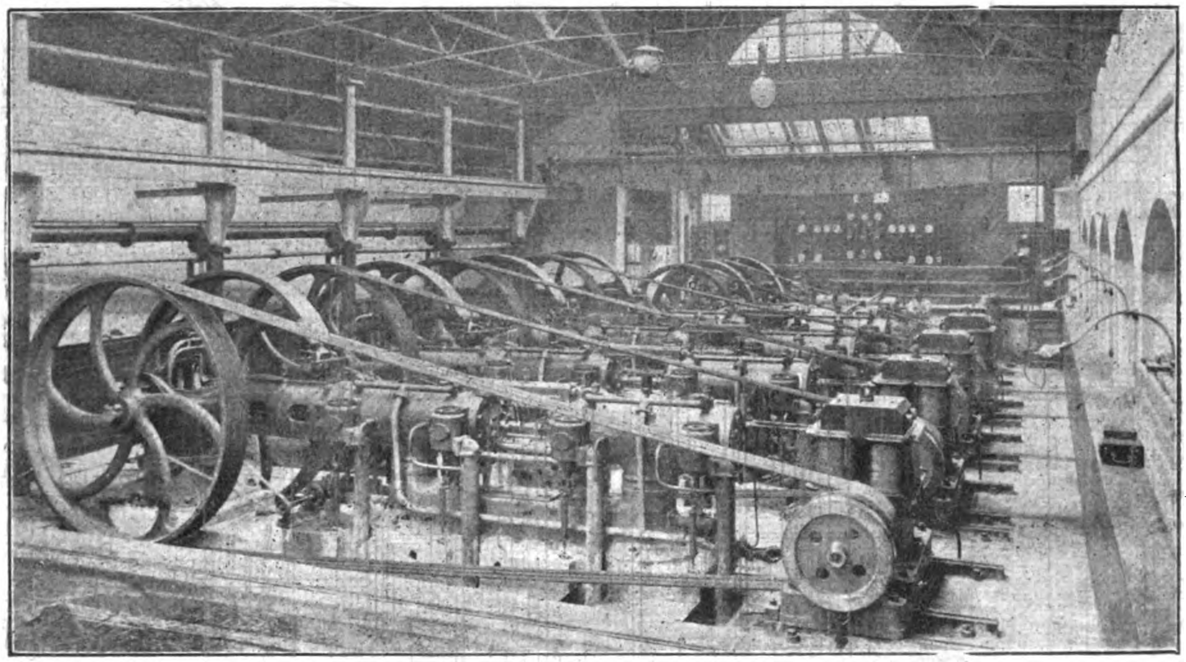

Fig. 3.—Engine and Dynamo Room, looking towards Switchboard.

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also effected, first by a graded charge, and afterwards by cutting out explosions. Each of these engines has a grooved cast-iron pulley, 7ft. in diameter, carrying eight ¾in. ropes, and a smooth-faced cast-iron flywheel.

One of the problems in connection with a gas-engine station is: how to arrange to economically and quickly start the engines as they are required. The old-fashioned plan of assembling the staff and friends for the ceremony may do very well for small engines in private installations, but is out of the question with large-power engines. The plan adopted at Coatbridge of starting the engines by admitting high-pressure steam for a few forward strokes is permissible where there is a boiler for generating water gas, but is inadmissible where town gas is used. The practice of pumping or otherwise admitting an explosive mixture into the motionless and inert engine, and then firing the machinery into activity by one sudden blast is used in some places, but it puts a heavy strain on the parts which are thus suddenly set in rapid motion, and it is not one which an engineer could ever bring himself to admire. At Belfast the simple expedient of running the dynamos as motors off the station batteries, or other engines when any are running, is resorted to, the dynamos thereby running the

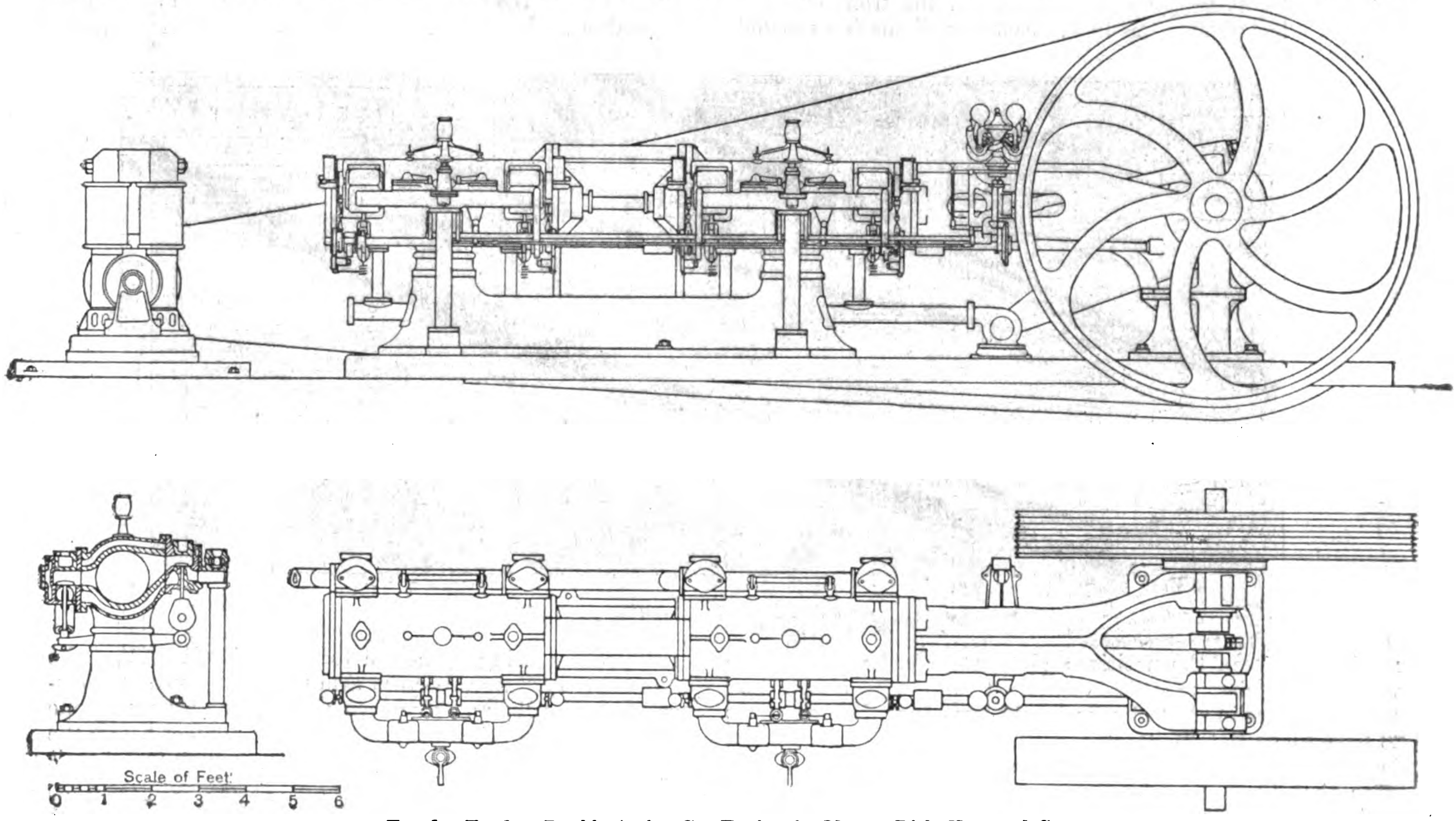

Fig. 4.—Tandem Double-Acting Gas Engine, by Messrs. Dick, Kerr and Co.

engines until the proper charge has been drawn into the cylinders and compressed, when it explodes and the engine runs up to the speed controlled by the governor. The amount of current sent through the dynamo when starting-up is regulated by a hand rheostat, the hand gear for which is situated by the switch platform rail, overlooking the engine room, and the resistance frames are placed beneath that platform.

Dynamos.—The six dynamos for this station were supplied by Messrs. Siemens Bros. and Co. The four larger machines are rated at 60 kilowatts, but are normally only intended to develop about 57½ kilowatts. They are two-pole, drum-wound, shunt machines, and are designed to run at 600 revolutions per minute. Under normal working the field is regulated to give from 225 to 240 volts at this speed, but the machines can be made to develop as high as 250 volts for exceptional work.

The two smaller machines call for more detailed consideration, on account of the diversity of the work for which they are designed. These machines are both of the two-pole shunt-wound type, and each is designed to develop about 26½ kilowatts, running at 750 revolutions per minute. The armature of each of these dynamos is double-wound, each of the windings being connected to an independent commutator. Each winding develops from 110 to 120 volts, at normal speed and excitation; and there are switchboard arrangements for putting these two windings in series or in parallel. When they are in series the voltage of the machine is, of course, normally between 220 and 240 volts; but on occasion, with this arrangement, a voltage of 270 volts is developed. These machines, when run with the armature windings of each in parallel, are intended for use as balancing machines on the three-wire network.

Electric Storage Plant.—Probably one of the greatest safeguards of a gas engine station against breakdown of supply and irregularities of pressure, in the present early stage of development of this industry, is the installation of ample electric storage plant. It is unnecessary to point out the impossibility of doing this, except where a system of continuous current is used. At the Belfast station there are two large storage batteries, one for each of the two sections of the three-wire network. The arrangement of these batteries in their special room is shown in Fig. 5, which gives a perspective view of a battery room about 28ft. square. Each battery consists of 63 E.P.S. cells of the 34-K type, in lead vessels. Besides these. there is a reserve of eight "hospital" cells, or "milkers."

Battery Regulation.—Reference has already been made to a unique system of battery regulation which is in vogue at the Belfast station, and which has been designed by Prof. Kennedy and one of his assistants, Mr. B. M. Jenkin. The usual plan of entirely cutting the end cells out of circuit, on the positive or negative battery, when the pressure on one side of the system is to be lowered, has here been abandoned, every cell being retained in the circuit whatever the pressure required on the feeders. In order to regulate the pressure applied to the feeders, the end cells of the batteries which are most remote from those connected to the 'bus bars on the switchboard are put in parallel with one another—the last few cells of the two batteries being, as it were, electrically telescoped; and the number of cells on each battery thus placed in parallel with the similar cells on the other battery is made to vary with the total pressure required between the

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positive and negative feeders. In addition, the point of connection of the middle wire will be shifted either towards the positive or towards the negative end—this middle wire making, of course, a contact at some point on the telescoped cells on each of the batteries—according as it is desired to give either side a greater or lesser pressure.

This ingenious method of getting over the need for removing cells from the circuit in order to regulate the pressure is more clearly explained by reference to Figs. 6 and 7. In **Fig. 6** it is supposed that the pressure of only 106 cells is

to provide that both the middle-wire contacts shall always be with cells at the same potential. This is provided for by a reliable interlocking switch gear, by which it is impossible to short-circuit sections of the batteries or to interrupt the circuits.

This switch is shown diagramatically in Fig. 8. The contacts connected to the cells in each battery on which the regulation is done are shown lying parallel to each other.

Two brushes held by a connecting cross arm connect these contacts to their respective 'bus bars lying beside them,

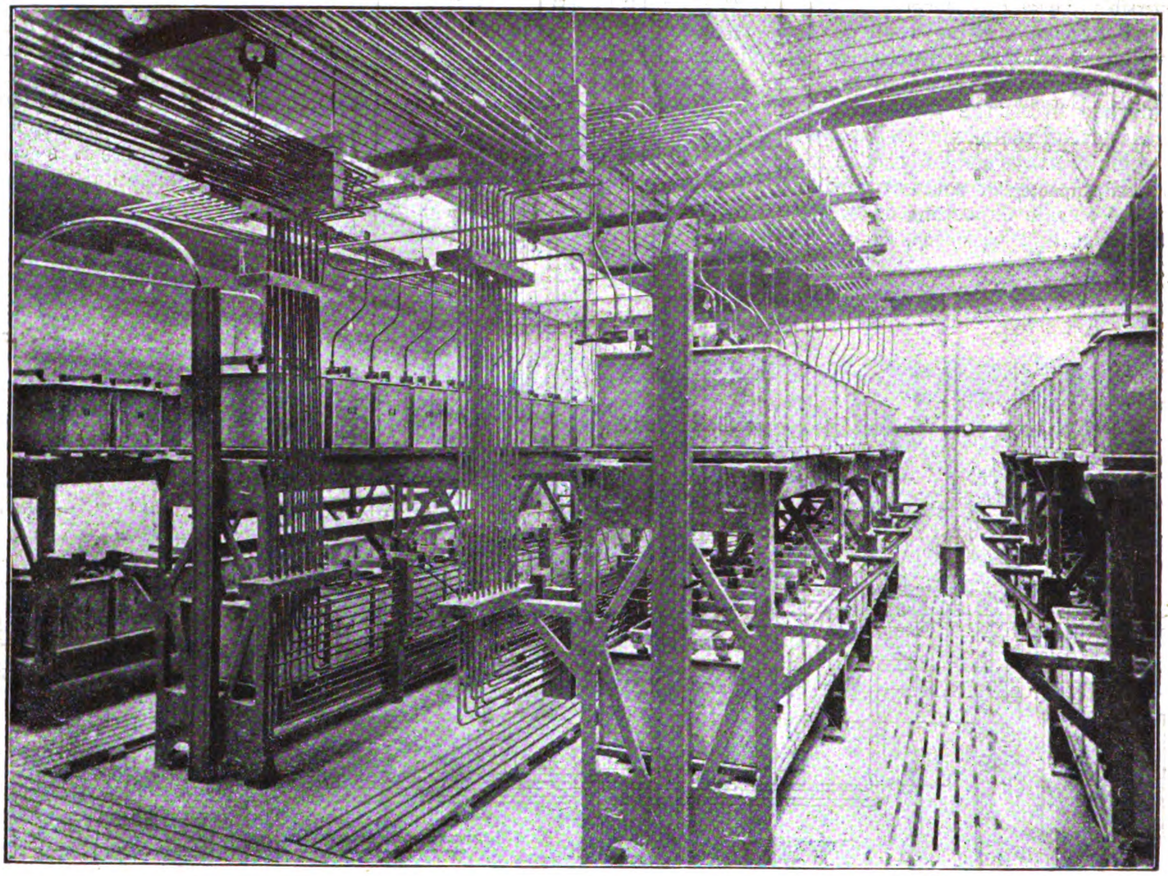

Fig. 5.—Battery Room.

required between the positive and negative feeders, and that an equal number of cells is required on the two sections. Now, there are in all 126 cells in the two batteries; so that 20 have to be put in parallel with another 20. In order to do this the cells are coupled as shown in the figure; and in order that there may be the pressure of 53 cells on each section, the middle wire must make contact with the 53rd cell of *each* battery. Now, turning to Fig 7, we suppose

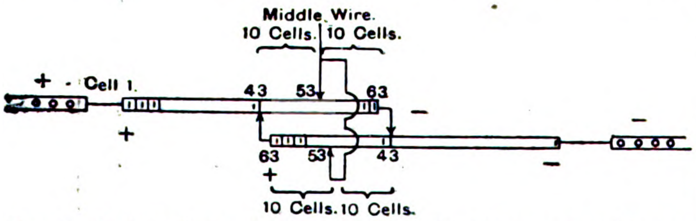

Fig. 6.—Battery Regulation. Pressure of 53 Cells on Each Side of System.

that it has been necessary to alter the balance given by Fig. 6, and that we now require the pressure of 54 cells on the positive section, and only that of 53 cells on the negative section. To obtain this, 19 cells will now be "telescoped"—instead of 20, as before—and the middle-wire contact will be with the 54th cell of the positive battery and with the 53rd cell of the negative battery, these two cells being at the same potential. In the same way adjustments can be made to give any desired pressure on either section, and it is only necessary

these 'bus bars being connected to the end cell (63) of the opposite battery. As this cross arm is moved down it "telescopes" more cells, and if moved up, fewer. By giving one of these brushes a small lead it will make contact before the other breaks, and in this way the use of pilot brushes is avoided.

The "middle" wire of the system is connected to two 'bus bars lying outside the contacts by two brushes to these same contacts. One of the middle wire brushes travels with

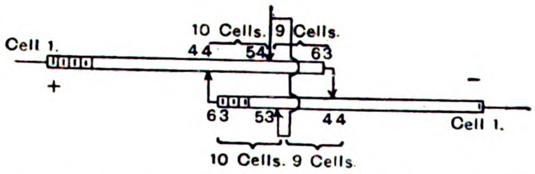

Fig. 7.—Battery Regulation. Pressure of 54 Cells on Positive Side; Pressure of 53 Cells on Negative Side.

the centre paralleling switch, while the other remains stationary.

Referring to Figs. 6 and 7, the paralleling switch moves from cell 43 to 44 in each battery, and the middle wire brush on the positive battery moves with it from cell 53 to 54. But the middle wire brush on the negative battery remains stationary on cell 53.

The paralleling brush is worked by a wheel on the front of the switchboard working a pinion geared into a rack. The

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middle wire brushes are worked by being locked to the main brush, as shown in Fig. 8, by a cross bolt, which catches in a rack in one or the other. This bolt is worked by a lever on the front of the board immediately below the wheel working the main brush

The number of cells each side of the system is shown by indicators on the front the board.

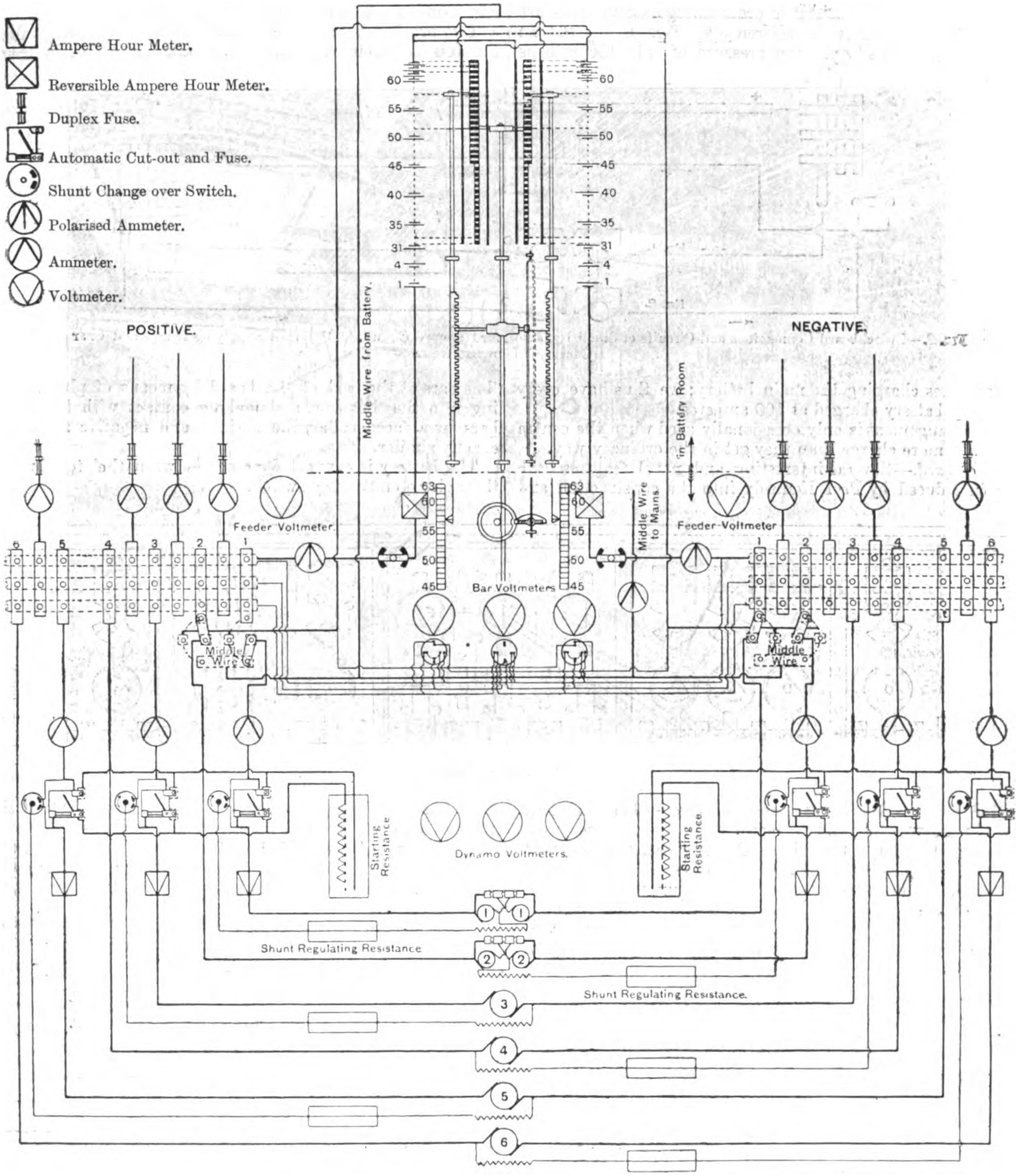

FIG. 8.—Diagram of Switchboard Connections. Portion below Horizontal Dotted Line is in Engine Room.

By setting the lever to one side or the other, and then turning the wheel one way or the other, the number of cells on circuit on either side can be adjusted.

The whole of the battery can be charged or discharged in parallel with the dynamos, the telescoped cells working at half the rate of the main battery. The telescoped cells can also be charged by themselves by altering the connections at the link switches on the small machines. This arrangement is shown in Fig. 9. Dynamo No. 1, or C, is now between the positive 'bus bar and the negative *end* of the positive battery; not between the 'bus bar and the middle-wire contact, as in Fig. 10. Similarly, dynamo No. 2, or D, is between the negative 'bus bar and the positive *end* of the negative battery. Current is going from the positive of C, by the positive feeders to the mains and lamps, back along the negative feeders, to the negative of D, from the positive of D, through the link switch to the positive *end* of the negative battery, where the current splits between the cells in parallel, charging them, then from the negative *end* of the positive battery, through the link switch to the negative of C.

The two balancing machines, C and D, can thus be run at full load on circuit and charge the centre cells at the same time.

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As the load on circuit falls the current can be sent into the main part of the battery charging it, and so keeping the dynamos at full load, until the load on circuit has dropped to half that of the small machines, when 100 amperes would be going out on circuit, and 100 into the main battery. As the current on circuit splits equally between the centre cells we have 50 amperes due to it, and also 50 each side due to the four negative, and one middle wire. The board consists of five slate panels, the two outer ones carrying the "'bus" bars and feeder and dynamo bars, and the centre panel the battery regulating handle, switches, and ammeters; also the middle-wire ammeter and the feeder and bar voltmeters.

The dynamos and feeders are connected to vertical bars on the front of the board. These bars can be connected to the

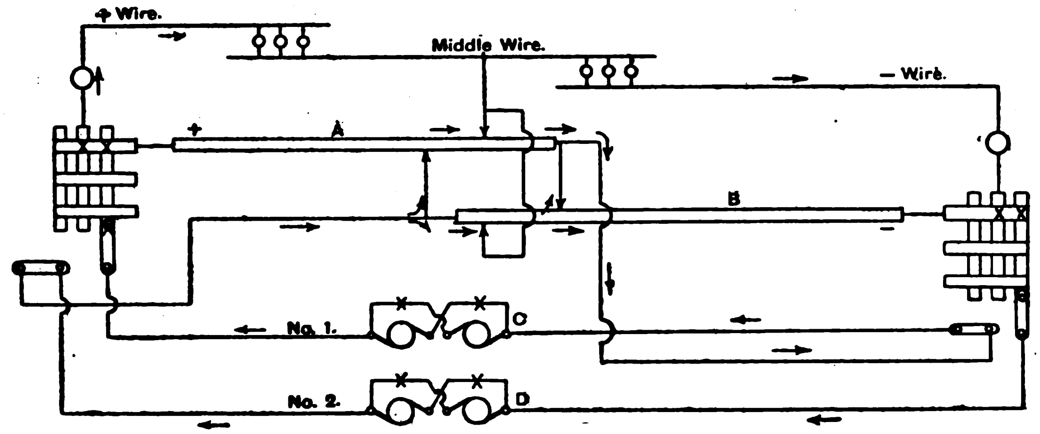

Fig. 9.—Switchboard Connections and Circuits of Small Dynamos, for "Looped Circuit." Dynamos Supplying Lamps and Charging Centre Cells of Batteries.

100 amperes charging the main battery; we thus have every cell in the battery charged at 100 amperes.

This arrangement is only occasionally used when the centre cells want more charge than they get in the ordinary way.

Switchboard.—Several interesting and novel features have been introduced by Prof. Kennedy into the construction and 'bus bars at the back of the board by means of plugs, screwing into the 'bus bar, and making contact with the vertical bars by a faced collar, the positive and negative sides being exactly similar.

The battery is connected across between the top 'bus bars through an emergency switch.

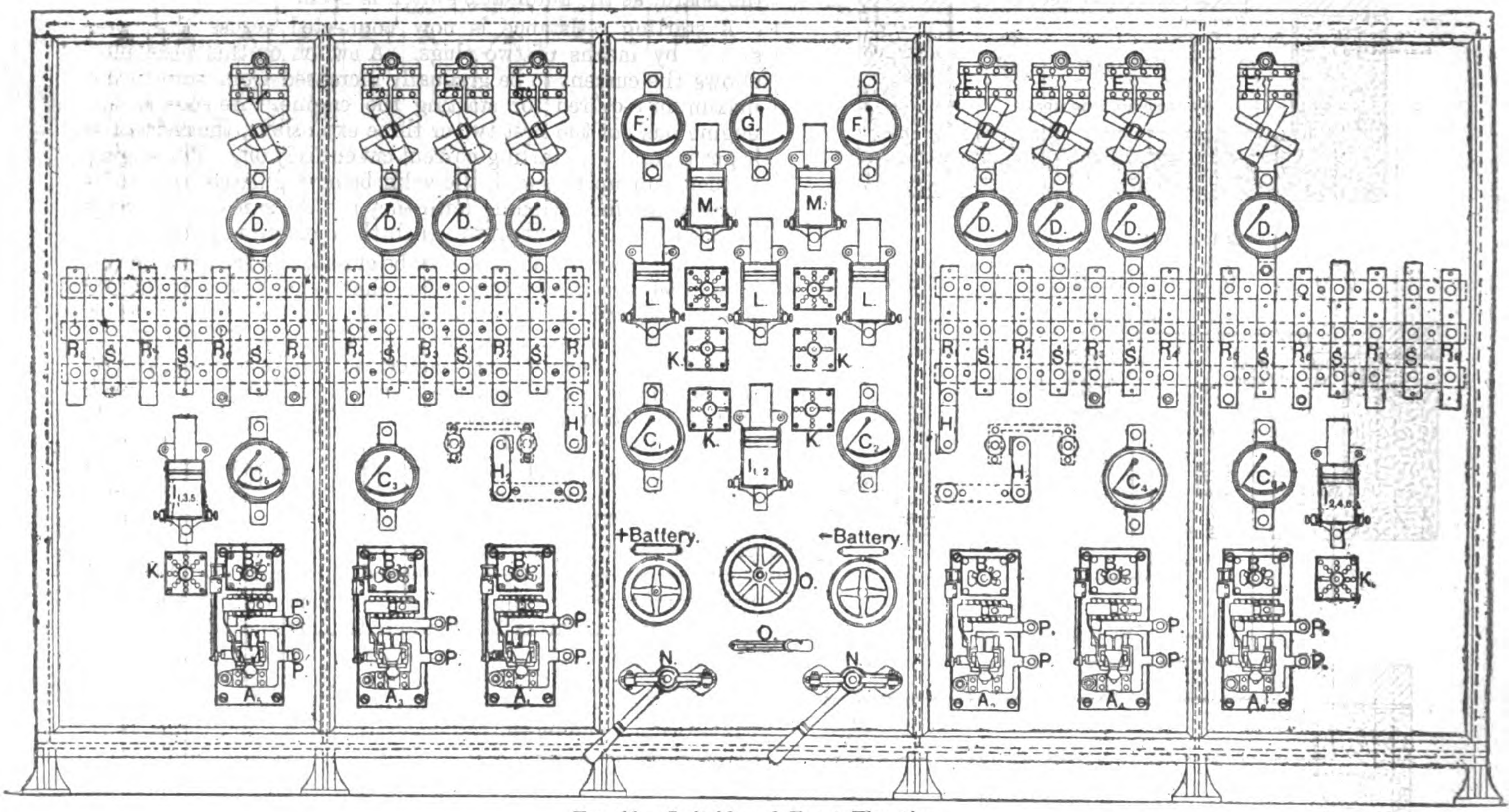

Fig. 11.—Switchboard Front Elevation.

A, Automatic Switch and Fuse.
B, Shunt Change-over Switch, interlocked with Automatic Switch.
C, Dynamo Ampere-meters.
D, Feeder Ampere-meters.
E, Duplex Fuses for Feeders.
F, Battery Ampere-meters, polarised.
G, Middle Wire Ampere-meter, polarised.
H, Link Switches, for balancing dynamos.
I, Dynamo Voltmeters.
K, Multipolar Voltmeter Switches.
L, Bar Voltmeters.
M, Feeder Voltmeters.
N, Battery Emergency Switches.
O, Battery Regulating Wheel and Lever.
P, Holes for starting Resistance Plugs.
Q, Horizontal Omnibus Bars.
R, Dynamo Bars.
S, Feeder Bars.

The suffix in every case refers to the number of the dynamo to which the instrument is connected.

manipulation of the switching gear for the dynamos and batteries at Belfast. A front elevation of the switchboard is shown in Fig. 11, and the diagram of circuit connections is given in Fig. 8. The switchboard at present is arranged for the working of six dynamos and eight feeders, four positive and

The leads from the dynamos are connected on one side direct to a vertical bar, and on the other through an automatic (minimum current cut-out) switch and ammeter to the other vertical bar. In the case of the small dynamos, which are used either at 220 volts or 110 volts for balancing, there

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is in each lead a link switch, which can be connected by means of a plug to three different places.

When pointing up, the link connects the lead to the vertical dynamo bar, when horizonal to the middle wire, and when down to the "charging circuit," which is described below.

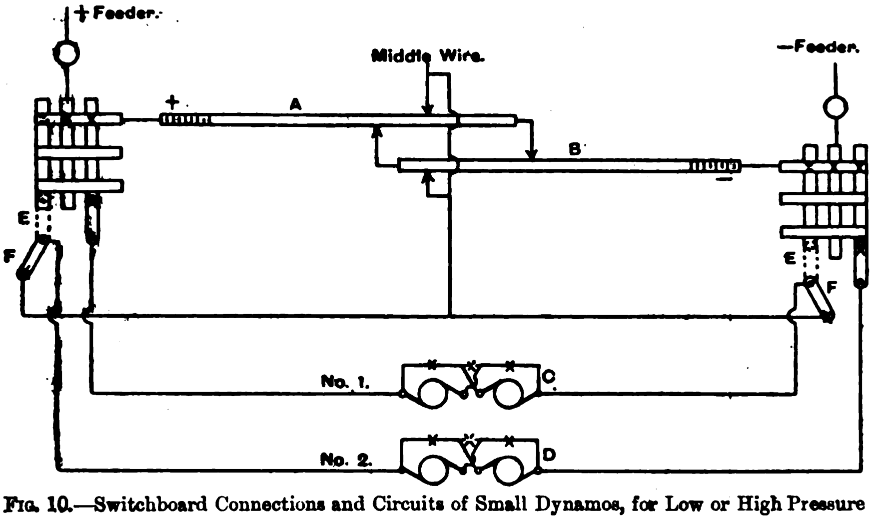

FIG. 10.—Switchboard Connections and Circuits of Small Dynamos, for Low or High Pressure

As already described, the double-wound armatures of these small dynamos can be put either in series or parallel by means of blocks and plugs, as shown diagrammatically in Fig. 8.

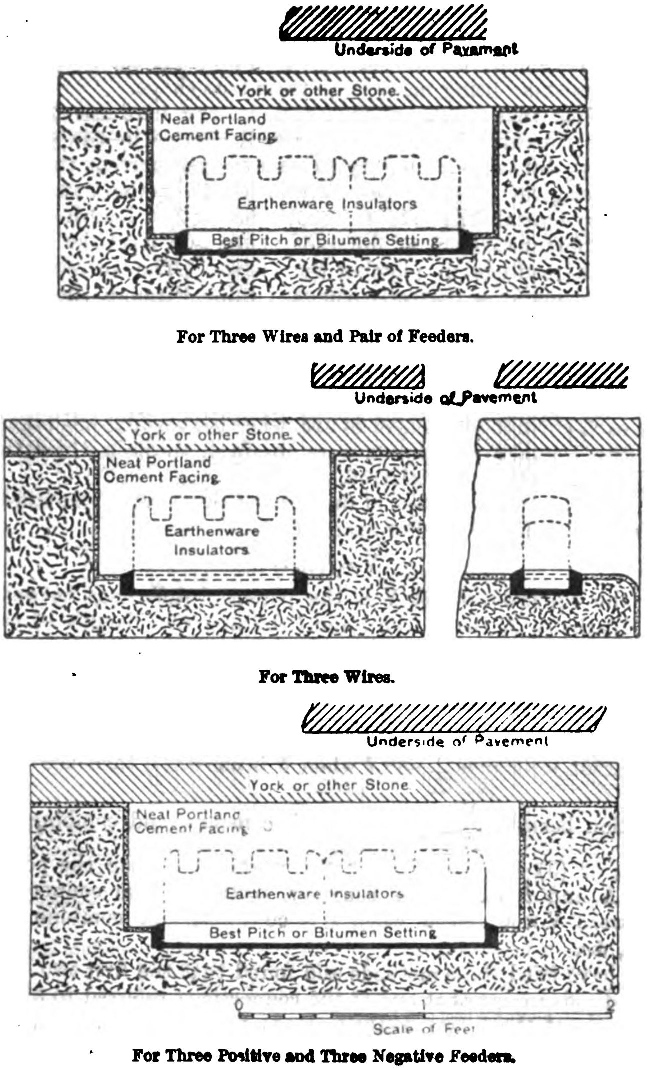

FIG. 12.—Three-Wire Bare Copper Strip Conduits.

When used as balancing machines at low volts, the connections are as shown in Fig. 10. The two machines are shown at C and D, the dotted portion of this part of the drawing representing the alternative connection of the armature windings, for putting these windings in series. Machine No. 1, or C, is shown on the positive side of the system; and machine No. 2, or D, is balancing the negative side. Across the mains are the two storage batteries, A and B, with the unique middle-wire connection, which will be described later. The switchboard connections, in this case, would be as shown at F. If now it is desired to use these machines as high-pressure generators, in parallel with the larger machines, on the 'bus bars, or when no larger machines are running, this will be done by arranging the switchboard connections as shown by the dotted connection E. The two machines will then be running at high pressure in parallel on the 'bus bars; but it is, of course, possible to use only one machine in this way, the other being out of circuit, or running on whichever side is out of balance.

To start the gas engines by means of the dynamos, run as motors, they must first be excited; this is done by plugging the vertical dynamo bars of the machine to be started on to the 'bus bars connected to the battery; the automatic switch being open. The shunt change-over switch is then turned in the direction indicated by the arrow (Fig. 8) until the brush is on the top of the two contacts on the right side of the switch. This contact is connected above the automatic, and is therefore "alive," and the current passes through the switch and the field winding to the negative pole of dynamo (considering dynamo 8). This excites the dynamo. The brushes can be put down without short-circuiting across the board, as the automatic switch is open.

A starting resistance is now connected across the open switch by means of two plugs. A switch on this resistance allows the current to be gradually increased from zero to the maximum required for starting the engine. As soon as the engine has got the first two or three explosions, the resistance is put in, and the starting current cut entirely off. The engine is then run up to speed, the volts being regulated by a resistance in the field winding until they are the same as the volts between the 'bus bars on to which the dynamo is plugged.

The automatic switch can now be closed, and the dynamo run in parallel with the battery. The shunt change-over switch is interlocked with the automatic, so that as the latter is closed the former is turned from the top to bottom of the two contacts. The lower contact is connected on the dynamo side of the automatic, and is at the same potential as the upper contact as soon as the "automatic" is closed, the brush bridging the gap as it passes over. Should the automatic now open, the dynamo is connected as a simple shunt machine, and is no longer separately excited. By this means all the difficulty of breaking the field circuit usually necessary in a separately-excited dynamo is avoided.

Mains.—The feeding and distributing mains are chiefly of bare copper strip, arranged in concrete conduits and supported on porcelain insulators; but, where the mains cross streets, or in some of the narrow streets, or again, in some places where the boggy nature of the soil makes bare copper distribution difficult and risky, covered cables have been laid down. These cables were made by the Callender Bitumen Company. Transverse sections of the bare copper strip conduits are shown in Fig. 12, which also shows a longitudinal section of one portion. The arrangements of the porcelain insulators for carrying either the three wires, or the three wires and a pair of feeders, will be clearly seen in these drawings. Belfast lies very largely upon a swampy or boggy soil, and this fact has had to be taken account of in the design of the conduits and street boxes, as well as in the arrangement for inspection. There is a small screw plug in each of the street box covers, and each man who goes the round of inspection carries with him a small portable pump and a gauge stick. With the latter instrument, which he inserts into the box after unscrewing the plug, he can gauge the accumulation of water in the box; and with the hand pump he can clear it out.

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The whole of the work has been carried out under the superintendence of Prof. Kennedy and his chief assistant, Mr. Burstall; Mr. Victor A. H. McCowan, who was appointed electrical engineer to the Corporation in April, 1894, acting as resident engineer.

In conclusion, we have to express our indebtedness to and to thank Prof. A. B. W. Kennedy, F.R.S., and his assistants; also Mr. Victor M'Cowan, the chief resident engineer, and Messrs. Dick, Kerr and Co., for their kindness in placing so much information at our disposal, and in assisting us in every way to make our account of the Belfast station complete.

THE ELECTRIC ARC.

BY HERTHA AYRTON.

(Continued from page 616, Vol. XXXIV.)

When beginning to study electric arcs on my own account, it appeared to me that it would be better to avoid the complications arising from the use of cored carbons, and to study the problems under their simplest conditions by employing none but solid carbons. Accordingly, my experiments have been conducted with solid carbons for both positive and negative, the positive carbon being 11mm. and the negative carbon 9mm. in diameter in all cases.

The make of carbon employed was the "Apostle," as that had been used in all the investigations carried out under Prof. Ayrton's directions. Thus the results obtained with solid carbons can be compared with those obtained when a cored positive carbon was used.

So far my attention has been turned to three points:—

1. The true equation connecting volts, amperes, and distance between the carbons, after the potential difference had in each case reached its steady value for the particular current and length of arc employed.

2. The drop of potential difference between the positive carbon and the arc, and between the arc and the negative carbon.

3. The real shape and size of the arc as distinguished from its visible shape and size.

In the present article I propose to deal with the equation I have obtained connecting volts, amperes and length of arc, when the potential difference has reached its steady value for each particular current and length of arc.

Having found it a very tedious and lengthy process, in former experiments, to obtain a steady potential difference with small currents, I started by using only currents of 5 amperes and upwards, and found the steady potential difference that would send each current through lengths of arc varying from 1mm. to 7mm. The currents used were 5, 8, 10, and 14 amperes respectively, the largest current that did *not* cause hissing for each length of arc, and two or three of the currents that did cause hissing; I then proceeded to draw curves connecting potential difference and current for the various constant lengths of arc, similar to those in Figs. 4, 5, and 6 (pp. 336 and 337, *The Electrician*, January 18th).

On attempting, with the data thus obtained, to find an equation that would fit all the curves, to my dismay I discovered that there were *two* equations, either of which might be correct, since all the curves could be deduced with a very fair amount of accuracy from each of them. One of these was the equation to a series of ellipses, the other the equation to a series of hyperbolas. If the curves were really ellipses, no current of less than about 4 amperes ought to be able to maintain an arc continuously with the carbons used; whereas if they were hyperbolas, any current, however small, ought to maintain an arc, provided a large enough potential difference could be supplied.

Now the difficulty, already alluded to, that had always been found in maintaining small currents, made it appear as if the ellipse equation were the correct one; for it seemed possible that, although these currents could be maintained for a short time after striking the arc, or changing the current from a larger to a smaller one, yet that when the excess of loose carbon supplied in the previous state was exhausted, the remaining supply, kept up by the small steady current, would be insufficient to maintain the arc, and so it would go out. As a matter of fact, it had been found in former experiments that the arc *did* go out again and again after small currents had been flowing for a short time.

It became necessary, therefore, to find out whether the conditions of the E.M.F. of the dynamo and the resistance of the circuit were such as to cause this instability, or whether it really was impossible with the size of carbons I was using to maintain an arc, with less than about 4 amperes, for a sufficient length of time for the potential difference to reach its steady value.

Using a dynamo producing a potential difference of about 150 volts between its terminals, and a large resistance in circuit, I found that currents of 2 amperes *could* be kept flowing long enough for the potential difference to become perfectly steady, although, with such small currents, the carbons took between one and two hours to form, and therefore the potential difference took the same length of time to become steady.

Thus it was evident that the curves were not ellipses. It remained to prove whether they were really hyperbolas, or only fairly close approximations to hyperbolas; whether, in fact, there was not some extra term in the true equation which remained too small to be noticed with currents of 5 amperes and upwards, but which would be large enough, with smaller currents, to show some discrepancy between the curves and the equation I had obtained. It seemed advisable, also, to determine a great many more points on the curves experimentally than I had hitherto done. I therefore decided to make an entirely new set of experiments, using the same apparent lengths of arc as before, but taking many more currents, and beginning with 2 amperes, so that the points on the curves should be so numerous as to preclude the possibility of any mistake being made as to their true shape.

Finding that a slight difference in the hardness of the carbons caused a corresponding small change in the steady potential difference necessary to send a given current through an arc of given length, I generally took two or three readings of the potential difference for each current and length of arc, with different carbons, at different times, and used the means of these readings in plotting the curves. The current was kept flowing at a perfectly constant value through the given length of arc for periods varying from a quarter of an hour for large currents to nearly two hours for very small currents, before each reading was taken, so that there might be no doubt as to the potential difference having reached its final steady value for each current and length of arc, when the reading was taken. In this way the 137 points were obtained, through which the curves in Fig. 33 were plotted.

There are various ways of finding the equation to the family of curves in Fig. 33. For example, if

$$V = f(A, l)$$

be this equation, where V is the potential difference between the carbons, A the current, and l the apparent length of the *silent* arc as measured on the projected image, we may (1) begin by finding the connection between V and l when A is constant, then the connection between V and A when l is constant, and combine the two; or (2) first find the connection between the apparent resistance $\frac{V}{A}$ and l when A is constant, then the connection between $\frac{V}{A}$ and A when l is constant, and combine the two; or (3) start by finding the relation between the power $V \times A$ and l when A is constant, next find the connection between $V \times A$ and A when l is constant, and combine the two, &c.

I have tried these methods and found that the first two have the disadvantage that one of the connections referred to above in each of these two methods leads to a non-linear law, and therefore its exact form cannot be easily ascertained. In fact it was by using the first of these three methods that I was erroneously led to the equation of an ellipse as being the equation connecting V, A and l.

If, however, we employ the third method, and plot curves connecting *power* and apparent length of arc for various

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constant currents, we obtain the series of *perfectly straight lines* seen in Fig. 34. And again, if we plot curves connecting *power* and current for various constant lengths of arc, we also obtain a series of *perfectly straight lines*, two of which are seen in Fig. 35.

In the case of carbons the positive of which was cored, it was found by the students working under Prof. Ayrton in 1893 that the curves connecting *power* and current for various constant lengths of arc were straight lines when the current was not less than about 5 amperes. With the *solid* carbons that I used, on the other hand, these lines are quite straight for all currents—even the smallest that I have tried, viz., one of 2 amperes.

As already stated, alm st every point in Fig. 33 represents the mean of several results obtained at different times with different pairs of carbons. But the curves in Fig. 33, having been drawn through the *average* position of these mean points,

W_0 be the power in watts that would be expended in sending the same current through an arc of 0mm., as shown by the curve, and

W_7 be the power in watts expended in sending the same current through an arc 7mm. long.

Then, by similar triangles,

$$\frac{W - W_0}{l} = \frac{W_7 - W_0}{7}. \quad . \quad . \quad . \quad . \quad . \quad (1)$$

This, therefore, is the general equation to the lines in Fig. 34. To obtain the equation to any particular line, W_0 and W_7 must be replaced by their actual values in the particular curve.

To give an instance. Take the equation to the line for a constant current of 6 amperes. In this case

$$W_7 = 406,$$

and

$$W_0 = 245.$$

Both Carbons Solid.

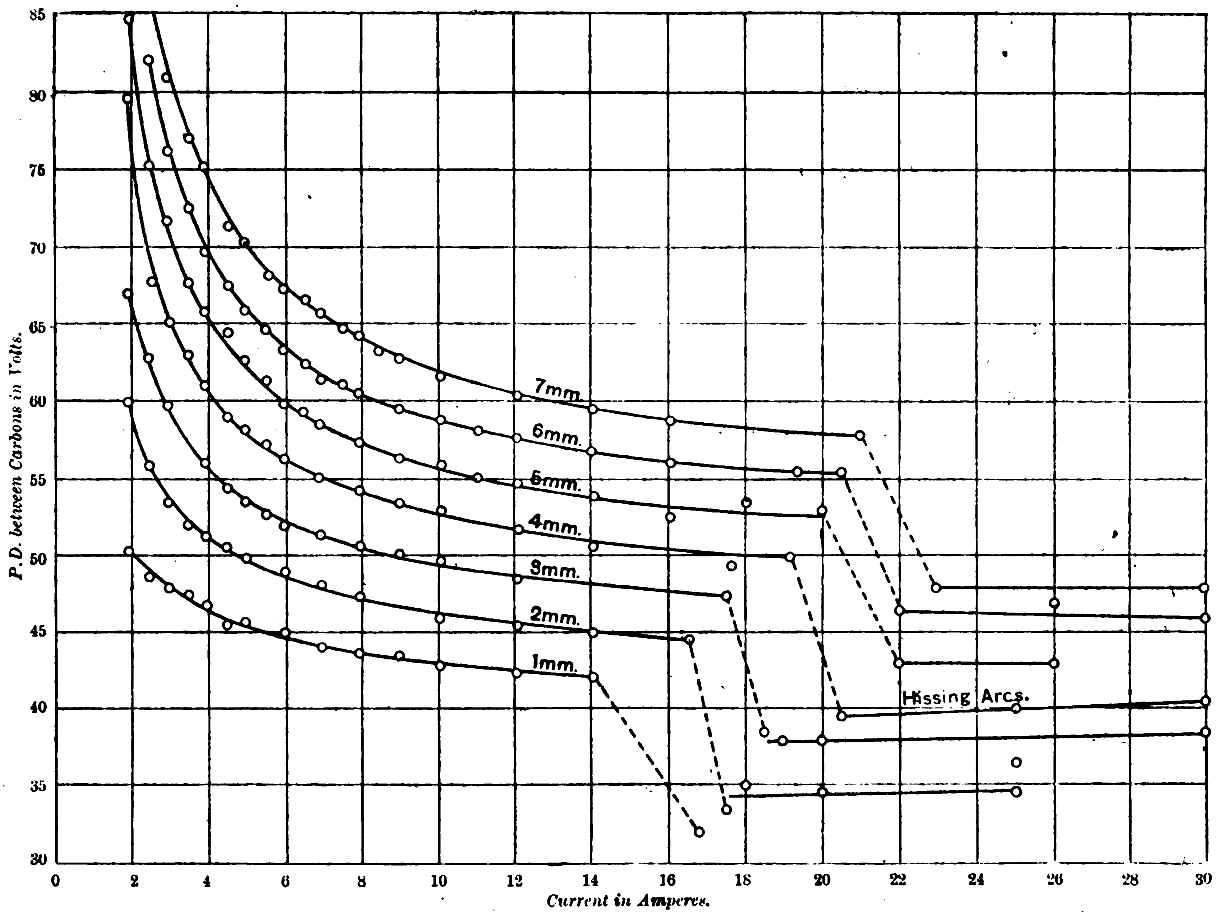

FIG. 33.—P.D. and Current for Different Lengths of Arc. Carbons :—Positive 11mm., Negative 9mm.

give still more accurately than the points themselves the ordinate corresponding with any given abscissa, *i.e.*, the number of volts corresponding with any given number of amperes. Hence, to obtain the number of watts for each point in Fig. 34, points were taken that were actually on the curves in Fig. 33, and the number of volts represented by their ordinates was multiplied by the number of amperes represented by their abscissæ. And it is because greater accuracy was obtained in this way that the points lie so well on the straight lines in Fig. 34. The ordinates of points in Fig. 35 were taken direct from the lines in Fig. 34.

From Figs. 34 and 35 we can ascertain the exact form of the general equation

$$V = f(A, l)$$

connecting the potential difference between the carbons with any current and any apparent length of arc. For, in any one of the curves in Fig. 34, let

l equal the apparent length of the arc in millimetres,

W equal the power in watts expended in sending a given current through an arc l millimetres long,

Therefore we have,

$$\frac{W - 245}{l} = \frac{406 - 245}{7},$$

$$= \frac{161}{7},$$

$$= 23.$$

Hence $W = 245 + 23\,l$ is the equation to the line representing the connection between power in watts and apparent length of arc in millimetres for the constant current of 6 amperes.

But in order to apply equation (1) to any of the lines in Fig. 34 we must know the two constants for that line, W_7 and W_0, and, as there are 11 such lines, it would be necessary to have 22 constants for those 11 lines. In order to get the complete equation, therefore, we must find some relation between all these constants.

Now the relation between W_7 with one current and W_7 with another current is simply the relation between power in watts and current in amperes for a constant length of arc of 7mm. Hence the next thing to be done was to find the law connecting

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power with current for various constant lengths of arc. This law, as already explained, is, I find, a strictly linear one for solid carbons, and in Fig. 35 are given the straight lines for a 7mm. arc and for a 0mm. arc, which are the only two cases required in the present investigation.

The upper straight line in Fig. 35 for an arc of constant length of 7mm. cuts the axis along which current is measured at a distance from the zero point which represents 1·6 amperes.

Therefore, calling A the current in amperes, and using the notation already adopted for W, we have by similar triangles

$$\frac{W_7}{A+1{\cdot}6} = \frac{\text{the watts corresponding with a current of 14 amperes}}{14+1{\cdot}6}$$

$$= \frac{833}{15{\cdot}6},$$

$$= 53{\cdot}397;$$

or $$W_7 = 53{\cdot}397\,A + 1{\cdot}6 \times 53{\cdot}397,$$

$$= 53{\cdot}397\,A + 85{\cdot}435.$$

Hence $$W_7 = 53{\cdot}397\,A + 85{\cdot}435 \quad . \; . \; . \; . \; . \; . \; . \quad (2)$$

is the equation to the upper line in Fig. 35.

Using the same notation for the lower curve, and remarking that it cuts the axis of current at a distance from the zero point which represents a current of 0·3 ampere, we have

$$\frac{W_0}{A+0{\cdot}3} = \frac{\text{the watts corresponding with a current of 14 amperes}}{14+0{\cdot}3}$$

$$= \frac{556}{14{\cdot}3},$$

$$= 38{\cdot}881;$$

or $$W_0 = 38{\cdot}881\,A + 14{\cdot}3 \times 38{\cdot}881,$$

$$= 38{\cdot}881\,A + 11{\cdot}664.$$

Hence $$W_0 = 38{\cdot}881\,A + 11{\cdot}664 \quad . \; . \; . \; . \; . \; . \; . \quad (3)$$

is the equation to the lower line in Fig. 35.

Substituting the above values for W_7 and W_0 in equation (1) we have

$$\frac{W-(38{\cdot}881\,A+11{\cdot}664)}{l}$$

$$= \frac{53{\cdot}397\,A+85{\cdot}435-(38{\cdot}881\,A+11{\cdot}664)}{7},$$

$$= \frac{14{\cdot}516\,A+73{\cdot}771}{7},$$

$$= 2{\cdot}074\,A + 10{\cdot}54.$$

Therefore $$W = 38{\cdot}881\,A + 11{\cdot}664 + l\,(2{\cdot}074\,A + 10{\cdot}54)$$

is the general equation connecting the power expended in a silent arc in watts, the current flowing in amperes, and the apparent length of the arc in millimetres for the *solid* carbons which I have used. But $W = A\,V$, therefore, dividing both sides of the preceding equation by A, and omitting the fifth significant figure, we obtain

$$V = 38{\cdot}88 + 2{\cdot}074\,l + \frac{11{\cdot}66 + 10{\cdot}54\,l}{A} \quad . \; . \; . \; . \quad (4)$$

This is the equation which we have been seeking, to the family of curves in Fig. 33, and it enables us to calculate V, the potential difference in volts that it is necessary to maintain between a pair of *solid* carbons of the size and hardness that I used, in order that a current of A amperes may flow through a silent arc whose apparent length, as measured on the projected image, is l millimetres.

In order to see how nearly this equation actually represents the curves in Fig. 33, I have used it to calculate the potential difference that should correspond with currents of 3, 4, 5, 6, 7, 8, 9, 10, 12, 14 amperes, and in some cases with currents of 2 and 16 amperes for all the arcs from 1mm. to 7mm. in length; and in Table VIII. are given the results of 81 such calculations, as well as the actual potential differences taken from the curves themselves.

An examination of this table shows that 59 out of the 81 calculated values of the potential difference do not differ by as much as 0·05 of a volt from the values of the potential

Both Carbons Solid.

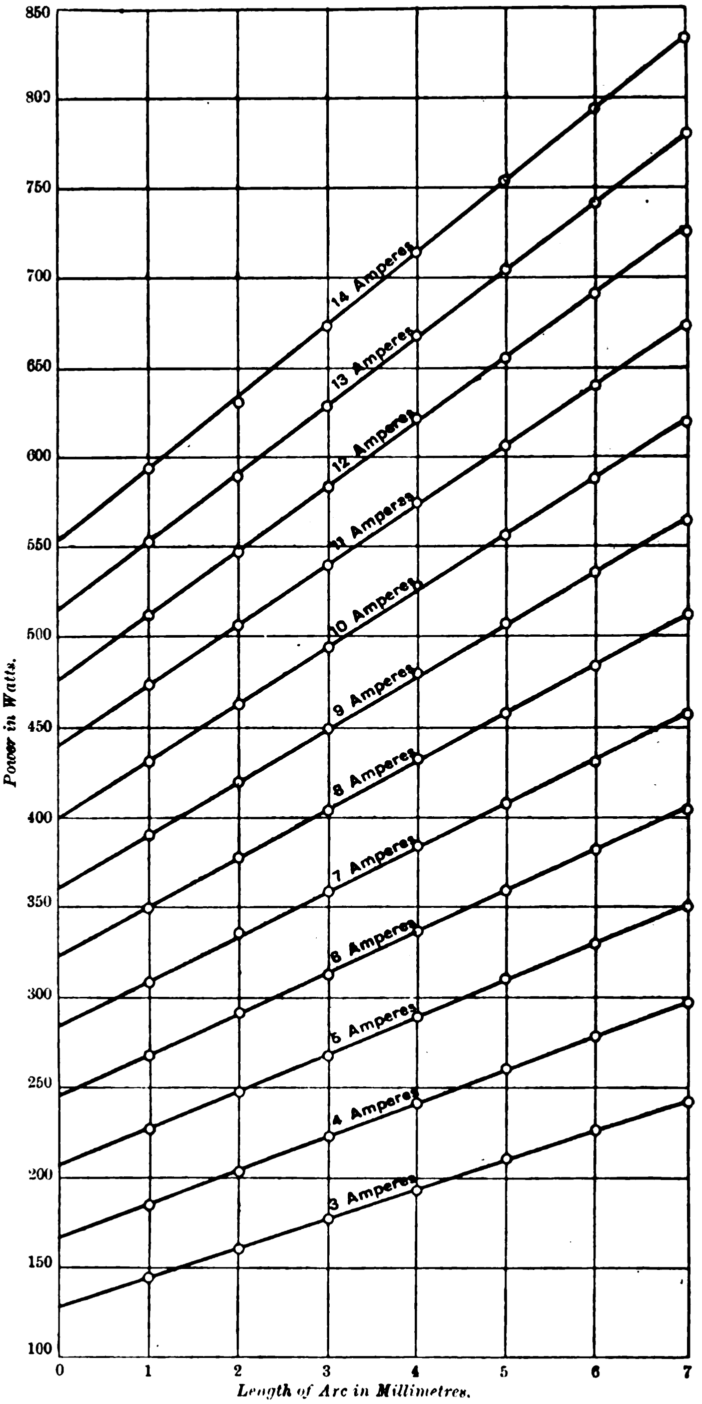

FIG. 34.—Watts and Length of Arc for Different Constant Currents. Carbons:—Positive 11mm., Negative 9mm.

Both Carbons Solid.

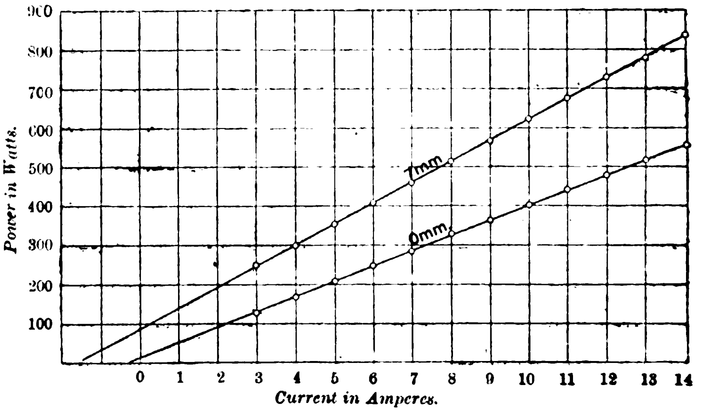

FIG. 35.—Watts and Current for Arcs of 7mm. and 0mm. Carbons:—Positive 11mm., Negative 9mm.

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Table VIII.—*Comparison of Potential Differences taken from the Curves in Fig. 33, with the Potential Differences calculated from Equation (4). Carbons solid.*

Amperes.	$l=1$		$l=2$		$l=3$		$l=4$		$l=5$		$l=6$		$l=7$	
	Volts taken from curves.	Calculated volts.	Volts taken from curves.	Calculated volts.	Volts taken from curves.	Calculated volts.	Volts taken from curves.	Calculated volts.	Volts taken from curves.	Calculated volts.	Volts taken from curves.	Calculated volts.	Volts taken from curves.	Calculated volts.
2	50·6	52·05	59·4	59·4	66·75	66·74	74·1	74·09	81·4	81·43	..	...	...	...
3	48·3	48·35	53·75	53·94	59·5	59·53	65·1	65·12	70·7	70·7	76·1	76·29	81·1	81·88
4	46·5	46·5	51·2	51·21	55·9	55·92	60·6	60·63	65·3	65·34	69·6	70·04	74·4	74·76
5	45·4	45·39	49·6	49·58	53·6	53·76	57·9	57·94	62·15	62·12	65·9	66·3	70·1	70·49
6	44·65	44·65	48·5	48·49	52·25	52·31	56·15	56·15	60·0	59·98	63·5	63·8	67·6	67·64
7	44·1	44·12	47·8	47·71	51·3	51·28	54·9	54·87	58·4	58·44	61·7	62·02	65·6	65·61
8	43·7	43·72	47·15	47·12	50·5	50·51	54·0	53·91	57·3	57·3	60·5	60·68	64·1	64·08
9	43·4	43·42	46·7	46·67	49·9	49·91	53·3	53·16	56·4	56·4	59·6	59·64	62·9	62·89
10	43·1	43·17	46·3	46·3	49·4	49·43	52·7	52·56	55·7	55·69	58·8	58·81	61·9	61·94
12	42·6	42·8	45·65	45·76	48·7	48·71	51·7	51·67	54·6	54·61	57·6	57·56	60·5	60·52
14	42·25	42·54	45·25	45·37	48·2	48·19	51·0	51·02	53·85	53·85	56·7	56·67	59·5	59·5
16	...	..	44·75	45·08	47·8	47·8	50·5	50·54	53·25	53·27	56·0	56·0	58·75	58·74

difference taken from the curves, while of the remaining 22 values

7 differ by 0·05 to 0·15 volts from the curve values,
5 differ by 0·15 to 0·25 volts " "
4 differ by 0·25 to 0·35 volts " "
4 differ by 0·35 to 0·45 volts " "
1 differs by 0·8 volt " "
1 differs by 1·5 volt " "

so that only two of the 81 calculated values differ from the curve values by as much as 0·5 volt, and, since these two values, viz., one belonging to a current of 2 amperes with an arc of 1mm., and the other to a current of 3 amperes with an arc of 7mm., are on the steepest part of the curves, the wonder is, not that there are two values somewhat wrong, but that the agreement between the calculated and the curve values of the potential difference should be so marked for all the other points even in the steep parts of the curves. For it must be remembered that a slight mistake either in the reading of the currents or of the length of the arc makes a large error in the potential difference when the current is small.

There can be no doubt, then, that equation (4) *accurately* gives the law connecting potential difference, current, and apparent length of arc for solid carbons of the size and hardness that I have used.

The general form of this equation is

$$V = a + bl + \frac{c + dl}{A},$$

which may be written

$$A\{V - (a + bl)\} = c + dl. \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Now this is the equation to a *rectangular hyperbola* when l is constant, and the asymptotes are—one the axis along which potential difference is measured, the other a line parallel to the axis along which current is measured. Hence the curves in Fig. 33 are a series of rectangular hyperbolas having one asymptote in common, which is used as the axis of potential difference, while their other asymptotes are lines parallel to the axis of current and at a distance from it depending upon the value of l. In fact, if d be the distance of the asymptote of any one of the curves from the axis of current, then

$$d = a + bl,$$

$$\text{or } d = 38{\cdot}88 + 2{\cdot}074\,l,$$

where l stands for the number of millimetres in the apparent length of the arc, and the unit of length for d is the length that has been arbitrarily taken to represent a volt in drawing the curves in Fig. 33.

These curves have not the appearance of rectangular hyperbolas, but that arises from different units of length having been taken to represent a volt and an ampere. In Fig. 36 I have therefore redrawn the particular curve in Fig. 33 which corresponds with a constant length of arc of 5mm., and since the same length has been taken to represent a volt and an ampere in Fig. 36, the identity of the curve in this figure with a rectangular hyperbola becomes evident. The asymptotes, the axis, and the focus of this rectangular hyperbola are also indicated.

The next step is to compare my equation (4) with equations that have been previously published by other writers to connect

Both Carbons Solid.

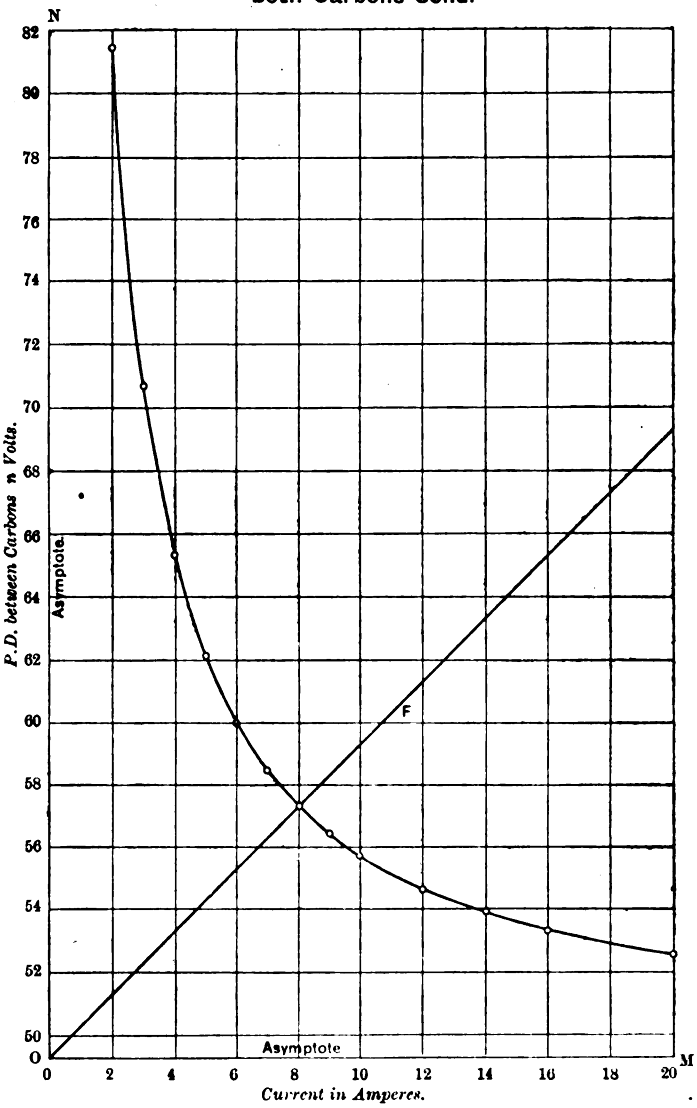

Fig. 36.—Hyperbola showing connection between Potential Difference and Current for constant length of Arc of 5mm., when Volts and Amperes are drawn to the same scale. O M, O N are the two asymptotes, O F the axis, and F the focus of the hyperbola.

the potential difference between the carbons, with the current, and the length of the arc.

(To be continued.)

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The Oldest Electrical Journal, 1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny
Editorial, Publishing and Printing Offices,

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ELECTRIC LIGHTING STATIONS AS FIRE RISKS.

Whether or no the cause of the recent fire at the Sardinia-street station is to become another of London's many mysteries or to be revealed in the fulness of time by the indiscretion of a subordinate or the enterprise of an inquisitive journal, we will not venture to prophesy; certain it is, however, that the thicker the obscurity with which it is sought to surround a mishap of this nature the wider the scope given to the exercise of the human imagination, especially of that of the gas man or alarmist by constitution. Indeed, so unfortunate are the effects of secrecy in matters of this kind, as in most others, that the next time the Electric Lighting Act of 1882 comes up for amendment we would suggest the introduction of a clause empowering the Board of Trade to demand an annual return of all fires occurring in central stations with a statement in each case of the origin. No doubt the space left for this particular return would, in the vast majority of instances, be left blank; so much the better. At any rate, the cause of a fire at a central station would no longer be kept as jealously from the public ear as a blotch on the escutcheon of a William-the-Conqueror family is kept from the public eye. Leaving, however, the cause of this disaster, and passing on to its effects of a reflex order, probably the most important is the rumour that the insurance companies are considering the desirability of raising their rates for electric lighting stations. Assuming for the moment that the rumour is more or less well founded, and that it is not intended merely as a warning of what may happen unless something more is done than has already been done to render electric lighting stations proof against fire, it may not be without interest to glance at what happened in the United States only a few years ago, and to see whether measures similar to those which were taken there should be resorted to in the United Kingdom.

Early in 1890, owing to the continual raising of the rates by the fire insurance companies the Electric Mutual Insurance Company was formed. At the beginning of 1891 this concern issued its first report, and a very glowing one it was too. The

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causes which had led to the formation of the Company were said to be "the exorbitant rates and exacting conditions imposed by the stock companies," and it was stated that property to the value of nearly £600,000 had already been insured at an average rate of about one and one-fifth per cent., and that not a dollar of loss had occurred on any station insured. If, the report went on to say, "the experience of the Company during the first eight months, continues to the end of the first year, we shall be able to pay back to members 50 per cent. of the premium paid for their policies, and add to our reserve besides." But in January, 1892, less than two years after its sanguine start, the Electric Mutual Insurance Company handed over its entire business to the Home Insurance Company of New York. The reasons given to the policy-holders for this step were to the effect that 1891 had been one of the severest years for fire losses ever known, and owing to an unusual number of fires on electrical property the Company was losing the support of concerns which had helped it to carry on a large proportion of its insurances; West of the Mississippi, indeed, it was entirely deprived of such support. No doubt bad management and the hostility of the regular insurance companies had much to do with this *fiasco*, but, if we may credit Mr. WILLIAM BROPHY, the inherent vices of American central-station structures at that date must have been the main factor in rendering their insurance at one and one-fifth per cent. a mere philanthropic enterprise. In a Paper read before the Massachusetts Electric Light Association in August, 1893, Mr. BROPHY delivered himself of one of those sweeping utterances which are apparently intended to carry conviction by the very superfluity of their vigour. In the early days of the electric lighting business, said Mr. BROPHY, "many of those who planned or projected an electric plant seemed to totally disregard all the well-known principles of mechanical engigineering, while the architectural designs most readily adopted were those that were least adapted to economy of labour or space, and most likely to invite incipient fire and ultimate total destruction; while the idea of providing a single appliance for promptly extinguishing fires was never thought of"; Mr. BROPHY's indictment, it is true, wound up with an appeal to his auditors to make haste and insure in the Industrial Mutual Insurance Company; but his Paper contained nevertheless a sufficient number of indisputable and undisputed facts as to fires in American central stations to show that there was good cause for the New York Fire Offices to fight shy of such risks. Wooden buildings, oil soaked wooden floors, feeder-equalisers inside wooden frames, together with a total absence of hydrants and the prevalence of bad discipline would seem to afford ample justification for abnormally high rates.

Nothing of the kind, however, exists on this side of the Atlantic, and if Insurance Offices do not find electric lighting stations a particularly remunerative class of risk it cannot be on account of the number of fires. There are at the present moment over one hundred electric lighting stations at work in the United Kingdom, and so far there have only been some three or four fires. The arrangement and construction of English central stations, moreover, is very different to that which characterises, or at any rate until quite recently characterised, those erected in America. Solid single-storied buildings of brick and iron predominate, and arrangements for the extinction of fire are not forgotten. It must, however, be confessed that many a station originally well-arranged becomes in course of time overcrowded, wood is allowed to creep in where it should not, and lumber and inflammable stores are allowed to accumulate without check; main switchboards are special offenders, presenting in front an imposing stretch of slate, copper and brass, and behind a tangle of cables and plenty of match-boarding. Again, too much reliance may be placed upon fire extinction appliances. Such things are good in themselves, nay necessary, but careful periodical inspection of every nook and corner, and a design and construction having the prevention or strict isolation of fire more in view are to be preferred. If the English Fire Offices were to raise their rates unduly and unreasonably an insurance reserve fund for each undertaking, or a system of mutual insurance, would quickly checkmate them. But apart altogether from considerations connected with premiums it is not desirable that interruptions of electric supply due to fire at the generating centre should become a by no means extraordinary incident in domestic life. Whether the mishap is due to the vicinity of dangerous buildings, to bad construction of the station itself, or to lack of fire-extinction appliances, it serves all the same to connect Electricity in a quite unnecessary, quite undeserved, highly undesirable manner with Fire.

REVIEW.

A Text-Book of Mechanical Engineering. By WILFRID J. LINEHAM. (London: Chapman and Hall. 1894.)

This work is an ambitious and not altogether unsuccessful attempt to embody the principal branches of mechanical engineering in one systematic treatise. The task which the author has set his face towards is well nigh encyclopædic, and might with advantage enlist the services of many minds and fill as many volumes. But, though the perfect performance of such a task is almost, if not quite, beyond the power of any single individual, we are still inclined to believe that there are counteracting advantages in having the views and experience of one well trained mind, such as Mr. Lineham evinces, extended over this entire range of the subject of mechanical engineering, and compressed into one concise and handy volume. By the careful selection of material and an excellent choice of illustrations, the author has contrived to cover the ground in some 750 pages or less, without excessively compressing any of the items. We may here express our admiration of the illustrations, of which there are some 782, including 18 large folding plates. These are nearly all carefully drawn to scale, and in every case where it would be of use the scale accompanies the drawing. Considered only as a collection of machine drawings, it is worth while for every draughtsman to possess a copy of the work.

The book is divided into two parts, Part I. being devoted to "Workshop Practice" and Part II. to "Theory and Examples." In the first seven chapters which constitute Part I., and which together occupy about half the volume, the reader is taken the round of the shops and is shown the why and wherefore of the chief operations which take place in them. Although this section should be of use to the student in his study, as serving to give him some insight into workshop methods, it will be vastly more useful to the apprentice or, as he likes now to be called, the "articled pupil"; it cannot, of course, in any sense *replace* actual workshop practice, for no literature can do that. The following extract is made in order to give some idea of the author's method of treatment of Part I.:—

"The student will have already noticed that a good deal of judgment has to be exercised by the smith in deciding upon the length and breadth of iron necessary to execute a certain piece of work, and although this can rarely be achieved with very great nicety, yet practice enables him to guess it with sufficient accuracy. As a rule the cubic contents, or the weight of stuff should be about the same in the rough as in the finished piece, some allowance being made for burning away in the fire; but it is best to err by having too much than too little, and in most articles the extra stuff can very easily be cut off. Some, however, require more exact measurement, as, from the nature of their construction, the after-cutting cannot well be resorted to. Wherever parts have to be afterwards machined, extra material should be allowed, say from one-sixteenth to one-eighth of an inch, but the careful smith will always leave as little as possible, and if he is directed to finish *black* he should make the work as exact to dimensions as his tools will allow."

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A lengthy chapter is the one devoted to "Boiler Making and Plate Work," which concludes Part I. Some attention is here paid to electric welding, the methods of using the Thomson-Houston and the Bernardos processes being described. The author believes that "the great advantage of electric welding lies in the local character of the heating, which prevents the spoiling of a finished piece of work." This is undoubtedly one of the advantages where certain kinds of work are required to be done; but we think that there are other advantages of still greater importance. Nor is excessive localisation of heat in boiler welding a thing always to be desired.

In Part II. a great diversity of subjects receive consideration. The section commences with a chapter on "Strength of Materials, Structures and Machine Parts." Testing machines receive very adequate and clear description, and a good general account of ordinary testing is included in this chapter. This chapter, we think, would be rendered more complete by the addition of a short account of the stresses in, and the strength of, flywheel rims—an important matter, which is far from being correctly treated except in the very latest editions of one or two of the text-books now in the hands of students. After a few lessons in theoretical mechanics, the student is led on to the study of the various methods of transmitting power to machines, and space is even devoted to a short study of electric transmission. The chapter dealing with these subjects is probably the most compressed of all; but it should be serviceable as an introduction to the study of larger and more complete works. Chapter X. covers the ground of "Heat and Heat Engines," and is followed by the concluding chapter on "Hydraulics and Hydraulic Motors." We do not care for the author's definition of heat as "a 'pendulum' motion of the molecules." It is inexact, and conveys two erroneous notions. The form of the motion is not that of an ordinary pendulum; nor is it the motion, but the energy of it, which is a measure of the heat. A short account of the thermodynamics of heat engines affords a useful introduction to Chapter X., and does not tax the mathematical abilities of the reader to any great extent. A rather loose and imperfect statement of the important second law of thermodynamics does not seem to affect the subsequent interpretation of this law in its relation to heat engines; and the author, if not quite as explicit and clear as might be desired, has at any rate rendered this part of his work free from the erroneous views on thermodynamics which are affected by a certain class of engineers. Steam engine valve quantities and valve gears receive very thorough treatment; and there is a series of well-illustrated descriptions of the principal types of this engine. Boilers, the construction of which receives such extensive notice in Part I., are in Part II. absolutely ignored. Indeed, the most serious defect of Chapter X., if not of the whole book, is the absence of information about steam generation and generators, from the point of view of their action and practical working. Not quite two pages on the chemistry of combustion, a short paragraph on forced draught and a still shorter one on fuel waste, are all that is afforded on this important subject. About six pages are devoted to the gas engine, some five of these being allotted to a description of the "Simplex" engine. A few pages on the Priestman oil engine bring the chapter to a close. The section on hydraulics needs no further notice than to say that what there is of it is very good, but that it is all too brief for more than a cursory treatment of such a subject. The work is provided with a good index, and it should be welcomed by the budding mechanical engineer as a practical and reliable text-book.

ON THE INVESTIGATION AND DESIGN OF ALTERNATE-CURRENT DYNAMOS.

BY DR. H. BEHN-ESCHENBURG.

The factor which best shows the quality and efficiency of an alternate-current dynamo is the fall of potential, *i.e.*, the difference between the terminal E.M.F. of the dynamo at constant speed and constant exciting current when the armature is on open circuit and when it is conducting a current of any given phase difference. In other words, what is meant by the fall of potential of a machine is the difference of the potentials of the machine at constant excitation and speed at no load and at a fixed load. The fall of potential is generally determined (1) by the self-induction of the armature; (2) by the copper resistance of the armature; (3) by the reaction of the eddy currents induced by the armature currents mostly in the solid iron masses of the field magnets. These three factors, which determine the fall of potential, may be represented as electromotive forces, with certain phase lags, producing with the E.M.F. of the dynamo the terminal potential. The three electromotive forces in the armature are proportional to the load current (*Belastungsstromstärke*), and may be represented in the well-known polar diagram (Fig. 1) in their effective values and phases or directions by e_1, e_2, e_3. In the same diagram I represents the armature current, *i.e.*, the load current of the dynamo; E is the potential of the dynamo running at open circuit. The directions of the different quantities will be fixed by the angle of the phase difference between the quantities in question and the current I. By the nature of things there exists between the E.M.F. e_1 of self-induction and the current I the phase difference $\frac{\pi}{2}$, and between the E.M.F.'s e_2 and e_3 and the current the phase difference 0. We assume further that with the load selected for the dynamo there exists between the potential E_1 and the current strength I the phase difference ϕ, defined by the relation of the watt output W and the apparent volts-amperes in formula 1—

$$W = E_1 I \cos\phi \qquad (1)$$

For lighting transformers ϕ is about 10deg., and cos ϕ practically $= 1$; for distribution of power in non-synchronous

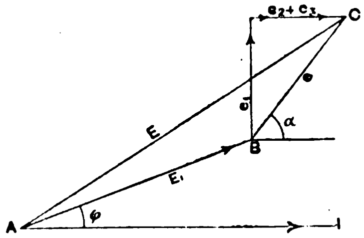

FIG. 1.

motors ϕ is about 35deg., and cos ϕ about 0·85. The fall of potential may be taken from the diagram and equals $E - E_1$. The same diagram may be used for synchronous motors, when the E.M.F. of the motor is taken in place of the terminal potential E_1 of the generator and *vice versâ*.

The resultant e of the three electromotive forces e_1, e_2, e_3, which has a phase difference α from the current I, represents the total counter electromotive force of the loaded armature. By this E.M.F. e and the current I the apparent internal resistance or impedance R of the armature can be defined by the equation

$$R = \frac{e}{I} \qquad (2)$$

It is an important point in the investigation of alternators to ascertain and calculate in advance this impedance R or the counter E.M.F. e; these factors fixed, all others required can be easily obtained from Fig. 1.

To this end I have used for some years the following method, which I should like to recommend to fellow electricians:—First of all, the characteristic of the E.M.F. E of the dynamo with the armature on open circuit has to be taken (*see* Fig. 2, curve E). The abscissæ represent the ampere-turns of the magnetising current, and the ordinates represent the induced potential E of the dynamo at a certain speed. Another characteristic, I_0, is taken, the terminals of the armature being connected in short-circuit through an ammeter. The abscissæ, again, are the number of ampere-turns of the field, and the ordinates the current in the short-circuited armature in amperes. This curve I_0 differs very little from a straight line; for high magnetisations it is, however, a little convex.

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In the case of the short-circuited armature the diagram (Fig. 1) must be altered so that $E = 0$; then we get immediately, in Fig. 3, $e = E$, and we have

$$R = \frac{E}{I_0} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

for each value of the abscissæ. These values of R we draw on the same curve diagram as ordinates, and obtain in this way a third characteristic R of the apparent resistance for each value of the field strength.

For any value of the load current I, e is given for a certain field excitation by the equation $e = R\,I$, and E_1 and ϕ can be calculated from the diagram. If, on the other hand, for a given field current E, ϕ and I are to be taken as given and E_1 has to be predetermined, or if E, E_1 and I are given

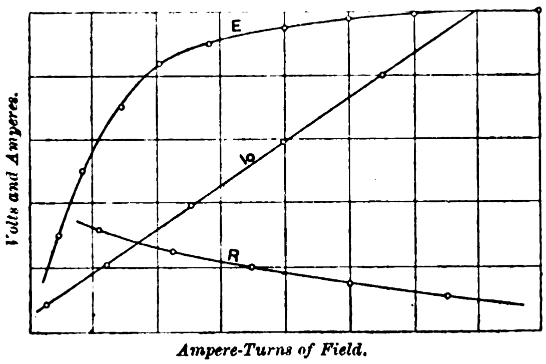

FIG. 2.

from observation, and ϕ has to be determined, the formulæ are obtained from the obtuse-angled triangle A B C of the diagram.

$$\cos(\alpha - \phi) = \frac{E^2 - E_1{}^2 - e^2}{2\,E_1\,e} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$E_1 = -e \cos(\alpha - \phi) - \tfrac{1}{2}\,\frac{[e\,.\,\sin(\alpha - \phi)]^2}{E}. \quad . \quad (5)$$

The electromotive force e will in practice, of course, be smaller than E.

Finally, to ascertain the phase difference α between e and I_0 or I, not only has the current I_0 of the short-circuited armature to be observed, but also the watt consumption $E\,.\,I_0 \cos \alpha$, either directly by means of a wattmeter or by measuring the energy required to drive the short-circuited dynamo. In well-

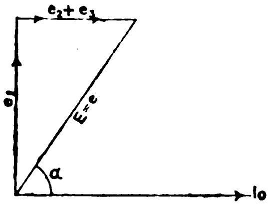

FIG. 3.

designed dynamos α is greater than 80deg., and can be taken approximately as $\frac{\pi}{2}$. This means that the loss in the copper and in eddy-currents should be very small as compared with the potential fall. The component e_2 of the E.M.F. e, since $e_2 = I\,.\,r$, is easily determined by measuring the resistance r of the armature. The component e_3 of the reaction of eddy-currents increases approximately as the square of the number of periods of the alternator, and can thus be separated from e_2 by means of observations. It is to be remarked that in most cases e_3 seems to be neglected by writers on this subject. Evidently α can be calculated when measurements at any load have resulted in values for E_1, E, I and ϕ; for instance, taking $\phi = 0$ or $\phi = \frac{\pi}{2}$ respectively when the machine is on an entirely inductionless load such as glow lamps or on a purely inductive load such as motors running empty, or ϕ may be ascertained by means of a wattmeter. It may also be remarked that for small values of ϕ—for instance, with lighting transformers—the determination of the potential fall by means of the diagram will give better results than a wattmeter measurement, as in the diagram $\sin \phi$ and with the wattmeter $\cos \phi$ is obtained.

If for approximation $\alpha = \frac{\pi}{2}$, then the formulæ (4) and (5) for E_1 and ϕ are simplified, and we get

$$\sin \phi = \frac{E^2 - E_1{}^2 - e^2}{2\,E_1\,e} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$$E_1 = E - e \sin \phi - \tfrac{1}{2}\left(\frac{e^2 \cos^2 \phi}{E}\right) \quad . \quad . \quad . \quad (7)$$

for the two extreme cases of $\phi = 0$ and $\phi = \frac{\pi}{2}$, we get respectively

$$E_1{}^2 = E^2 - e^2 \qquad \phi = 0 \quad . \quad . \quad . \quad . \quad (7\text{A})$$

$$E_1 = E - e \qquad \phi = \frac{\pi}{2}. \quad . \quad . \quad . \quad . \quad (7\text{B})$$

The plotting of the two characteristics E and I_0 can be done in a very short time with the assistance of a voltmeter, a continuous-current ammeter, an alternate-current ammeter, and a speed counter, and the driving of the dynamo only requires 10 to 20 per cent. of the normal load—*i.e.*, the energy which is lost in the loaded dynamo. During the short time which is required for its measurement the short-circuit current I_0 can, without hesitation, be made twice or three times the normal current. In taking the short-circuit curve I_0 the speed is a secondary matter, as naturally for a constant field magnetisation the short-circuit current remains the same for all speeds.

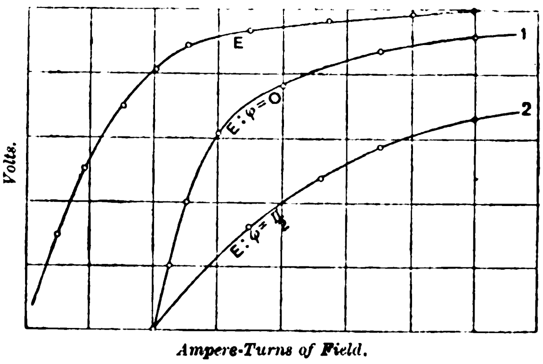

FIG. 4.

In Fig. 4 are plotted from Figs. 1 and 2 the specially calculated characteristic curves of the potential for the two limiting cases of $\phi = 0$ and $\phi = \frac{\pi}{2}$. Between these curves 1 and 2 must lie for all possible values of ϕ all the potentials of the dynamo with the current I.

Besides giving us the quantity R, this method gives us a clear picture of the conditions which determine the magnetic leakage of the field. The ampere-turns of the armature are magnetising the magnetic circuit in the same manner as the ampere-turns of the field coil. Those magnetic lines of force which are induced by one of the two coils without cutting the other coil are called lines of leakage. Let us assume that of the total lines induced by the field coil S_1 per cent., and of the total lines induced by the armature S_2 per cent. are lost due to the leakage. Let the number of windings of the field be W_1, of the armature W_2, so that both sets of windings may be reduced to the same magnetic circuit. This reduction can easily be effected by means of a diagrammatic drawing, in which the closed circuits of the magnetic lines are drawn as linear conductors analogous to a diagram of electric currents; the ampere-turns of the armature and of the field are shown as magnetomotive forces, analogous to electromotive forces at the points where the windings are cut by the lines of force. The number of the lines of force can be calculated in the same way as is done for electrical currents by means of Kirchhoff's laws. When the armature is short-circuited a balance must exist between the magnetomotive force of the armature currents and that of the field coils, excepting the ampere-turns which produce the leakage field and those which induce the E.M.F.'s

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e_2 and e_3. These give the magnetomotive forces which induce the E.M.F.'s E and e_1. We get then with the important relation:

$$(1-S_1)\, i_0\, W_1 = \frac{(1+S_2)\, I_0\, W_2}{\sin \alpha} 1{\cdot}4, \quad . \quad . \quad . \quad (8)^*$$

i_0 being the exciting current in the field windings. The factor 1·4 on the right determines the maximum number of the ampere-turns from the mean value I_0.

If the field system has a single magnetising coil, then, as is easily seen, W_1 should be multiplied by half the number of poles. If the armature system consists of N phases (*Phasenabtheilungen*), then on the right W_2 must be multiplied by $\frac{N}{2}$, so that W_2 denotes the number of windings of one phase.

From equation (8), which besides the number of turns only requires the observation of the curve I_0, there is given for any field excitation the ratio of the counter electromotive force e to the E.M.F. E of the dynamo for a load current I—in other words, the percentage potential loss. We have

$$\frac{e}{E} = \frac{I}{I_0} \text{ or } \frac{e}{E} = \frac{I\, W_2}{i_0\, W_1} \times \frac{1{\cdot}4\,(1+S_2)}{(1-S_1)\sin \alpha}, \quad . \quad . \quad (9)$$

in other words, e is to E as the load current I is to the short-circuit current I_0 at the same excitation or as the number of ampere-turns of the armature to those of the field multiplied by a factor which approximates to 1·4. Further,

$$\frac{(1+S_2)\, 1.4}{(1-S_1)\sin \alpha} = \frac{i_0\, W_1}{I_0\, W_2}. \quad . \quad . \quad . \quad . \quad (10)$$

The leakage loss S_1 is easily calculated when the principal dimensions of the dynamo are known, and the above formula (10) therefore gives the value of S_2, which is otherwise difficult to calculate. The total magnetic resistance X of the magnetic circuit of the field and armature windings is calculated in the usual way from the individual resistances of the air and the iron construction at the selected density. If we denote the total lines induced by the ampere-turns of the field by B and the alternations by n, then the following equations apply:—

$$E = \frac{B\,.\,W_2\,.\,2\pi n}{1{\cdot}4 \times 10^8}\ ; \quad (11) \qquad 1{\cdot}2\, i_0 W_1 = B\, X\,(1+S_1)\ ; \quad (12)\dagger$$

also

$$1 + S_1 = \frac{5{\cdot}4\, i_0\, W_1\, W_2\, n}{E\,.\,X\,.\,10^8}.$$

For the case of the short-circuit we have $I_0\,.\,R = E$, and

$$R = \frac{7{\cdot}5\, W_2^{\,2}\,.\, n\,(1+S_2)}{X\,(1+S_1)\,(1-S_1)\sin \alpha\,.\,10^8}. \quad . \quad . \quad (13)$$

This last equation shows us the constructive importance of the apparent resistance R of the dynamo. R is proportionate to n and the square of the number of turns W_2. With higher saturations of the iron R decreases, since the magnetic resistance X increases.

In this outline I believe I have given a convenient method which furnishes direct values, and which permits of the comparison and discussion of alternators; it is a method which I have thoroughly tested in a large number of cases. With a knowledge of the two characteristics when running on no load and on short-circuit, one may predetermine for any alternate-current dynamo up to what limits the load—that is to say, up to what values of current and phase difference between current and potential a dynamo can maintain a certain terminal potential.

* The correctness of this equation is open to criticism. It is derived from the diagram Fig. 3, where $\sin \alpha = e_1/e$. Now e depends on the field magnet lines cutting the armature, or $i_0\, W_1\,(1-S_1)$ as given; the value of e_1 depending on the E.M.F. of self-induction is due to all the lines produced by the armature, or $I_0\, W_2\,(1) \times 1{\cdot}4$. The equation makes it depend on all the lines produced, including leakage, plus the leakage in addition. If this view is correct it will correspondingly modify the equations which follow.—[Translator.]

† If X denotes the magnetic resistance of the magnetic circuit carrying the lines B, which traverse both the armature part and the field magnet part, then $1{\cdot}2\, i_0\, W_1 = B\, X + B\, S_1 M$, where M is the magnetic resistance of that part of the circuit traversed by both leakage lines and lines cutting the armature; hence this equation is only true assuming the leakage path to be of the same magnetic resistance as the path through the armature coils. This will modify equation (13).—[Translator.]

FORMATION OF PERSULPHURIC ACID, AND THE CHEMICAL REACTIONS WHICH TAKE PLACE IN LEAD ACCUMULATORS.*

The apparatus used consisted in its simplest form of a beaker, in which stood a porous cell of about 100c.c. capacity. A piece of sheet lead 2mm. thick and 150 sq. cm. in area, surrounding the porous cell, served as cathode. The anode was of platinum wire or foil. The temperature was kept at 8°C. to 15°C. by cooling the beaker with ice, and in some of the experiments the cathode was placed in the porous cell in the form of a thin lead tube, through which ice water flowed. The temperature was thus kept at 5deg. to 6deg. at the anode, which in this case was a platinum wire wound round the porous pot. The theoretical yield per ampere-hour is 3·63 grammes of persulphuric acid, and preliminary experiments showed that very little persulphuric was formed by the electrolysis of solutions of sulphuric acid whose density was under 1·2. The E.M.F. was five volts, and the current density 100 amperes per square decimetre of anode surface.

The yield was largest in the first hour, and acid of density 1·450 gave the best result. When sulphuric acid is largely diluted with water, it breaks up into the ions (H) (H) (SO_4); when moderately diluted it breaks up partly into the ions (H) (HSO_4), and the more concentrated it becomes the greater is the preponderance of the ions (HSO_4). The authors consider that under suitable conditions the ions (HSO_4) give up their electric charges, and unite to form $H_2S_2O_8$ (persulphuric acid) in a manner analogous to the formation of Cl_2 molecules from the Cl ions in the electrolysis of hydrochloric acid. For the formation of persulphuric acid, however, certain conditions must be fulfilled, for the residues SO_4 as well as HSO_4 react upon water, forming H_2SO_4 and evolving oxygen. Therefore a high current density is required to compel the HSO_4 ions to combine before they meet water molecules. The yield of persulphuric acid does not increase as the density of the solution increases, but begins to fall off at a specific gravity of 1·5, partly owing to the higher resistance of the concentrated sulphuric acid, partly to its viscosity, partly also to the local warming at the anode, which causes decomposition of the persulphuric acid already formed. The yield of persulphuric acid decreases as the electrolysis is continued, being less in the second hour than it is in the first. The authors consider that their results support Küster's theory that the electrolytic formation of persulphuric acid is due to the union of HSO_4 ions, and not to oxidation, and regard Oettel's experiments on oxidation by electrolysis as confirmatory. There is a limit to the amount of persulphuric acid which can be obtained, as it, like pure sulphuric acid, is a very bad conductor, and forms an almost insulating sheath round the anode if it is produced more rapidly than it can diffuse into the surrounding liquid. The yield decreases very rapidly with rise of temperature, and at 60°C. persulphuric acid decomposes almost as soon as it is formed. The most concentrated acid the authors obtained by electrolysis contained 433·8 grammes of persulphuric acid per litre.

The authors proceed to discuss the bearing of the results of their experiments on the theory put forward by M. Darrieus, that the formation of persulphuric acid during charge converts the lead oxide and lead sulphate on the positive plate into peroxide, the completion of charge being denoted by the decomposition of any excess of persulphuric acid in sulphuric acid and oxygen with the evolution of gas. They point out that the results of their experiments are not in accord with this theory, for with the low-current densities used with accumulators very small quantities of persulphuric acid would be formed even when the acid has the unusually high specific gravity (1·3) employed by M. Darrieus. With a current density of 2,800 amperes per square metre such acid was found to give 24 per cent. of the theoretical yield of persulphuric acid; when the current density was reduced to 1,300, the amount of persulphuric acid formed could not be estimated quantitatively, and could only just be detected qualitatively. When acid of 1·15 specific gravity was electrolysed in an ordinary voltameter no persulphuric acid at all was found at a current density of 4,000; traces only began to appear when the current density was raised to 10,000. Now the current densities normally used in working accumulators are much lower than these; *e.g.*, the normal current for charging an 80 ampere-hour accumulator with positives of 20 square decimetre area would correspond to a current density of 5 amperes per square metre. The authors meet the possible objection which might be taken to their experiments, namely, that they were made with a platinum anode which might exercise a catalytic action on the persulphuric acid formed, by observing that were this the case they would have been unable to obtain solutions containing 400 grammes of persulphuric acid per litre. They further point out that lead and lead sulphate are not converted into peroxide of lead by solutions of sulphuric acid containing persulphuric acid.

* K. Elbs and O. Schonherr. *Zeits. f. Elektrotechnik und Elektrochemie*, 1895, 417-421, and 468-474

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however concentrated they may be, but that a clean lead plate sulphates more rapidly in such solutions, while in the case of a plate coated with peroxide of lead, the peroxide is reduced with evolution of oxygen gas and the formation of lead sulphate. These results do not agree with Schoop's experiments on potassium persulphate. In accumulators, however, we have only to deal with solutions containing free sulphuric and free persulphuric acids, and though the authors admit that the latter can occasionally be found in charged accumulators, they regard it as only an accidental and secondary product, and that it is in no way entitled to the importance attached to it by M. Darrieus.

THE LECTURE THEATRE.*

In those early days when man first began to acknowledge the solidarity of the world and to appreciate the instruction conveyed in the conversation of his more experienced contemporaries, when books were rare, and the press undreamt of, the lecture was a most fitting means of imparting instruction. Even when printing had made the circulation of thought and learning more rapid, the price of books still left the lecture theatre an admirable and economical place for education, and a mass of notes was a valuable contribution to the student's scanty library; but in these days, when the thought and the accumulation of years of study may be bought for a few shillings, the lecture is an example of an absurd conservative adherence to an antique system which has long ceased to justify by results the favour with which it is received. When every professor publishes a text-book for the benefit of his students, containing all, or practically all, that he purposes to repeat to them during the session, and when even a superficial acquaintance with the leading journals would keep them more up to date than the interpolations in a stereotyped course of lectures do, we do not see why college authorities continue to include courses of lectures in the curriculum, and even rigidly insist upon regular attendance at them. That many professors consider their own lectures of such very little importance as to deliver them more from a sense of duty to the board than of utility to their hearers, is well known, and it is only natural to suppose that the discourses of their compeers are held in even less respect by them. The lecture is not even a satisfactory way of educating professors, to look at the subject from the Teutonic point of view. To go through the same matter in the same way, perhaps in the same words, year after year, without any clue to the real benefit that is being derived from it, is scarcely edifying to the speaker or the hearers. If the professors—we are now speaking of engineering colleges—mixed intimately with their pupils so as to gain a direct acquaintance with the difficulties which they have to face, and would take the trouble to discover whether their remarks are being appreciated at their real value or not, something useful might be done in the lecture theatre. As matters stand, however, the demonstrator is of far greater importance to the welfare of the student than the professor. To the demonstrator he talks on more equal terms, discusses his difficulties, and ventilates his opinions. It is the demonstrator who assists him at his experiments, overlooks his drawings, checks his calculations, &c. It is to be regretted that his dignified position, or his avocations, render it impossible for the professor to mingle sufficiently intimately with his students to get some idea of their individuality.

It is a disadvantage attendant on all forms of education, and unfortunately so to a remarkable degree in technical education, that while it makes many parasites, if we may use the term, it only develops the individual characteristics of those who could in all probability succeed without its assistance. The ever increasing demand for the "ready reckoner" form of technical literature is sufficient proof of the parasitism to which we refer. The book that receives the most favour on the market is that which provides cut-and-dried formulæ for everything; it is time-saving, and therefore economical, but when science has brought the simplicity of formulæ to a little greater perfection, and art has consummated the calculating machine, mathematics will become abstruse learning, willingly given over to the lucubrations of misguided students! We have too many laws, that is the truth of the matter. "It is liberty, not law, that makes great men," as Schiller said, and though he spoke of ethical law, his observation applies equally to science. Whatever a man wants to know he should discover for himself. This continual drumming of first, second and third into the ears of drowsy students makes parrots, not men, of them. If they are to be taught anything, teach them how to learn, and not how to be taught. If the laws of motion are to have any reality to them, show them how to find them out for themselves. Teach students to draw deductions, and you teach them to reason. Instil into them only other men's thoughts and other men's reasons, and you set their feet on the primrose way to ignorance. A good memory is in many cases the cloak of a poor intellect. Memory is not, as it is often taken to be, cleverness; it is the servant of ability. The wholesale dosing of roomsfull of students with lecture matter is not a good means of imparting instruction. An attempt should be made to draw out the individuality and personality of each student, a fact which Prof. Herkomer has fully recognised, and uses with success in his art school.

We ask, it will be said, for an impossibility. We admit that such is the case under the existing ridiculous conditions. Education is a great deal too cheap to be good. The number of students is entirely out of proportion to the number of instructors. The instruction is such that it develops the memory at the expense of the intelligence. It will be urged that we have lost sight of the benefits derived from the laboratory and the college workshop. By no means. We have studied both. In the former, except in isolated cases, the student is expected to complete an experiment in as many hours as there should be days. He is given a card of instructions, and follows them mechanically; he is marked by his results, and if he cannot get satisfaction from his instrument, he cooks the figures; the law that he should deduce is put in italics under his nose; he knows what the results should be before he commences observation; finally, he is not always honest, and one demonstrator is responsible for perhaps thirty to forty students. The college workshops are comparatively pleasant as a playground, fairly useful as an advertisement, occasionally handy for repairs, eminently useless for instruction. We are not dealing with these matters now, or we would justify our hard sayings. Our object is to call attention to the misdirection of energy in the lecture theatre, and to put forward the proposition that the aim of technical education should be to draw out and develop the natural abilities of students, not to coach them for examinations, nor to lay snares to draw them into the seductive slough of parasitism.

* From the *Engineer*.

THE NEW ELECTRIC SUPPLY PLANT AT BUDAPEST.

This plant, which has been lately described in German and American journals, was erected by the Austrian General Gas Company to compete with the old supply station of Ganz and Co. It supplies low-pressure continuous current, whilst the old station supplies high-pressure alternating current. Both undertakings run their mains through the same streets and districts, and consumers have the option of either current. The new Company has adopted the mixed system, that is to say, it generates high-pressure alternating current and distributes low-pressure continuous current. A two-phase current is generated at 1,800 to 1,900 volts and transformed down at the sub-station by means of rotary transformers, consisting of two-phase motors and continuous-current generators, to continuous current of 240 volts for three-wire distribution. Accumulators are provided to allow of the generating plant being shut down at the hours of light load at the generating station, which is about two miles from the centre of distribution.

The equipment in the main dynamo room consists of three vertical triple-expansion Schichau engines, driving three two-phase Schuckert alternators of 300 kilowatts capacity each, direct-connected. The engines, which are of the marine type, run at 120 revolutions a minute, and, at an initial pressure of 150 pounds, develop 400 E.H.P. normally and 500 H.P. at a maximum, with jet condensation. The alternators have 28 poles, and the number of alternations is about 51 a second, this low rate being chosen because the only load is the sub-station equipment of motors. The magnet frame is of soft iron, in two parts, and is bolted to a cast-iron bedplate. The poles are cast in one piece with the magnet frame, and the pole-pieces, which are a little broader than the cores, are screwed to the latter. The armature frame consists of a solid wheel with six spokes, on the rim of which there is a bronze ring carrying the laminated armature core. This latter does not rest directly on the bronze ring, but on 16 projections from it, between which the air can circulate abundantly, so that the ventilation of the armature is provided for in the most effective manner. The diameter of the armature is 9ft. 10in., and the outer diameter of the magnet frame 12ft. 5¼in. The alternators, large as well as small, can be run in parallel with ease, which is done by means of a simple switch without the aid of artificial resistances.

At the acceptance tests, which were most carefully conducted by Prof. Kittler, of Brunswick, when the large alternators were run at the primary voltage of 1,780 to 1,790, the current in phase I. was 85·7 amperes, in phase II. 90·2 amperes. The energy consumed by the alternator was as follows:—

Loss in armature windings	8,550 watts
Loss in field winding	7,450 watts
Loss due to eddy currents, hysteresis and friction.	17,000 watts
Total	33,000 watts

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The total energy delivered by the alternator was 284,000 watts; the efficiency of the machine was, therefore, slightly over 90 per cent.

The electrical plant at the primary station contains also a continuous-current dynamo, of 110 volts and 140 amperes capacity, for lighting the station and running the motors of the repair shop, and two non-synchronous two-phase motors, which serve to operate the pumps. The current for these motors is transformed from 1,800 to 110 volts. The condensing water is pumped to a cooling tower 36ft. high, whence the water falls through sieves to a tank, from which it is taken for condensing service. Besides the main plant there is also a temporary installation consisting of two 66-kilowatt two-phase machines.

The sub-station is located almost exactly in the centre of the district to be supplied. The dynamo room here contains two 120-kilowatt and two 240-kilowatt rotary transformers. The larger machines run at 220 revolutions per minute, at which speed the continuous-current armature gives 240 volts. The acceptance tests of the rotary transformers showed a commercial efficiency of 82 8 per cent. These machines are switched in in the following manner: Current from the accumulators is led to the continuous-current dynamo; the latter runs as a motor, and carries with it the alternating machine on the same shaft. When the proper speed of the alternating motor has been reached, and as soon as the latter is in step with the primary alternator, the motor is connected with the primary circuit, and the accumulators are disconnected from the direct-current machine, which is then connected in on the distributing mains as a dynamo, in the usual way.

Tudor accumulators are used, and the plant comprises four batteries of 148 cells each, connected in parallel. The whole accumulator plant has a capacity of 6,260 ampere-hours with a discharging current of 1,876 amperes, or 8,980 ampere-hours with a discharging current of 1,072 amperes, and can, therefore, supply 7,500 16 c.p. incandescent lamps for 3½ hours, or 4,288 lamps for 8⅓ hours. The batteries are set up in the four stories of the accumulator house. Each storey holds a complete battery of 148 cells. The four batteries are connected in parallel by vertical conductors passing through the four stories. The accumulator switching device is rather novel. The connections are so arranged that an upward movement of the sliding contact raises the potential and a reverse movement lowers it, which avoids confusion on the part of the attendant. By two complete revolutions of the regulating handle one accumulator cell is cut in or out. When the sliding contact rests on the battery contact bars in such a position that the dynamo current goes directly into the accumulators, or the accumulator current directly into the omnibus bars, if the handle is then given one complete turn, resistances, which can be varied to suit the current, are thrown into circuit. By this simple contrivance the gradations of potential between adjoining cells are halved, and the cutting in or out of cells is hardly perceptible at the lamps. The battery switches have two contacts, charging and discharging. By a combination reversing switch both contacts can be used for discharging, and it is then possible to divide the feeders into two groups, and to regulate the potential of each group independently. The distribution is done on the three-wire system; underground cables of the lead-covered, iron-armoured type are being employed, laid direct into the ground. The high-pressure feeders are concentric cables.

In order to eliminate the troubles due to unequal discharging of the batteries used on the two sides of the three-wire system, a compensating dynamo was recently put in, which, when necessary, completes the charge of that half of the battery which had discharged at the greater rate on the preceding day.

LONDON COUNTY COUNCIL.

LIGHTING OF THE VICTORIA EMBANKMENT AND THE WATERLOO AND WESTMINSTER BRIDGES.

At the weekly meeting of the London County Council, held at the County Hall, Spring-gardens, on Tuesday, Sir Arthur Arnold presiding, the report of the Highways Committee on the subject of lighting the Victoria Embankment and Waterloo and Westminster Bridges came up for discussion. The recommendation of the report (which has appeared in *The Electrician*) was as follows:—"That, subject to an estimate being submitted to the Council by the Finance Committee as required by the statute, the Highways Committee be authorised to take all the necessary measures for establishing, at a cost not exceeding £16,590, electric lighting for the Victoria Embankment and the Waterloo and Westminster Bridges (but exclusive of the Embankment Gardens), authorised by the Council's (General Powers) Act, 1893; and that for this purpose the Committee be authorised to obtain tenders and to enter into contracts on behalf of the Council."

Mr. J. Thornton said he would move as an amendment, "That the report be referred back, and the Highways Committee be instructed to obtain reports from the engineer and the chemist upon the question whether the lighting of the Victoria Embankment and the bridges could be improved by the substitution of incandescent burners for those at present in use." It was within his knowledge that the cost of incandescent lighting would be much cheaper. In the case of a private consumer it had come to his knowledge that the incandescent burner consumed one-third less gas than the ordinary burner, and if that was so they could get a much better light from the same cause. The question was brought forward as to whether the delicate nature of the burner was suitable for the purpose, but they had no information of that.

The Earl of Onslow, in seconding the amendment, said there were two classes of traffic using the Embankment. There was the vehicular traffic, which was at no time excessive, and which in the evening time was very slight. Then there were the pedestrians who used the Embankment for promenading. He was one who used it for that purpose, and he certainly would not welcome a brilliant electric light, because in his case a walk in the quiet by the silvery Thames was far better than the brilliant glamour of Piccadilly. He supported the proposition of Mr. Thornton, and would go a step further, and include in the amendment the third alternative which would be suggested—of ascertaining upon what terms a private company would supply electricity.

Lieut.-Col. Ford said that it was unfortunate that new members of the Council, before opposing the motion, did not take the trouble to investigate the past history of the question. He happened to know that the Committee had given an infinite amount of pains to the matter. There was a much more important aspect of the question than merely lighting the Embankment, for there was the lighting of the two bridges. He spoke for the thousands of working people who used those bridges, that they should be given every convenience. It was said the cost was excessive, but he saw that the cost of installing the electric light in one of their asylums was £21,000; and if they would spend that sum for lighting a single building, surely they would spend a smaller sum to light the principal thoroughfares of their city. The mover and supporters of the amendment seemed to think that the question of lighting with gas had not been considered by the Committee. It was considered very carefully in 1893, and the Committee came to the conclusion that the best way to deal with the question was to light the Embankment and bridges by electricity. In some of the smallest municipalities they used electricity for lighting the streets. Seeing that the Council got their Act in 1892 it was time they did something.

Mr. Jones said that, although two of the speakers had said the Embankment was sufficiently well lighted at the present time, he did not think that was the opinion of the people of London. Their arguments proved that the place was insufficiently lighted. He knew the incandescent light had been successful in many places. In a large business with which he was connected it answered admirably, but out of doors it was a question whether it would do. As far as Westminster and Waterloo Bridges were concerned, he thought it would not answer at all—the situation was too exposed, and the wind and so on would be too great. In Kensington it was found that the vibration caused by the traffic interfered with the delicacy of the burners. He had no objection to trying the experiment on the Embankment, because when the Parks and Open Spaces Committee had thinned the trees it would enable them to place the standards for the electric light with better advantage some time hence.

Col. Rotton expressed the opinion that the incandescent light was stronger than the electric light of the same power, and the consumption of gas was much reduced by the use of the burners. The trouble caused by the vibration of traffic had been got over. He thought there were sufficient reasons for referring the matter back, and trusted that course would be adopted, as it was much too late to adopt electric lighting for the coming winter.

Alderman Beachcroft said there was no doubt the streets of London were the worst lighted in the world, and the question raised was exceedingly pertinent. They wanted more information. It might be that the Committee had got information, but so far the report seemed of a barren character. He read that the incandescent burner had treble the lighting power of the ordinary burner, and only used half the gas. If so it would be advisable to have a report prepared as to gas being superseded by electricity. They were asked to spend £12,380 to establish the electric current, and seeing that there were four electric lighting companies in the surrounding neighbourhood who could supply them, it was only right the Council should have more information. The cost per year of the electric light was put at £2,768, which struck him as a very large increase upon the cost of gas. He trusted the Council would refer the report back for further information to justify them in coming to a conclusion.

Alderman Hubbard (Chairman of the Committee) said the question had been before the Council since 1892, and was brought before

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them in consequence of the complaints of the insufficiency of the lighting of the Embankment. He was sorry Mr. Hoare did not on that occasion rise in his seat and tell them the light was sufficient. At any rate, it was on the assumption that the Embankment was insufficiently lighted that the Highways Committee brought up a recommendation to light it, the cost of the installation to be £10,000. The Council thought the bridges should be included, and it went further, and said also that the gardens should be lighted. The Committee brought forward an amended estimate of £15,000, and then the Council would not have the standards erected in the centre of the road, and sent the report back, and the Committee had to increase their estimate from £15,000 to £20,000. The question was raised whether the Council had power to undertake the work, but they went to Parliament and had got the power. Their engineer told them it would cost some £1,300 to place the incandescent light on the Embankment, and they would need new burners and standards. They were also told that the incandescent light cast great shadows down the road, and it would be a great mistake to place the light there if that was a fact. He believed the incandescent light had just been given up at St. Martin's Hall because it was found to be affected by the vibration. If they wanted to send it back for a year they had better at once discharge the order.

The amendment was then put and carried by 43 votes to 12.

Mr. E. WHITE then moved that the following words to be added to the amendment:—"That the Committee be instructed to report what is the cost of the present lighting, what would be the cost of incandescent gas lighting, and what would be the cost of electricity supplied by a company." He said that he was not opposed to the electric lighting of the Embankment, for if there was one place which should be lighted by electricity it was the Thames Embankment. What struck him, however, was the enormous cost at which it was proposed to instal the light. He found the capital expenditure was £16,590, which, divided amongst 83 lamps, amounted to £200 per lamp. That appeared an enormous sum, and he was informed by a gentleman well able to judge that the installation could be carried out for £10,000. Then, again, the annual cost was set down at nearly £3,000, which amounted to £33 per lamp. At Portsmouth the cost was only £18 per lamp. And, again, the wages appeared very large, averaging £9 per light. He thought they should know what the electric lighting companies in the neighbourhood would supply the light for. Then, again, he was told the installation station would be on the vacant land under Charing Cross bridge. It was said that was not so, and that would be another reason why the matter should be deferred so that they could find out where it would be, for they did not want to disfigure the Embankment. His motion was not hostile, for he was in favour of electric light, but he would like to know if it could not be carried out at less cost.

Major PROBYN seconded the motion, observing that an important point was to have the Embankment well lighted to assist navigation on the river. There was the Strand Electric Supply Corporation and the Metropolitan Electric Supply Company, and they could obtain information for them as to what they would supply the light for.

Mr. JONES said the electric lighting station would be on a piece of ground on the east side of the underground railway. The Committee had had the cost of one company before them, which was £30 per lamp, which amounted to £2,490 per annum, whilst the Council would have to provide standards, wire, &c., which made the difference in the estimate only £217. The estimate also was for a larger number of lights, and the hours allowed for lighting 260 less than the Committee's estimate.

The motion was then carried.

Mr. BENN further moved that the Committee be instructed to bring up an estimate of the cost of lighting the Victoria Embankment Gardens, and this was accepted without discussion.

CORRESPONDENCE.

SHIPBOARD GALVANOMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The want of a more satisfactory instrument than the ordinary ironclad Thomson marine galvanometer is so generally felt by those who "go down to the sea in ships" that any improvement will be cordially welcomed. In your impression of March 22nd I notice that the Sullivan "Universal" galvanometer is fully described, and in your later issues of July 5th and 12th the advantages of both this form and also of the more recent damping devices applied by Messrs. Weatherall and Clark to the ordinary Thomson *marine* galvanometer are set forth by their respective inventors. As no results of tests with the two instruments have, however, been published, the following comparison may be of interest to your readers. By the kindness of Messrs. Elliott Brothers I have had an opportunity of making a few experiments with a marine galvanometer fitted with the Weatherall and Clark damping device, and as these were made under precisely the same conditions as for similar tests when using the Sullivan "Universal" galvanometer they may be taken as indicating the comparative merits of the two instruments.

The Sullivan galvanometer experimented with was a new form, having a rather wider coil than those usually constructed, and a fixed internal soft-iron core. Resistance of coil = 600 units. This particular form of coil is said to secure more perfect throws for discharge tests and greater freedom from movement under excessive vibration, but to be less suitable for speaking purposes.

The other instrument experimented with was an ordinary Thomson marine galvanometer, fitted with the Weatherall and Clark arrangement for damping the mirror suspension so as to give it an almost dead-beat movement. Resistance of coil = 7,000 units. Distance from the mirror to the scale in both cases = 3ft. 5in.

Value of Readings under Prolonged Currents of Varied Strengths. Sullivan's Universal Galvanometer.

	ω.	
One cell (Leclanché) through	250,000 Sh. = ∞	= $126\frac{1}{2}$ divs.
	200,000 Sh. = ∞	= $158\frac{1}{2}$ divs.
	150,000 Sh. = ∞	= 211 divs.
	100,000 Sh. = ∞	= 317 divs.
	50,000* Sh. = ∞	= 634 divs.

These values show that the readings are in direct proportion to the current strength. No *creeping* was observed—the spot of light going straight to its position on the scale without any apparent oscillation, and remaining steadily at the same point when the current was kept on for five minutes. When the current was removed the light returned immediately to zero without the least deviation.

Weatherall and Clark's Galvanometer.

	ω.	Throw.	Fell back to	Creeping in ½ min. to	Light returning to
One cell through	250,000 Sh. = ∞	72	64	68	– 3†
	200,000 Sh. = ∞	91	81	84	– 3†
	150,000 Sh. = ∞	120	108	112	– 7†
	100,000 Sh. = ∞	175	157	168	– 12†
	50,000 Sh. = ∞	334	295	313	– 12†
	50,000 Sh. = ∞	335	295	330‡	– 37†

Second Test.

	ω.	Throw.	Fell back to	Creeping in ½ min. to	Light returning to
One cell through	50,000 Sh. = ∞	308	295	320	– 19†
Two cells through	50,000 Sh. = ∞	640	592	638	– 35‡

Since making the above comparisons I have been informed that experiments are being conducted with a view to reducing the *creeping*.

Sensibility of the two Galvanometers.

The above figures show that under a prolonged continuous current the Sullivan galvanometer is about twice as sensitive as the Thomson marine galvanometer with the Weatherall and Clark damping device; but even were the latter instrument equally sensitive and free from *creeping* and a varying zero, it still has a very great disadvantage, to which this kind of galvanometer is always subject—viz., that the zero is displaced as the ship's course is altered. From this frequent source of annoyance a galvanometer on the d'Arsonval principle is fortunately free. Moreover, when the silk fibres stretch or the ship changes her latitude considerably, the balance of the Weatherall and

* Zero taken was 315 divs. on the opposite side of the scale zero.

† These readings are only approximate, for, though the spot of light settled down at about these positions, it continued to return slowly to the scale zero. What with the deflection creeping up the scale and the light not returning to a definite zero, exact measurement was next to impossible, and readings during a prolonged insulation test would be very unsatisfactory.

‡ Prolonging the current for five minutes creeping increased the deflection from 295 to 330 divs.

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Clark suspension will frequently have to be touched up. However carefully this is done it is always liable to strain the silk suspension. A slight slackening of the fibre in the ordinary Thomson marine would not prevent the slide from being useful for testing; but so narrow must necessarily be the limits in which the Weatherall and Clark suspension moves (in order to obtain the requisite dead-beat effect) that a good deal of trouble is likely to arise from this cause. The suspension shown to me at Messrs. Elliott Brothers' was very beautifully made and remarkable for its finish, but, speaking from a familiarity with marine suspensions extending over many years, it appears to me likely to give trouble on board ship when from any cause the fibre slackens slightly.

As a Speaking Instrument.

For speaking purposes both instruments are sufficiently *dead beat*, and signals are easily readable, whether working on short-circuit with a shunt of next to no resistance between the terminals or through 250,000 units with shunt infinity. In the case of the Weatherall and Clark instrument, however, there is the slight *throw back* after each signal, as pointed out when testing by direct deflection. This is noticeable both at a moderate and high speed of signalling, whereas the Sullivan galvanometer is absolutely free from any of these *back kicks*, and the signals are on that account rather more distinct.

Reading Discharges from a Condenser.

The Sullivan instrument gave the following results:—

Discharge from	$\frac{1}{3}$ mfd. condenser	with	1 cell Sh = ∞ =	20	divs. approx.
„	$\frac{1}{3}$ „	„	2 cells Sh = ∞ =	41	„ „
„	$\frac{1}{3}$ „	„	3 cells Sh = ∞ =	61½	„ „
„	$\frac{1}{3}$ „	„	4 cells Sh = ∞ =	82	„ „
„	$\frac{1}{3}$ „	„	5 cells Sh = ∞ =	103	„ „
„	$\frac{1}{2}$ „	„	5 cells Sh = ∞ =	162	„ „
„	$\frac{1}{3}+\frac{1}{2}$ „	„	5 cells Sh = ∞ =	266	„ „

The foregoing results show that the throws are practically in proportion to the capacity of the condenser and the E.M.F. of the battery used. In every case the spot of light returned to the scale zero. For the Weatherall and Clark galvanometer the following results were obtained :—

				Throw to left.	Displacement of zero.
Discharge from	$\frac{1}{3}$ mfd. condr.	with	1 cell Sh. = ∞ =	27 divs.	1 to right*
„	$\frac{1}{3}$ „	„	2 cells Sh. = ∞ =	53 divs.	10 „
„	$\frac{1}{3}$ „	„	3 cells Sh. = ∞ =	86 divs.	15 „
„	$\frac{1}{3}$ „	„	4 cells Sh. = ∞ =	112 divs.	21 „
„	$\frac{1}{3}$ „	„	5 cells Sh. = ∞ =	140 divs.	23 „
„	$\frac{1}{2}$ mfd. „	„	5 cells Sh. = ∞ =	211 divs.	35 „
„	$\frac{1}{3}+\frac{1}{2}$ mfd.† „	„	5 cells Sh. = ∞ =	349 divs.	58 „
„	$\frac{1}{3}+\frac{1}{2}$ mfd.‡ „	„	5 cells Sh. = ∞ =	332 divs.	46 „

In the above discharge tests it will be seen that the results are decidedly in favour of the Sullivan instrument. The weak point about the Weatherall and Clark instrument in this case is the failure of the spot immediately to return to the position of the scale from which it started, so that the true reading is always doubtful. Both instruments are rather rapid in their movements, and it is necessary sometimes to observe two or three throws in order to make quite sure of the correct reading.

Judging from the satisfactory results obtained with the Sullivan galvanometer, there is no question that it is very superior to the Weatherall and Clark instrument tested by me, and a very important improvement in every way on the ordinary Thomson marine galvanometer, and will therefore be welcomed by electricians for board-ship work.

The limited time at my disposal prevented me from trying the two instruments when inclined to one side, as when the ship is rolling. Under such conditions it is probable that a discharge to the lee side will exceed the discharge to the opposite side of the scale; for however well balanced, there must necessarily be a certain degree of sag owing to the weight of the suspension, which would increase the throw to the leeward side. For capacity or discharge tests in general a *null* method is on board ship, for many reasons, I think, preferable.—Yours, &c.,

J. Rymer-Jones.

* In all cases returning very slowly indeed to zero.
† Zero in this case was 100 divs. to the right of scale zero.
‡ Starting from the scale zero.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In my letter of July 2nd (see *The Electrician* of July 5th, p. 335), mentioning an "improved method of damping marine mirror galvanometers," I refrained from publishing a full description until I had made the improvement as perfect as possible. I now send you particulars of the system with diagrams.

The damper *d*, Fig. 1, is of sheet aluminium of length and width necessary to obtain the degree of air damping required. A hollow, *b*, to hold the mirror is stamped in the centre, and the magnet *m* is riveted at the back of it. Small claws *c* are cut out on the edge of the hollow *b*, and these are used to clamp the mirror in position. The small spaces left in the damper *d* by the turning over of these claws are utilised for balancing purposes by inserting suitable weights, thus dispensing with shellac, which was formerly employed for securing mirror, magnet and weights. The damper *d* is divided down the centre of its length by a slot $\frac{1}{16}$th of an inch wide to a

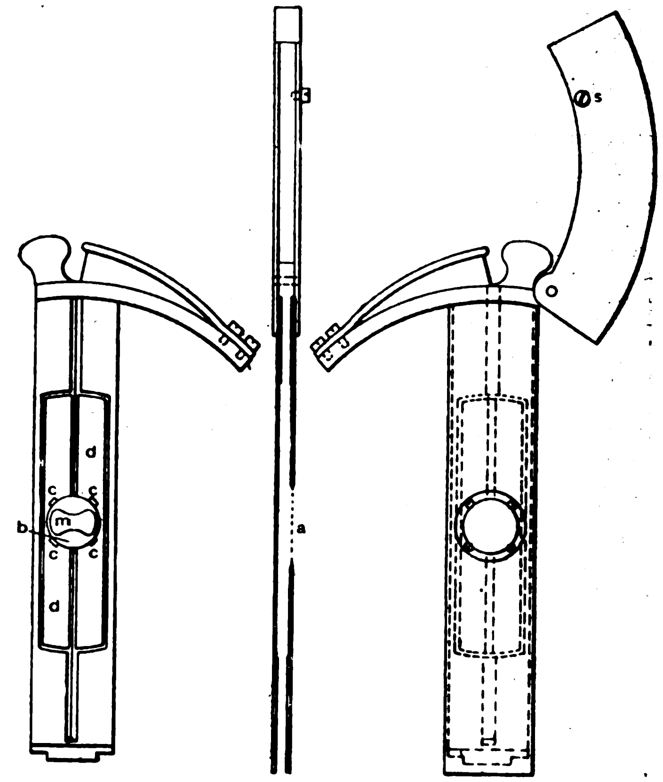

Fig. 1.—Slide. Back view. Fig. 3.—Jacket. Section. Fig. 2.—Jacket. Front view slide inside.

position slightly inside the rim of the hollow *b*, and two lugs about $\frac{1}{16}$th of an inch long are left, which project above and below the hollow, each pierced on its outside rim with a pinhole to receive the fibre for suspending. The magnet is very light and, as shown, of dumb-bell form. The total weight of the system (damper, mirror, magnet and the necessary weights for balancing) is about three grains, which is very much the same as that of the old style of suspension.

The jacket, of which a front view is given in Fig. 2 and a section in Fig. 3, completely envelops the slide and protects it. The cover, shown open for the removal of the slide from the jacket, is, when closed, secured by a screw, *s*; thus the whole arrangement is rendered air-tight and portable.

The aperture *a* in front of the mirror is filled in with microscopic glass or any transparent substance.—Yours, &c.,

East Greenwich, July 16, 1895. Thomas Clark.

THE WIMSHURST INFLUENCE MACHINE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to your reprint of Father Schaffers' article in last week's issue, I must confess I fail to see exactly in what respect he has succeeded in improving the Wimshurst machine.

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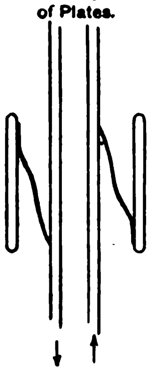
The final stage of development he arrives at has certainly very little in it that is novel, being simply a somewhat distorted Wimshurst. The two collecting combs in connection with each electrode certainly are set farther apart than others have previously set them ; but this is a very doubtful improvement, as it means increased facility for leakage across to the diametral conductors, and consequently a lower maximum potential difference between the knobs. Also the contact brushes are on the collecting combs instead of on the diametral conductors. I do not see that this is a matter of vital importance so long as one of the two is not provided with them.

A word also with regard to the method of comparison. It should be borne in mind that the Wimshurst machine is essentially a high-tension machine—that is to say, it works at its best with the knobs far apart and small capacity in connection with them. Father Schaffers does not give dimensions of the machine, or say what length of spark the Lane bottle was adjusted to give (and for anything approaching accuracy this must necessarily be short), but it appears that the method of testing keeps the machine working at a comparatively low tension. This is unfair. For whatever purpose the machine is to be used, it can always be arranged to keep the electrodes at a high difference of potentials, even when charging Leyden jars of large capacity, by simply introducing a spark gap into the charging circuit.

With regard to the change of sign of the charge on the plates after passing the collecting combs; this may be so whilst the machine is working at a low tension, but when working at its normal high tension, so far from changing sign, a strong charge of the same sign is undoubtedly left on the plates and greatly assists the action. I have described a modified Wimshurst machine in the pages of a contemporary (*Electrical Review*, Vol. XXXI., p. 457) some three years ago, having, among other improvements, collectors made of flaps of stiff oiled silk or paper edged with conducting material, which allowed contact with the rotating plates both in the collectors and diametral conductors, the flaps being attracted up to the plates automatically by the action of the machine, restoring themselves directly the tension becomes dangerously low. These flaps also collected from the plates on opposite sides, at points which were designedly considerably in advance of the horizontal diameter in the direction of rotation, thus :—



With reference to the preceding article in the same issue, I cannot see from it that Prof. Holtz has made good his claim of priority of invention of the Wimshurst machine, and certainly the form of machine usually described as Holtz No. 2 is far behind machines of the Wimshurst type from all points of view.

In conclusion, I must say that both the articles referred to are by no means easy reading, not only on account of the expressions used, but also through being complicated by the idea of + and − charges, and their mutual and counter inductions. Unfortunately the whole science of electrostatics is based on such old-fashioned notions that it is only by the free use of these symbols that one can make oneself understood.—Yours, &c., J. E. TAYLOR.

Holloway, N., July 22, 1895.

LEGAL INTELLIGENCE.

British Insulated Wire Company v. the Prescot Urban District Council.

On Monday last Justices Grantham and Wright had before them an application to mark this case as urgent, and to put it into the list for Monday next.

Mr. SANDERSON stated that the question was whether an agreement made between the plaintiffs and the defendants was invalid by reason of a subsection of the Public Health Act. The urgency lay in the fact that unless the matter was determined before the Long Vacation the Local Board would be unable to enter into another contract for their winter lighting, and the winter lighting would thus be impossible. The matter was tried at the Liverpool Assizes, and Mr. Justice Day said that it ought to be tried as a special case, and he therefore asked that the case be put into the list for Monday next.

The application was granted.

National Electric Engineering Company (Limited) v. Arnold.

Recently, at the Brentwood County Court, the National Electric Engineering Company (Limited) brought an action against W. Arnold, a tailor and outfitter, of Brentwood, to recover possession of a dynamo and packing case, valued at £20. 16s., and the plaintiffs further claimed £5 damages for the detention of same.

Mr. A. C. COCKBURN (a Managing Director of the Company) deposed that a dynamo was sent to Mr. Arnold's premises by the direction of a Mr. Miller. He subsequently saw Mr. Arnold, and asked him to return the machine, who said it had been supplied to him by Miller, and that he intended to keep it in order to pay for the completion of Miller's work. Subsequently the defendant was served with a formal notice demanding the return of the dynamo.

His HONOUR (Judge Paterson) held that the defendant had to prove that Mr. Miller was the owner of the dynamo, and, in answer to his Honour,

Mr. COCKBURN said his Company did not sell the dynamo to Mr. Miller.

Mr. WALKER (plaintiffs' solicitor) said the dynamo was not sold to anyone, but it was supplied on certain specific terms.

In cross-examination, the WITNESS admitted that Miller had been asked to pay for the dynamo or return it. The dynamo was loaned to Miller on the condition that it should be kept if satisfactory.

His HONOUR said that as the dynamo had not been returned it would be taken that it was satisfactory, and that if it had been illegally obtained from Miller he (Miller) must bring an action to recover it.

HENRY MILLER said he entered into negotiations with the Company regarding the dynamo, and he came to an arrangement with the defendant by which the dynamo, if satisfactory, would be left on Mr. Arnold's premises and sold to him, but if not it would be returned by witness. As it did not arrive in time he got another dynamo, and when the dynamo in dispute arrived Mr. Arnold asked him to see if it worked better than the other one. He did so, but as it did not he took it out again, and when he went to take it away the defendant would not release it.

His HONOUR said that to his mind there was no case whatever, and non-suited the plaintiffs with costs.

Dawson v. Foster.

The plaintiffs in this case, which was heard on Friday in the Bloomsbury County Court (London, W.C.), Roger Dawson (Limited), electrical engineers, sought to recover payment of an account in respect of the installation of the electric light. The evidence went to show that the order for the work was given by the defendant's wife, and he objected to pay the plaintiff's claim on the ground that he had strictly forbidden his wife to pledge his credit. In giving judgment his Honour said it was a hardship upon tradesmen after they had done the work to be met with a defence like this, but at the same time they should be careful to find out who they were to look to for payment before carrying out orders which were given by women. The defence was fatal to the plaintiffs' claim, and judgment must be for the defendant, but he certainly should not allow the defendant's costs.

Barclay v. The New Zealand Electrical Syndicate (Limited).

Mr. Justice North, in the Chancery Division, on Saturday last, made an order continuing the receivership, which was originally to have expired in October next. There had, since the Receiver and Manager was appointed in March last, been a further default in payment of interest and principal upon an issue of debentures of £30,000, which were held by the plaintiff. The Company was originally formed to light the City of Wellington, New Zealand, by electricity, and was practically a branch of the Gulcher Company. Reference is made to the affairs of the New Zealand Electrical Syndicate in the report of Mr. Fitch Kemp, the liquidator of the Gulcher Company, in another part of this issue.

Martin v. The New British Electrical Installation Contractors (Limited).

Mr. Justice Kekewich has appointed a Receiver and Manager in this failure. The application was not resisted by the Company. Mr. Lester, of Worcester, is the Receiver and Manager, his Lordship refusing to give any directions as to the management.

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Clements v. Edwards.

This action, which came before Mr. Justice Wright (without a jury) in the Queen's Bench Division last Saturday, was brought by Mr. Isaac Clements, of Birmingham, to recover £71. 13s. 9d., balance of an account for electric light fittings supplied during the years 1894 and 1895 to the defendant, a builder and contractor, carrying on business in London. The defendant pleaded that when the writ was issued in April the money was not due for some of the goods, and the plaintiff admitted that the goods were supplied on the understanding that they should be paid for at the end of the following month, when a discount of 5 per cent. would be allowed, and some of the goods were supplied to the plaintiff in March.—His Lordship, having gone through the account, reduced the plaintiff's claim to £45. 13s. 9d., for which he gave judgment, with costs.

Scarlett v. Frank and Co. (Limited).

The plaintiff in this action held nearly all the debentures issued by the defendant Company, a firm of electrical engineers and contractors, and Mr. Justice North appointed a Receiver and Manager, with the usual reference to Chambers.

Wood v. Woodhouse and Rawson United (Limited).

A summons was to have been heard before Mr. Justice Vaughan Williams on Wednesday last for leave to institute proceedings in this action, but the case was not reached. It is to come on again next week.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices:—*

Laboratory Notes and Forms.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett (*now ready*). Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A Large-Sheet Table, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s.—each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

A Sheet Table showing Total Capital Outlay and Receipts and Expenditure for the year 1894 of the Statutory Electric Supply Undertakings of the Metropolis is now ready, printed on thick paper, price 6d. each.

"The Work of Hertz."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. nett, is now ready.

"Electrical Engineering Formulæ," a pocket-book by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"Drum Armatures and Commutators."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson, price 6s. 6d., post free.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d. post free (abroad 11s.).

Tenders Invited.—**The Corporation of Brighton require tenders for the supply and erection, at their electricity works, North-road, of evaporative brass tube surface condensers, electrically-driven air pumps, and exhaust and condenser pipings. Tenders must be in before 10 o'clock August 10th.**

——— Tenders are invited by the Vestry of Hammersmith, London, W., for complete schemes for public and private lighting, and for the supply of motor power in the compulsory area of the Vestry's Provisional Order. Some particulars are given in our advertisement columns, and all further information can be obtained of Mr. H. Mair, Surveyor to the Vestry. Tenders have to be sent in by 6:30 p.m. of Wednesday, September 4th.

——— The Salford School Board invite tenders for the installation of the electric light in their new offices in Chapel-street, Salford. Plans and specifications may be obtained from Mr. S. V. Clirehugh, Temple Chambers, Brazenose-street, Manchester. Tenders, addressed to the Chairman of the Board, must be in by 12 o'clock on Wednesday, July 31st. Additional particulars may be obtained from our advertisement columns.

——— The Electric Lighting Committee of the Wakefield Corporation invite tenders for the supply and erection of (*a*) boiler and fittings, mechanical stokers and engine, economiser, feed pump, injector, &c.; (*b*) steam alternators, condensers, oil filter, fittings, &c., steam, exhaust, feed, blow-off and sundry pipes, valves and water tank, &c.; (*c*) main switchboard and instruments; (*d*) cables, junction boxes, culverts, and trenching, &c.; (*e*) transformers and switchboard, &c.; (*f*) arc lamps and posts; (*g*) meters, and (*h*) overhead crane. Plans and specifications may be obtained from Mr. Robert Hammond, the consulting engineer, Ormond House, Great Trinity-lane, London, E.C., after Friday next, August 2nd, and tenders, addressed to the Town Clerk (Mr. Chas. Jas. Hudson), Town Hall, Wakefield, must be in by 2 p.m. on Saturday, August 24th. Some further particulars appear in our advertisement columns.

——— The Crown Agents for the Colonies require tenders, to be delivered by 11 a.m. on Thursday next, for the supply of materials in connection with the installation of the electric light in the Civil and War Department buildings at Malta. The materials required comprise cables and wires, tools, &c., fittings, fixtures, &c., and sundries.

——— Tenders are being invited for the electric lighting of the Mechanics' Hall and Saloon, Bradford. Tenders to Mr. T. C. Hope, architect, 27, Kirkgate, Bradford, by July 30th.

——— Wednesday next, the 31st inst., is the last date for sending in tenders for the supply and erection of plant for the electric lighting of the Schaerbeck-Nord Railway Station, Brussels. Tenders to the Ministère des Chemins de Fer, Postes et Télégraphes, Brussels.

——— The municipal authorities of the Deva, Guipuzcoa province, Spain, invite tenders for the electric lighting of the public streets under a ten years concession. Tenders, by the 28th inst., to the Secretaria del Ayuntamiento de Deva, Guipuscoa, Spain.

——— The French Post and Telegraph Authorities are inviting tenders until August 1st for the supply, in one lot of 50 kilometres of telephone cable (double conductor), and for the supply of a quantity of paper-insulated electric cables in five lots. Tenders are also being invited until the 30th inst., by the same department, for the supply and laying of a submarine telegraph cable between Djibonti and Obok. Tenders in each case are to be addressed to the Direction Générale des Postes et des Télégraphes, 103, Rue de Grenelle, Paris.

——— The Shoreditch Vestry invite tenders for the erection of a chimney shaft at their electricity works. Tenders must be sent in to the Vestry Clerk (Dr. H. Mansfield Robinson), Town Hall, Old-street, Shoreditch, E.C., by Monday next.

——— The Secretary of State for Foreign Affairs has received a copy and translation of a notice issued by the Municipality of Vienna, inviting tenders for plans, construction and working of a network of electric railways in and round that city. Tenders must be in by November 14th next. The notice may be seen at the Commercial Department of the Foreign Office, Downing-street, S.W., between the hours of 11 and 6.

Tenders Accepted.—The Electric Light Committee of the Bedford Corporation have accepted the following tenders for the supply and erection of water-tube boilers, engines, and alternators:—

Two water-tube boilers.—	
Babcock and Wilcock (Limited)	£960
Two engines.—	
W. H. Allen, Son and Co.	906
Two alternators.—	
Siemens, Bros. and Co. (Limited)	1,530
Three transformers.—	
Johnson and Phillips	225

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TENDERS ACCEPTED.—The Metropolitan Asylums Board have accepted the tender of Messrs. Thorpe and Waring for wiring for the electric light the five new wards and other buildings now being erected at the North-Western Hospital, Haverstock Hill, London, N.W., for the sum of £554. The following is a complete list of the tenders sent in :—

Thorpe and Waring, Theobald's-road (accepted) £554 0 0

Vaughan and Brown. .	£1,557	0	0	J. C. Howell (Limited) ..	£981	16	4
V. G. Middleton	1,440	0	0	Julius Sax and Co.	944	8	9
Hayward Tyler and Co.	1,340	0	0	Paterson and Cooper ...	895	0	0
Roger Dawson (Limited)	1,140	0	0	Benham and Sons.........	870	0	0
Tayler-Smith Electric Company..............	1,121	0	0	Fowler, Lancaster and Co., Birmingham	859	15	0
Sharp and Kent.........	1,098	0	0	Waring and Sons	688	15	0
Miller and Woods	1,070	0	0	T. Matthews..............	650	0	0
London and Lancashire Electric & General Engineering Company	1,050	0	0	Electrical and General Engineering Company.	649	0	0

All other firms of London.

——— The Brighton Town Council have accepted the tender of Messrs. John Fraser and Son, of Millwall, London, E., for the supply and erection of steam and feed piping, feed pumps, economiser, water purifier, tanks, coal elevator, and sundries required at the electricity generating station for £3,220. This was the only tender received.

APPOINTMENT.—The Shoreditch Vestry have appointed Mr. W. C. Gardner clerk of the electricity works at Pitfield-street, at a salary of three guineas per week.

APPOINTMENTS VACANT.—The Electricity Department of the Vestry of St. Mary, Islington, London, N., require an electrician to take charge of the electric mains, house connections, transformers, &c., at a salary of £2. 10s. per week; also a jointer for vulcanised rubber work. Further particulars will be found in our advertisement columns, and applications for both appointments have to be in by Wednesday, the 31st inst.

——— The Governing Body of the Northampton Institute, Clerkenwell, E.C., are prepared to receive applications for the appointment of a principal. The salary attached to the office has been fixed at £600 per annum, and the duties will commence on January 1st next. Applications must be sent in, before 10 a.m. on September 4th, to the Clerk (*pro tem.*), Mr. J. J. Lambert, 8, Dowgate-hill, Cannon-street, London, E.C.

——— The University College of South Wales and Monmouthshire require an assistant lecturer and demonstrator in engineering. Applications should be sent to the Registrar and Secretary (Mr. J. A. Jenkins, B.A.) by August 31st next. Further information is given in our advertisement columns.

CHANGE OF ADDRESS.—Mr. R. Falshaw, electrical engineer, has removed to Albert Chambers, Harrogate.

LEGAL NOTICE.—Our advertisement columns contain a notice relating to proposed alterations in the Memorandum of Association of the Consolidated Telephone Construction and Maintenance Company (Limited), by which it is proposed that the scope of the Company's operations shall be extended. A petition to this effect, presented to the High Court of Justice on the 12th inst., is directed to be heard before Mr. Justice Chitty on the 10th prox., and creditors and shareholders are notified that any opposition to this course must be made at the time of hearing. Copies of the petition can be obtained by any creditor or shareholder of the Company on payment of the usual charges. Messrs. Linklater, Hackwood, Addison and Brown, 2, Bond-court, Walbrook, London, E.C., are solicitors in this matter.

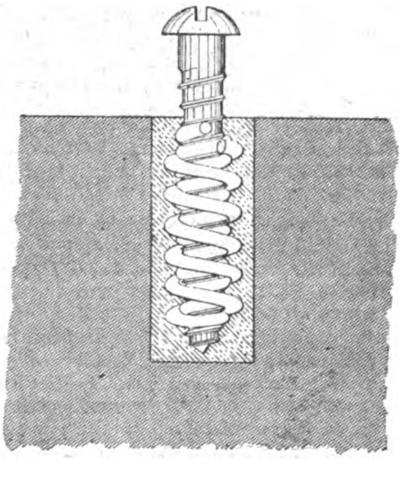
PURCHASE.—The Nalder and Harrison Construction Syndicate (Limited) have purchased the stock, plant and goodwill of the old-established engineering business hitherto carried on by Messrs. John Brown and Co., at the Perseverance Iron Works, Bow, London, E.

AGENCY.—Messrs. Francis and Spilsbury have been appointed agents for the sale of Messrs. Connolly Brothers' manufactures in the South, East, and West of England, not including London.

BANKRUPTCY.—In the failure of Joseph Torr Todman, a general meeting of creditors was held on Tuesday to consider a scheme of arrangement. The debtor has lodged a proposal to pay a composition of 7s. 6d. in the £ by instalments extending over eight months, and the terms of the proposal were deemed by the creditors to present an advantage over bankruptcy proceedings, subject to the security offered for the payment of the deferred instalments being fully approved. The Court is to be asked to sanction the scheme.

LIQUIDATIONS.—At a meeting on the 4th inst. it was resolved that the Printing Telegraph and Construction Company of the Agence Havas (Limited) be wound up, and Mr. W. H. King, 13 and 14, Basinghall-street, London, E.C., was appointed liquidator.

THE BOEDDINGHAUS DOUBLE-SPIRALLED PLUG.—We have received from Mr. Julius Boeddinghaus, of Dusseldorf, Germany, a sample "double-spiralled" plug. This consists of an inner tightly-twisted spiral, which serves as a female screw, and an outer loosely coiled spiral. The use of this device is recommended wherever an object has to be secured to a wall without causing much damage. A small



hole is cut in the wall, and a "double-spiralled" plug dropped in and secured in its place by means of plaster of Paris or cement, the switch base or rosette being then secured to the wall by means of screws driven into the plugs beneath. This system would seem to possess many advantages, especially where large screws have to be driven into a plaster wall.

ACTON.—The District Council have determined to oppose the application of the Capital and Counties Electricity Supply Company for a Provisional Order for lighting this district by electricity.

A NEW GOLD RECOVERY PROCESS.—The usual treatment of the tailings from gold mining crushings by what is known as the cyanide process is associated with electrolysis, but a recent discovery by Messrs. Sulman and Teed is stated to enable the ore taken from gold mines, whether largely or only lightly mixed with the baser metals, to be treated without the use of the electrolysis method. A company called the Gold Ore Treatment Company of Western Australia (Limited) has been formed to work the new process in Australia with a capital of £150,000 in £1 shares.

BIRMINGHAM.—The new Birmingham Meat Market and slaughter houses, the foundation stone of which was laid on Wednesday last by Mr. Ebenezer Parkes, M.P., will be lighted electrically.

BRADFORD.—The Electric Lighting Committee of the Corporation held a meeting on Monday to consider the question of the appointment of an electrical engineer in the place of Mr. S. Baynes, who has received a similar appointment from the St. Pancras Vestry. Fifty-six applications were received in answer to the advertisement recently issued by the Committee, and out of this number three were selected from whom a final choice is to be made. The salary attached to the office is £300.

DERBY.—Col. W. M. Ducat held a Local Government Board inquiry at Derby on Wednesday into the application of the Town Council to borrow, amongst other sums, £13,000 for electric lighting extensions. The Town Clerk (Mr. H. F. Gadsby), who explained the nature of the various loans, said the Local Government Board had already sanctioned the borrowing of £35,000, and the additional £13,000 now asked for was to make up the actual expenditure over and above the sum previously granted. This extra expenditure was caused by alterations to the adjoining premises and the putting down of additional boilers.

EDINBURGH.—The Town Council have approved the recommendation of the Cleaning and Lighting Committee (referred to in our last issue) that George-street and the streets leading thereto from Princes-street, along with St. Andrew-street, St. Andrew-square, Charlotte-square and Hope-street, should be lighted electrically.

EMBEZZLEMENT.—At the Bow-street (London) Police Court, on Monday, Wm. D. Boddy, a cashier in the employ of the Charing Cross and Strand Electricity Supply Corporation, pleaded guilty to embezzling £26. 19s. 3d., which had been handed to him on behalf of his employers. The prisoner admitted receiving other sums for which he had not accounted. Four months' hard labour.

FACTORY LIGHTING.—Messrs. Nicholson, Sons and Daniels have given instructions for the installation of an electric lighting and motive-power plant in their extensive factory and tan yards at Bethnal Green-road, London, E. The plant will comprise two

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30 H.P. steam engines, a 160 H.P. water-tube boiler, a 250 light dynamo, motors, &c. The work has been entrusted to Messrs. Lee and Warren, who have executed similar contracts for Messrs. Lymington, of Market Harborough, and Messrs. Snook and Co., of Nottingham.

FULHAM (LONDON, S.W.).—The Vestry, at their last meeting, discussed the report recently presented by the Electric Lighting Committee, and referred to in our last issue, on the electric lighting of the parish. Mr. Cranfield moved the adoption of the report, but Mr. Thelwall thought that as only four members were present at the Committee some members hardly understood the scope of the scheme, and what a large matter it was. He moved that the Clerk obtain information from parishes where the electric light had been adopted, and, after some remarks from Mr. Sayer, it was agreed to refer the report back to the Committee for further consideration.

GLASGOW.—The Gas and Electric Light Committee of the Corporation have presented their financial statement for the past year. The gross revenue of the gas department was £629,362. 6s. 5d., and the gross expenditure £557,428. 15s. 5d., leaving a gross profit of £71,933. 11s. It was also decided to reduce the price of gas from 2s. 6d. to 2s. 4d. per 1,000 cubic ft. The gross revenue of the electric lighting department was £21,196. 11s. 4d., and the gross expenditure (including depreciation) £17,138. 18s. 9d. A payment of £5,000 on loans and sinking fund account leaves a deficiency of about £1,000, which was transferred to the gas account. It was agreed that the price of current should remain at 6d. per unit. The Committee anticipate that next year will be more prosperous, as they are now supplying current to 208 additional consumers.

HALIFAX.—As announced in our last issue, Major F. H. Tulloch held a Local Government Board inquiry on Friday last into the application of the Town Council to borrow £10,000 for electric lighting purposes. The Town Clerk (Mr. K. Walton) stated that the Council originally obtained permission to borrow £30,000. They had, however, found that they would require an additional £4,947 to complete their scheme, and £5,000 for extensions. They had expended £34,947, whereas the original estimate was only £26,100. The Corporation had intended to use some land that belonged to them for the purpose of erecting a generating station, but after further consideration it was decided that a more convenient site should be obtained, and this was done at a greater cost than the estimates provided for. The Committee had now decided to extend their mains to Skircoat, the chief residential part of the borough. There was no opposition to the proposed loan.

HAMPSTEAD (LONDON, N.W.).—At the last meeting of the Vestry the report of the Lighting Committee, recommending further electric lighting extensions at an estimated cost of about £3,182, was adopted. These extensions include Alexandra-road (£842), Avenue-road (£755), Belsize Park-gardens (remainder) (£201), Fairfax-road (£275), Finchley-road (£217), Hampstead Hill-gardens (£170), Heath-street (remainder) and North End (£571), and Kidderpore-avenue (£151).

HARROGATE.—Mr. George Wilkinson, M.I.E.E., has been appointed to advise the Corporation of Harrogate on the lighting of the New Montpellier Baths, which are being erected at a cost of £75,000. The current will be taken from the Corporation supply, Mr. Wilkinson acting as consulting engineer in this matter also.

HUDDERSFIELD.—At the last meeting of the Town Council the report of the Electric Lighting Committee, recommending certain extensions of the electric lighting mains, &c., at an estimated cost of £130, was approved.

IPSWICH.—Mr. E. A. Paris attended the last meeting of the Paving and Lighting Committee of the Town Council on behalf of the Brush Provincial Company for the purpose of ascertaining their views as to a proposed application by that Company for a Provisional Electric Lighting Order for Ipswich. After some discussion the Committee directed Mr. Paris to lay his application formally before the Town Clerk.

ISLINGTON (LONDON, N.).—The Vestry have decided to present a petition to His Royal Highness the Prince of Wales asking him to perform the ceremony of opening the electric supply station in November next. Islingtonians are very proud of their electric lighting scheme, the result of which, they claim, will be the finest installation in England. The chimney stack was completed last week. The shaft is 182ft. in height from the floor level, and its internal diameter is 24ft. at the bottom and 12ft. at the summit. Half-a-million bricks have been used in constructing the chimney, which is of sufficient size to provide for 16 boilers. Nearly 50 miles of cable have been laid in the compulsory area.

LIMERICK.—A special meeting of the Town Council was recently called for the purpose of formally adopting an electric lighting scheme for the town, but as a quorum could not be formed the consideration of the matter was postponed. The gasworks are under the control of the Corporation, and the members have been notified by the Board of Trade that if they do not adopt an electric lighting scheme the Board will give the necessary permission to a company seeking to have the Provisional Order, which the Corporation some time ago obtained, enforced in Limerick.

LOANS TO LOCAL AUTHORITIES.—The remarkable success which has attended the London County Council in its recent issue of Two and a-Half per Cent. Metropolitan Consolidated Stock brings the question of the rate of interest charged by the Council to the London vestries for loans for electric lighting, drainage and other important works prominently forward for discussion. The issue was for £1,000,000, and the applications reached no less than £3,232,800, at prices ranging from £101 the minimum, to £103. 5s. Nearly 70 per cent. of the loan will be placed at £102. 2s. 6d., and the average was £102. 7s. 5d. As the Council have fixed 3½ per cent. as the basis upon which loans shall be granted to local authorities for amounts under £5,000 and 3¼ per cent. for loans above that amount, the whole question must immediately come up for reconsideration. It is clearly evident that the London vestries would experience no difficulty in obtaining loans to any amount on the security of the rates at 2¾ per cent. and small amounts at 3 per cent. At the last meeting of the Council the Finance Committee took this subject into consideration, and they recommend that the rate of interest to local authorities on loans under £10,000 should be 3 per cent. and 2⅞ on sums above that amount. The London School Board have resolved to apply to Parliament for power to issue a Two and a-Half per Cent. Stocks, and the Finance Committee of the County Council are of opinion that it is inexpedient that there should be two Metropolitan Stocks, one consolidated and the other not consolidated, and recommend that the School Board should make its issue part of the Council's Metropolitan Consolidated Stock.

NEW ADMIRALTY BUILDING.—This handsome range of offices in Whitehall, London, S.W., is now nearly completed, and is expected to be out of the architect's hands in a few weeks. The whole of the building is to be lighted by electricity, and to have very complete outfit of telephones and electric bells.

NEW CRUISERS.—On Wednesday, the first-class protected cruiser "Powerful" was successfully launched at Barrow-in-Furness from the yard of the Naval Construction and Armaments Company. This is one of the latest type of warships, and an important feature is the substitution of electrical for mechanical motors for working the heavy guns, an alteration which it is expected will greatly increase the facilities for repairs while in action.

NORTHWICH.—At the last meeting of the District Council a letter was read from Mr. W. M. Beckett, of Manchester, informing the Council that he had prepared a scheme for supplying electric current to Northwich for lighting and power purposes, the scheme to be carried out either by the Council or by a private company. The letter was referred to the Lighting Committee.

REVISED ELECTRIC SUPPLY SCALE.—The St. James's and Pall Mall Electric Light Company (Limited), of Carnaby-street, Golden-square, London, W., have recently revised the scale of discounts and rebates under which electric current is supplied by the Company. The price per unit is 6d., or a minimum charge of 10s. per quarter. The following scale of rebates commences Lady Day, 1895:—

Units per annum.	Rebate per cent.	Approximate equivalent in pence per unit.
Under 3,000	—	6d
Over 3,000	1	
„ 4,000	2	
„ 5,100	3	
„ 6,300	4	5¾d.
„ 7,700	5	
„ 9,300	6	
„ 11,200	7	
„ 13,400	8	5½d.
„ 15,800	9	
„ 18,500	10	
„ 21,700	11	
„ 25,400	12	5¼d.
„ 30,000	13	
„ 36,200	14	
„ 45,000	15	
„ 60,000	16	5d.

Electric current for motive power, heating and cooking purposes is supplied at 4d. per unit.

ROTHERHITHE (LONDON, S.E.).—At the last meeting of the Rotherhithe Vestry a letter was read from the Capital and Counties Electricity Supply Company intimating their intention of applying for an electric lighting Provisional Order. It was decided to offer no opposition to the application.

SALFORD.—The Corporation Electricity Works are now practically completed and thoroughly equipped. Although the number of applications for current is smaller than was at first anticipated, it is thought probable that a greater demand will be made as the days become shorter. The charge for current will be 7d. per unit.

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SHANGHAI TRAMWAYS.—A recent issue of the *North China Herald* contains the correspondence which has passed between Mr. L. S. J. Hunt and the Municipal Council of Shanghai on the subject of the concession for the proposed electric tramways. The final decision of the Council is that the matter be submitted to the ratepayers for confirmation or rejection. Mr. Hunt acknowledges the receipt of this notification, and reviews the questions raised by the Council's engineer as to the terms upon which the concession for the line is to be granted. The engineer's report is considered by Mr. Hunt to be favourable to the introduction of electric tramways into Shanghai, and with regard to a criticism as to the unsightly appearance of the overhead system Mr. Hunt points out that many of the objections that were raised in the early part of 1894 have been overcome by recent improvements. On the financial aspect of the question Mr. Hunt takes exception to the proposal that the concession should be for 21 years on condition that the Municipality should be able to purchase the property after that period, "on a basis which does not take into account the earning capacity." Mr. Hunt is of opinion that the clauses introduced in England for the acquisition of the tramways by local authorities have done more to obstruct tramway enterprise than to benefit the public. He thinks that if tramways are objectionable they should be forbidden, and if advantageous sufficiently good terms should be made to enable builders to reap a fair reward for their outlay. As to the tax which is claimed by the Municipality, Mr. Hunt agrees that some such tax should be paid, but if the requirements suggested by the municipal engineer are viewed by those working with Mr. Hunt as he views them, it would be better to withdraw from the field rather than attempt to carry such a burden. Mr. Hunt expresses his willingness to register the Company to work the tramways in Hong Kong, thus placing it under the jurisdiction of the English Courts.

SIEMENS AND HALSKE ELECTRIC COMPANY (OF AMERICA).—After the destructive fire which took place at this Company's works last year negotiations were immediately entered into for the purchase of the Grant Locomotive Works, and this purchase has now been completed. The ground owned by the Company is about 80 acres in extent, 30 of which are covered by buildings constructed and equipped for the production of heavy machinery. The works are situated in the town of Cicero, west of Chicago, close to the track of the Wisconsin Central and Chicago and Northern Pacific Railroads.

SOUTH STAFFORDSHIRE AND EAST WORCESTERSHIRE INSTITUTE OF MINING ENGINEERS.—The members of this Institute, on Monday, paid a visit to the electric generating station of the South Staffordshire Tramway Company. The manager (Mr. A. Dickinson) gave the deputation a full description of the system and of the appliances at the works, and the visit afforded much interest to all present.

SUNDERLAND.—The Highways Committee of the Town Council have adopted by six votes to three the Electric Lighting Committee's report as to electric lighting extensions in the borough. The report recommends that the Thornhill and Christ Church districts be lighted electrically at the estimated cost of £3,000.

TELEGRAPHIC EXTENSION.—The Scottish Office notify that telegraph facilities are to be provided immediately from Gairloch to Badachro and other parts of Ross-shire. The Treasury has for some time past been asked to provide increased telegraphic communication in the western parts of Ross-shire and throughout the Island of Lewis, and the work is to be commenced immediately.

TRAIN LIGHTING.—The Directors of the Barry Railway Company are making arrangements for lighting the whole of their passenger trains electrically. For testing purposes the Company recently attached a first and second-class coach, especially fitted with electrical appliances, to one of the trains, and the experiment proved highly satisfactory. The supply for the coaches will be entirely independent for each. It is expected that the whole of the passenger trains on the Barry railways will shortly be lighted by electricity.

WHITECHAPEL (LONDON, E.).—The District Board of Works, at their meeting on Monday, decided to oppose the application of the Capital and Counties Electricity Supply Company for a Provisional Electric Lighting Order for Whitechapel. It will be remembered that the Board obtained a Provisional Order about two years ago, but has done nothing to comply with its provisions.—Mr. Catmur moved that the question of the introduction of the electric light into the district be referred to the Streets Committee for consideration and report, and this was agreed to with one dissentient.—Mr. Barham stated that, in his opinion, the Board would be able to supply the district with current 2d. per unit cheaper than a private company could.

BOOKS RECEIVED.

"Taschenbuch für Monteure elektrischer Beleuchtungsanlagen." By S. Freiherr v. Gaisberg. (Munich and Leipzig, R. Oldenbourg.)

"Indicator Diagram Record Book." By the late Joseph Wright, M.I.M.E. Edited by Howard T. Wright, A.M.I.M.E. Price 15s.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

July 3, 1895.

12,888. H. H. LAKE. London. Improvements in electric arc lamps. (I. Einstein and S. Kornprobst, Italy.)

July 4, 1895.

12,954. THE CHLORIDE ELECTRICAL STORAGE SYNDICATE (LIMITED) and G. A. GRINDLE. London. An improvement in secondary voltaic batteries.*

July 5, 1895.

13,014. A. G. NEW and A. J. MAYNE. London. Improvements in dynamos and electric motors, the invention being particularly applicable to motors carried in the rudders of vessels.

July 6, 1895.

13,090. S. Z. DE FERRANTI. London. Improvements in electrolytic cells.

13,091. S. Z. DE FERRANTI. London. Improvements in electric switches.

13,113. H. H. LAKE. London. Improvements in telephonic installations (Ed. Baivz, Belgium).

July 8, 1895.

13,164. W. L. WISE. London. Improvements in alternating-current dynamos. (The Maschinenfabrik Oerlikon, Switzerland).

13,168. R. MYERS. London. Improvements in electrical contact-making devices.

July 9, 1895.

13,255. J. B. TORRES. London. Improvements in apparatus for the electrolysis of oxides, salts, and other chemical compounds.

July 10, 1895.

13,285. M. ROHMANN. Johannesburg. Improvements in electrical switches.

13,303. E. A. PELLET. London. Improvements connected with arc lamps.

13,312. H. P. MADSEN. London. A rain-making contrivance to be used in conjunction with the barometer, hydrometer, electrometer, &c., under Government control by wire (telegraph).

July 11, 1895.

13,348. F. H. ROYCE and E. A. CLAREMONT. Chorlton-cum-Hardy. Improved methods of distributing power by electricity.*

13,380. M. MOSKOWITZ, L. D. ADLER, A. S. ADLER, and T. W. MYERS. London. Improved electric lighting system for railway vehicles and dynamo therefor.*

13,388. J. DEVONSHIRE. London. Improvements in electric arc lamps. (E. Thomson and C. E. Harthan, United States.)*

13,389. J. DEVONSHIRE. London. Improvements in methods of and means for regulating the speed of continuous current motors. (M. J. Wightman, United States).*

July 12, 1895.

13,404. F. H. ROYCE and E. A. CLAREMONT. Chorlton-cum-Hardy. Improvements in dynamo-electric machinery.*

13,405. A. MARR. Manchester. Improvements in and relating to electric telephone systems.*

13,410. W. W. G. WEBB and A. ECKSTEIN. Crewe. A binder for attaching telegraph and other aerial lines to their insulators.

13,411. F. H. ROYCE and E. A. CLAREMONT. Chorlton-cum-Hardy. Improved methods of distributing power by electricity.*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

15,282. BRUTSCHKE and SCHIMPFF. Ploughing by electricity.

15,353. ROUTLEDGE. Electric motors.

15,617. MUNCH. Registering number of telephonic conversations.

15,737. EDISON-BELL PHONOGRAPH CORPORATION (LIMITED) and WILKINSON. Phonographs.

15,843. BOUDET and LACOMBE. Telegraphic apparatus.

16,131. HAWKSEY and LAMB. Electric signs, &c.

16,331. HARRISON. Electric organs.

18,359. WILLCOX (Eisenwerk, late Nagel and Kaemp, Actien Gesellschaft). Electric elevating mechanism.

19,176. ERICSSON. Telephone indicators.

1895.

1,797. STIENS. Electric lamps.

8,049. THOMSON (Knapp and another). Electric alarm clocks.

8,393. MOSKOWITZ and OTHERS. Electric lighting of railway vehicles.

8,394. MOSKOWITZ and OTHERS. Dynamos.

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COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Company (Limited).

The forty-sixth half-yearly general meeting of this Company took place yesterday (Thursday) at Winchester House, Old Broad-street, London, under the presidency of the Marquis of Tweeddale.

The SECRETARY (Mr. George Draper) having read the notice calling the meeting, the report of the Directors was taken as read.

The CHAIRMAN said that it had been necessary to hold the meeting a few days later than usual, but this would not occur again, and they might calculate upon the meeting next year being held at the usual time. The Chairman was unavoidably absent on that occasion, it being the polling day for the Wick Burghs, and he was sure they would all join in expressing the hope that Sir John Pender might accomplish his aim and be successful. That was their forty-sixth meeting, and Sir John had presided on every occasion excepting the present. He proposed to follow the example which Sir John had set them at their meetings in dealing with their affairs. The gross revenue for the half-year under review—to March 31st last—had amounted to £420,526, being an increase of £31,212 on that of the corresponding period of 1894. There had been a small decrease in the traffic with India, but a considerable increase in the traffic beyond—to Australia and China. There was also a marked increase in the traffic with South Africa, attributable, no doubt, to the activity in mining business which had prevailed there for so long. At their last general meeting the Chairman announced that the Eastern and South African Company (in which their Company was largely interested) was about to complete an arrangement with the Governments of Great Britain, the Cape of Good Hope, Natal, and the South African Republic, as well as with the British South Africa Company, for a continuation of a portion of the subsidies now payable for telegraphic communication with South Africa, in consideration of a reduction of the tariff over the associated companies' lines between Europe and South Africa. The negotiations were brought to a satisfactory conclusion, and, as bearing on this point, he read a telegram from Sir John Pender expressing his great regret at not being present at the meeting, and stating that he (Lord Tweeddale) could "tell the shareholders that arrangements just completed with the Cape, Natal, and the Transvaal insure us 15 years' prosperous traffic." That was the consideration they had received for a lowering of the tariff. The rates were reduced from 8s. 9d. to 5s. per word for public telegrams, and from 2s. 2½d. to 1s. 6d. per word for Press telegrams. The accounts now submitted were not affected by the reduction, which came into operation on April 1st last, but the result so far might be considered satisfactory to all the parties to the Agreement, as well as to the telegraphing public. The total ordinary expenses for the half-year had been £98,060, or an increase over those of the corresponding period of 1894 of £3,220. From this increase, however, must be deducted about £2,293 for the proportion of stationery charged against this half-year's accounts, as fully explained at the last two general meetings. The comparison of one half-year with another would in future be easily made, as each period would bear its proper share of the annual cost. The actual increase in the ordinary expenses was therefore only about £927, notwithstanding a very large increase in the number of messages to be dealt with—an increase of 500,000 words, and of very nearly 100,000 messages. The working expenses at the stations had been £81,22?, or an increase of £4,579, but, deducting the item of stationery just referred to, the net increase under this head amounted to only £1,396, which was mainly due to the salaries and allowances of the larger number of staff required to cope with the additional traffic, and also to the annual promotions of the other members of the staff. They took great pains to make their employés comfortable wherever they might be stationed, and in return they looked for an active and zealous discharge of their duties. In this they had not been disappointed, and he questioned if any service could show a body of men more efficient and animated with a desire to do their duty to their employers. The expenses attending repairs and renewals of cables had been £52,730, or £3,070 more than in the corresponding period of 1894. The ordinary expenses of the ships for the half-year had been about the same as in the corresponding period of 1894, notwithstanding that they had been actively employed in the half-year under review. The credits received from other companies for the hire of their ships showed an increase of about £8,000, so that the increased expenses attending repairs to cables were due to their having laid an exceptionally large quantity of new cable—about 300 miles—into the original Aden-Bombay section. It was interesting to know that this section, which was laid so far back as 1870, was now, with the repairs in question effected, in good working order. The depreciation of spare cable amounted to £3,222, or an increase of £844, but this item must necessarily vary according to the stock of cable in the tanks from time to time, but it was kept as low as possible compatible with the efficiency of their service. The amount carried to maintenance ships' reserve fund was £9,000, or an increase of £4,000. This increase was really necessary in order to strengthen this fund in view of expenses which they saw coming before them. They had made a profit, as he had said, from the hire of their ships during the half-year, and they thought that the maintenance ships' fund should have the benefit of any profit the ships might earn. The net result of the half-year's work was that, after providing the usual amount for interest on debentures, debenture stock, and Preference shares, they were able to recommend the usual final dividend of 1¼ per cent., and a bonus of 1¼ per cent. making, with the interim dividend already paid a total distribution of 6¼ per cent. for the year ended March 31st last, and to carry the sum of £100,000 to the general reserve fund against £110,000 in 1894. They had also, in pursuance of an arrangement which was approved by the shareholders some time back, applied a further sum of £50,666 from the reserve fund in reduction of the cost of the Aden-Bombay No. 3 cable and other expenditure chargeable to capital. The total amount applied from reserve fund now amounted to £1,451,718, and their capital account, with the exception of some additions to buildings, practically remained at the same figure as it had done for many years past—a little over £6,000,000. Although their general reserve fund was a very substantial sum, and the securities in which it was invested were higher in value than they cost the Company, yet the sum fell very far short of what they considered it should stand at, having regard to the number and age of their cables. It had been urged by speakers at some of their recent meetings that the Directors should raise money to provide for capital expenditure, and thus furnish a large sum available for dividend purposes. This, however, had not been the Directors' policy, which had been to keep down the capital account of the Company, to provide an adequate reserve, and at the same time to pay a good and, he thought he might say, a handsome dividend to the shareholders. This policy was, he believed, approved by the great body of their shareholders, and he saw no reason to expect that it would be altered. He observed from a return which had been made to him of the market value of their capital that on the 23rd inst. their Ordinary shares, which were of the value of £4,000,000, stood in the market at £6,700,000, and, taking the whole of their capital together—Ordinary and Preference shares and debenture stock—the full amount represented was £6,099,690, which stood in the market at the date mentioned at the valuation of £9,719,439, or an appreciation of 59 per cent. The Company was in a flourishing condition, the management was both efficient and economical, their traffics were improving, and their relations with the Colonies and foreign powers—thanks to their Chairman's tact and energy—seemed to be on the most satisfactory footing. He concluded by moving a resolution for the adoption of the report and accounts and the payment of the dividends recommended.

Mr. G. G. NICOL seconded the motion.

A short discussion followed.

The CHAIRMAN, in answer to Mr. Goodsall, stated that the 300 miles of new cable referred to had been laid in different parts of the Aden-Bombay cable. In reply to Mr. Baynes, he said that he could only repeat what was stated by the Chairman at their last meeting—that as soon as the reserve fund was sufficiently large, the Directors would be only too glad to pay a higher dividend to the Ordinary shareholders.

The resolution was then unanimously adopted.

On the motion of Mr. BAYNES, seconded by Mr. H. T. BURGESS, a cordial vote of thanks was passed to the Chairman, Directors, and staff, both speakers expressing a hope, amid cheers, that Sir John Pender would return from the North successful.

The CHAIRMAN, acknowledging the vote, remarked that Sir John Pender would be extremely gratified at the kindness which had been displayed towards him by the meeting.

The proceedings then terminated.

[A full report of this meeting will appear in our next issue.]

West African Telegraph Company (Limited).

The tenth ordinary general meeting of this Company was held yesterday (Thursday) at Winchester House, Old Broad-street, under the presidency of Sir Henry C. Mance, C.I.E.

The SECRETARY (Mr. John Cambrook) read the notice calling the meeting.

The CHAIRMAN: Gentlemen, the duty of presiding here to-day has fallen to me in consequence of the absence of our Chairman, Sir John Pender, in the North, where he is very busy electioneering. I am sorry he is not able to be present with us to-day, because during the last two or three meetings the results we have submitted have not been completely satisfactory to the Ordinary shareholders, and I should have been pleased if it had fallen to his lot to communicate to you the position when better prospects appear to be opening out before us. I feel sure that nothing but the fact that it happens to be the polling day at Wick to-day would have prevented our Chairman from being in his usual place. There is another point I should like to refer to before passing to the accounts—namely, the loss we have sustained by the death of our late colleague, Mr. Thomas Fuller. Mr. Fuller had not been more than a year or two on this Board, but he had been closely connected with us in consequence of being the Managing Director of the African Direct Company, with whom we have mutually advantageous working arrangements. He had been intimately connected with the telegraph business in this city for more years than I can remember, and I am sure that he will be greatly and sincerely missed by a large circle of friends. You have all had the report and accounts in your hands for some time, and I presume that, in accordance with your usual custom, you will take them as read. That being so, I pass on to make a few remarks, which appear to me desirable, on some of the items. The gross revenue for the year ended December 31, 1894, amounted to £64,761, as against £61,847 for 1893, showing the very satisfactory increase of £2,914. Analysing the receipts from various sources, we find an increase in some classes of local traffic and a decrease in others. The principal increase in the message receipts is derived from the joint purse arrangement we have with the other companies associated with the South African telegraph connections with Europe. The loss on exchange amounted to £6,419, but in connection with this item it is satisfactory to note that this amount, although still large, and representing 2 per cent. or 3 per cent. on the capital of the Company, is much less than it was last year—less by £1,332, and we hope that there will be a further improvement in this respect. The total working expenses for 1894 amounted to £17,286, as against £18,829, or a decrease of £1,543. I am glad to state that this decrease has been effected while our efficiency has increased. The principal

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decrease is in the expenses at the stations, nearly all the items under this head showing satisfactory decreases. The expenses attending repairs and renewals of cables amounted to £13,473, as against £31,234, or a decrease of £17,761. Although the diminution seems large, it must be remembered that we are making comparisons with a year when the expenditure under this head was abnormally high. The item of £13,473 for this year is still heavy, owing to the number of repairs required on the various sections of our cables. Looking therefore to the fact that after nine years' working our reserve fund only amounted to £21,775 at the end of last year, your Directors' after very mature consideration, arrived at the conclusion that they would be acting in the best interests of the Company in recommending you to carry the whole balance of net revenue to the reserve fund, thereby practically replacing the amount which we found it necessary to withdraw from that fund to balance our revenue account at the end of last year. This, I think you will agree with me, was undoubtedly the soundest policy to adopt, and we have no doubt that it will be approved by the general body of shareholders. We are glad to be able to announce that the revenue, so far as we have gone, and the expenses on account of repairs, both justify us in paying a small interim dividend on account of the present year's working, and we can only hope that in future the present condition of affairs will be at least maintained, so as to enable us to pay dividends regularly, after providing a fair contribution to the reserve fund. I had occasion at our last annual meeting to make a few remarks, and I ventured to predict that before long we should rejoin the ranks of dividend-paying companies. I am glad to find that my prophecy is correct. The circular which you all received with the report and accounts will, I hope, have been satisfactory reading to you, and I do not think there can be any question as to the prudence of putting the whole of the surplus amount available from last year to the reserve fund. I think that until a telegraph company has a substantial reserve fund it is not lifted out of the range of speculative business. I think we may say that we are now getting fast into a sound financial condition. Our reserve fund is higher than it has ever been before, and our debentures obtain a better price in the market. These results have been obtained notwithstanding the depreciation in silver and also our bad luck in the matter of repairs. We have now a telegraph steamer, the "Duplex," stationed on the coast. We have a very economical arrangement by which she is maintained, and, if interruptions do occur, I think that they will be repaired at a minimum cost and the least possible expenditure of time. I may also mention that during the year there has been, in concert with the other companies working to the Cape, a reduction in the tariff, which has given great satisfaction to the community at the Cape, and I am glad to find that the results are entirely satisfactory to us up to the present. I think that that is nearly all I have to say, and I may briefly sum up the position. Our cables, I am glad to inform you, are in good working order; the efficiency of our system has been improved during the year, and it is most gratifying to the Board to be able to say that the health of the staff is good. I have already pointed out the decrease in our working expenses and in the loss by exchange. On the other hand, there is an increased traffic, and judging from the reports from the Cape as to the sound condition of the gold industry now, there is every reason to expect that the improvement will be maintained. With these remarks I beg to move—

"*That the report and accounts for the year to December 31, 1894, submitted to this meeting, be and they are hereby received and adopted.*"

The MANAGING DIRECTOR (Mr. J. Denison Pender) briefly expressed his pleasure in seconding the motion.

The resolution was carried unanimously.

The CHAIRMAN then stated that in accordance with the Articles of Association two of the Directors retired, and he had much pleasure in proposing—

"*That Robert Kaye Gray, Esq., and the Hon. A. G. Brodrick be and they are hereby re-elected Directors of this Company.*"

The MANAGING DIRECTOR seconded the resolution, which was carried unanimously.

On the motion of Mr. A. HENDERSON, seconded by J. F. EAST, the auditors, Messrs. Deloitte, Dever, Griffiths and Co., were re-elected for the current year at a remuneration of fifty guineas.

A SHAREHOLDER proposed a vote of thanks to the Chairman and Directors. He regretted that Sir John Pender was unable to be present, as that gentleman had always conducted the business in such an efficient and courteous manner. It was, however, very important for him to endeavour by his personal efforts to secure his seat in Parliament.

Mr. HENDERSON seconded the motion, which was carried unanimously.

The CHAIRMAN: I have to thank you on behalf of the Directors, and I shall have great pleasure in being the medium of communicating the expression of your kind wishes to Sir John Pender.

The proceedings then terminated.

Telegraph Construction and Maintenance Company (Limited).

A half-yearly general meeting of this Company was held on Tuesday at the offices, Old Broad-street, under the presidency of Admiral Sir G. H. Richards, K.C.B.

The SECRETARY (Mr. E. Dickens) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, at these half-yearly meetings you know we have no accounts to present to you, and, as a matter of fact, that means that there is no business to present. At the same time, we are very happy to see you on these occasions, and to give you any information that we are able to impart to you in regard to the affairs and the progress the Company for the six months that are ended. I regret that we have not much to give you. Perhaps the best thing I can say is that we shall pay you to-morrow morning the usual dividend which we have distributed for a great many years at this season, that is to say, 12s. per share, or at the rate of 10 per cent. per annum. I cannot say that this has been a good year for the manufacture of telegraph cables, which, as you know, are not an article of everyday use—I might say they are not an article of every year use. What I mean by that is that we do not look forward every year to get any very large orders for telegraph work. Of course, cable is made every year, but we do not expect every year to be able to say that we have done any very great work. However, it is not at all an unusual thing to have a slack time occasionally in making such articles as submarine cables. As regards our general trade—the gutta-percha work—that has gone on pretty much as usual at this time of the year; it is slightly better than it was at this time last year. Our factories, our ships, and our machinery are in good and efficient condition, and we are quite ready for any work that we may receive an order for; and we can only hope that we shall not be long unoccupied. This is really all I have to tell you, gentlemen; but if anything suggests itself to you to ask I shall be very glad to give you any information I can. As I have said, however, there is really very little to say. After a pause, he added: If no one has anything to say, the business of the meeting is at an end.

Mr. CROFT said he desired to move a vote of thanks to the Chairman and Directors for the great attention they had given to the affairs of the Company, and he would like to join in this expression of thanks the officers of the Company generally. He thought that what the Chairman had said about the work being rather slack went to confirm the opinion which the Chairman and his predecessors had always expressed to the shareholders regarding the wisdom of the policy of not dividing their profits up to the hilt. He believed that the Company had a very large reserve, and he thought that what the Chairman had stated showed the very great wisdom of keeping that reserve at as large an amount as possible so as to enable the Directors to maintain the dividend which the Company had been paying for a great many years. He regarded theirs as one of the best managed companies in the City of London.

Colonel GARDNER seconded the motion, which was carried unanimously.

The CHAIRMAN, in returning thanks, expressed a hope that the Directors might have better news to tell the shareholders at their next meeting.

Direct United States Cable Company (Limited).

The report of the Directors of this Company for the six months ended June 30th, to be presented at the thirty-sixth ordinary general meeting, to be held at Winchester House, 50, Old Broad street, E.C., on Tuesday, the 30th inst., at 2 o'clock, is as follows:—

The present report and statement of accounts, with the accounts to December 31st, presented at the meeting on January 25th last, show the financial result of the eighteenth year's working of the Company. The half-year's revenue, after deducting out-payments, amounted to £37,653 2s. 4d., compared with £34,843. 9s. 4d. for the corresponding period of 1894, an increase of £2,809. 13s. The expenses for the same period, including income tax, but exclusive of cost of repairs of cables, amounted to £18,909. 0s. 10d., leaving a balance of £18,744. 1s. 6d. as the net profit, or with £1,807. 19s. 3d. brought forward a total of £20,552. 0s. 9d. For the same period of 1894, the expenses amounted to £18,750. 3s. Three quarterly interim dividends amounting to £18,213 have been declared and paid during the financial year, and a final payment of 2s. per share is now proposed, making, with the three interim dividends, 2 per cent. for the year, being a total distribution of £24,284. After transferring £7,000 to the reserve fund account, the balance of £1,410. 0s. 9d. is carried forward.

Repairs of the Company's cables have cost £1,730. 7s. 4d. This amount, together with £673. 14s. 8d. written off the buildings account, Ballinskelligs, in respect of old buildings pulled down, have been debited to the reserve fund account, the balance of which, with the addition of interest, profit, and amount transferred from revenue account, now stands at £298,369. 18s. 10d.

Mr. Charles E. Günther and Admiral the Hon. Sir Henry Keppel, G.C.B., D.C.L., seek re-election as Directors, as do Messrs. Deloitte, Dever, Griffiths and Co. and Messrs. J. and J. Sawyer and Co. as auditors.

Globe Telegraph and Trust Company (Limited).

The report of the Directors of this Company, to be presented to the twenty-second ordinary general meeting to be held this day (Friday), at Winchester House, London, E.C., at 12 o'clock, states that the net revenue of the Company for the year ended 18th July, after deduction of expenses, amounts to £179,465 6s., or, with a balance of £527. 2s. 4d. brought forward, £179,992. 8s. 4d. From this amount there has been distributed £123,361. 5s. 5d. in interim dividends, leaving an available balance of £56,631. 2s. 11d. The Directors recommend a final dividend of 3s. per share on the Preference and 3s. 3d. per share on the Ordinary shares, making, with previous distributions, a total for the year of 6 per cent., less income tax, upon the Preference, and 4½ per cent. net (against 4½ per cent. for the preceding year) upon the Ordinary shares, the balance forward being £1,238. 3s. 4d., against £527 2s. 4d. last year. Since the last meeting a further sum of £38,592. 9s. 7d., resulting from the paying off of the Direct Spanish Telegraph Company's Six per Cent. Debentures, has been invested. Sir Henry D. Gooch, Bart., has resigned his seat at the Board, and it is not proposed to fill the vacancy at present. Sir John Pender, G.C.M.G., and the Hon. St. John Brodrick, M.P., offer themselves for re-election as Directors, as do also the auditors, Messrs. Deloitte, Dever, Griffiths and Co., and Mr. William Griffith, B.A., barrister-at-law.

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City and South London Railway Company.

The report of the Directors of this Company is issued for the half-year ended June 30th last, and will be submitted to the half-yearly meeting to be held at Winchester House, Old Broad-street, E.C., on Monday next, at three o'clock.

The report states that the receipts from all sources for the half-year amounted to £24,401. 15s. 8d., and the cost of working to £15,019. 16s., leaving a profit of £9,381. 19s. 8d. With the balance brought forward the net revenue account shows an aggregate total of £10,379. 8s. 8d. After making provision for the Debenture and Debenture Stock interest, a balance remains available for dividend of £6,420. 16s. 2d. Out of this sum the Directors recommend that the full dividend of 5 per cent. per annum be paid on the Preference shares, and a dividend at the rate of 1⅛ per cent. per annum be paid upon the Consolidated Ordinary Stock, leaving £964. 11s. 2d. to be carried forward.

The following table shows the number of passengers (exclusive of season ticket holders) carried in each half-year since the opening of the railway :—

Half-year ended	Passengers.		Receipts (inc. season tickets).
December 31, 1890 (11 days)......	165,000	...	£1,568 3 9
June 30, 1891	2,412,343	...	19,403 6 9
December 31, 1891	2,749,055	...	19,798 16 6
June 30, 1892	2,813,162	...	20,931 4 2
December 31, 1892	3,117,602	...	22,002 17 5
June 30, 1893	3,146,656	...	22,458 6 9
December 31, 1893	3,093,351	...	22,067 14 10
June 30, 1894	3,383,154	...	23,564 10 6
December 31, 1894	3,275,649	...	23,540 12 4
June 30, 1895	3,113,199	...	23,711 5 8
Total since the opening of line..	27,269,171		£199,046 18 8

During the first three months of the present year there was a satisfactory growth of the traffic on the line, but the very hot and fine weather of the last three months affected it so much that the increase was not only checked, but a small decrease resulted as compared with the same quarter last year. The receipts, however, still show a small increase.

In accordance with the authority given at the last half-yearly meeting, detailed plans have been prepared for the extension to Finsbury-pavement, and negotiations have been entered into for the purchase of some of the property, but the arrangements are not yet sufficiently completed to enable a report to be made to the shareholders on the present occasion.

During the past six months a further sum of £23,200 Terminable Mortgage Debenture Bonds has been paid off. The Bill for the extension of time for the works of the Clapham Extension Act, 1890, and for other purposes, received the royal assent on May 14th last. A contract has been let for the construction of the new siding at Stockwell. This, when completed, will enable the work at that station to be carried on with greater economy and convenience.

Edison and Swan United Electric Light Company (Limited.)

The following report is issued by the Directors of this Company for the year ended June 30th last, and will be presented to the ordinary general meeting to be held at the Cannon-street Hotel, London, E.C., on Monday next, at two o'clock :—

The profit and loss account shows a credit balance of £25,876. 3s. 2d., and after providing for the interest accrued upon the £100,000 Debenture Stock, there remains a balance of £21,376. 3s. 2d. available for distribution. An interim dividend at the rate of 5 per cent. per annum having already been paid in respect of the first half-year, to December, 1894, a further payment at the same rate in respect of the second half is recommended, the balance of £3,702. 5s. 2d. being carried forward. The business of the Company during the year has been satisfactorily maintained, notwithstanding the severe competition which has set in since the expiration of the Company's patents.

The liquidation of the Swan United Electric Light Company (Limited) is now practically completed, and the final meeting for winding up will shortly be held.

The Directors announce the resignation of Mr. Shelford Bidwell, F.R.S., and the election of Mr. Joseph Wilson Swan, F.R.S., in his place. The Earl of Lichfield and Mr. Ernest Villiers seek re-election as Directors, as do the auditors, Messrs. Welton, Jones and Co.

At the meeting a resolution to strike out the present Section 87 of the Articles of Association and substitute a new section as under, will be proposed, and, if passed, will be submitted to a subsequent extraordinary general meeting for confirmation as a special resolution :—

87. The amount from time to time declared by the Board as available for dividend, including the amount (if any) recommended by them to be withdrawn from reserve for equalisation of dividends, shall be applied as follows :—

(1) There shall be first set aside thereout a sum equal to a preferential cumulative dividend of 7 per cent. per annum on the aggregate amount for the time being paid or credited as paid on the "A" shares.

(2) Out of the sum so set aside there shall be paid a preferential cumulative dividend at the rate of 5 per cent. per annum on the amounts paid or credited as paid on the "A" shares without distinction.

(3) Subject thereto, there shall be paid out of the sum so set aside a further cumulative dividend at the rate of 2 per cent. per annum on the amount paid or credited as paid on the "A" shares, provided that until all the "A" shares be fully paid, no "A" share, whether fully paid or not, shall for the purpose of this subsection be deemed to have paid upon it more than the amount paid up or called up upon the "A" shares for the time being having the least amount called up or paid thereon.

(4) The balance of the sum so directed to be set aside shall be carried to the reserve fund.

(5) The residue of the amount declared to be available for dividend, after setting aside the sum mentioned in Subsection 1, shall be applied in payment of dividends *pari passu* on the amounts paid up or credited as paid on the "A" and "B" shares, but so that, for the purposes of this subsection, the amounts to be deemed paid up on the "A" shares shall be ascertained as in the case of Subsection 3.

The following dividends are announced by the Edison-Swan Company:— On the 89,261 Ordinary shares, 1s. 6d. per share ; on the 12,139 fully-paid "A" shares allotted to the Swan United Company, 2s. 6d. per share ; and on the 5,000 fully paid "A" shares allotted to the Edison Company, 2s. 6d. per share. This distribution, together with the interim payment already made in respect to the first half-year, will be equal to 5 per cent. for the year. The dividend warrants will be posted on August 12th.

Thomas Parker (Limited).

The first annual report of the Directors of this Company, which has just been issued, is as follows : The Company was formed in April, 1894, but only commenced work about the end of January last. By far the larger portion of the management and working expenses, staff salaries, &c., having been incurred in the development of the business, planning, designing, and erection of the buildings and plant, the preparation of loose tools, patterns, &c., the Directors might have charged a very considerable proportion of these expenses to plant, &c., but have preferred to charge them all to a general account, the balance of which is £4,143. 6s. The Directors propose to transfer £3,000 of this amount to the goodwill and development account, and to treat the balance (£1,143. 6s.) as preliminary expenses, to be dealt with in future accounts. Many important contracts and orders have been already secured, and the trading prospects for the year are such as to give the fullest satisfaction. After lengthy negotiations the actions between the Electric Construction Company (Limited) and Thomas Parker (Limited) and the points in dispute have been settled on terms, the Directors think, highly favourable to their Company. The retiring Directors are Messrs. Mander, Graham and Thomas, who offer themselves for re-election, as do the auditors, Messrs. Allen Edwards and Smith.

Gulcher (New) Electric Light and Power Company, Limited (in Liquidation).

An extraordinary general meeting of this Company is to be held at 73, Lombard-street, London, E.C., on Monday next, at 2:30 p.m., to receive the account of the liquidator (Mr. C. Fitch Kemp), showing his acts and dealings and the manner in which the winding-up has been conducted, and to consider, and if approved to authorise, the acceptance of an offer received by the liquidator to purchase of and from him, at the price of £2. 10s. per share, 680 Ordinary shares of £10 each, fully paid, in Easton, Anderson and Goolden (Limited).

The statement of receipts and payments issued by the liquidator gives little hope of any ultimate payment to the trade creditors of the Gülcher Company, and Mr. Kemp in his report has a doleful tale to tell of promises made and unfulfilled, of great expectations and small realisations ; and those who, at the outset, cast doubts upon the sanguine statements of Mr. De Castro and those responsible for the management of the Company find their gloomy prognostications fulfilled to the letter. Mr. Kemp states that he accepted the position of liquidator of the Company upon the basis that cash assets, viz., the stock-in-trade and plant, and a debt owing to the Company in New Zealand from the New Zealand Electrical Syndicate, would be sufficient to pay off the First Debentures, that the uncalled capital of the Company would be sufficient to pay off the Second Debentures, and would probably provide a surplus of cash which would pay a substantial dividend to Third Debenture holders, and that, ultimately, the unsecured creditors would be fully paid, and some return would be made on the share capital, when time had been given to realise the holding of the Company in the shares of the New Zealand Electrical Syndicate. This forecast of liquidation has entirely failed of realisation owing to causes which Mr. Kemp sets out in his report, but which we may here say are mainly connected with a member of the late Board of Directors.

The attention of the contributories is called to the resolution which was passed at the meeting held on August 1st last, authorising Mr. Kemp to enter into an arrangement with Messrs. Easton, Anderson and Goolden (Limited) for the sale of the Gülcher Company's plant, machinery and stock-in-trade at the price of £12,500, payable as to £5,700 part thereof in cash, and as to £6,500, the balance thereof in 680 shares of £10 each, fully paid, in Easton, Anderson and Goolden (Limited). The cash paid was alone greater than the liquidator could have expected to receive at a break-up price. The shares, therefore, were taken for what might be their value, it being well known that there was no market for them at that time, and that they were not earning a dividend. An offer has been received of 5s. in the £ for these shares, that is, £1,700, and if this meeting authorises the liquidator to accept that offer he will, after discharging the expenses of the liquidation to date, apply the moneys obtained in further reduction of the £2,500 which remains owing on the security of the First Debentures, as it is obvious that until those First Debentures are discharged there can be no payment to the unsecured creditors.

The liquidator, more sanguine than most folks, does not take at all a despondent view of the ultimate realisation of the assets of the Company, but cannot hold out the hope that funds will reach his hands available for dividend at an early date.

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NEW COMPANIES, STATUTORY RETURNS, &c.

AVELING AND PORTER (LIMITED).—This Company was registered on July 16th with a capital of £150,000, in £10 shares, to acquire and carry on the business of engineers, boiler makers and ironfounders now carried on at Rochester, Kent, and London by Messrs. "Aveling and Porter," and to enter into an agreement, dated July 11th, made between T. L. Aveling and R. T. Porter, and Harry Pitts for the Company.

ELECTRIC OZONE SYNDICATE (LIMITED).—This Company was registered on July 19th with a capital of £12,000, in shares of £10 each, to purchase certain letters patent, patent rights and inventions granted to or obtained by Emile Andreoli in England and abroad, for generating and dealing with ozone by means of electricity and using ozone for various purposes, to enter into an agreement for the purpose of such acquisition, and to carry on the business of mechanical and electrical engineers, and manufacturers of and dealers in all apparatus and things required for or capable of being used in connection with the working of any patents, patent rights or inventions for the time being belonging to the Company, or in which the Company is interested. The subscribers, with one share each, are: C. Hanbury, F. J. Hanbury, W. P. Henderson, E. Andreoli, R. Arnot, W. L. Castleden, and G. Andreoli.

LIGHTING CORPORATION (LIMITED).—This Company was registered on July 18th with a capital of £250,000, in £1 shares, to maintain and uphold any appliances, apparatus or plant requisite for electric, gas, oil and any other methods of lighting, and to carry on the business of manufacturers of and dealers in incandescent lights and other apparatus for increasing the illuminating power of gas, spirits, oil, and other light and heat-producing agents, suppliers of light, heat, electricity and motive power, electricians, chemical manufacturers, mechanical engineers and ironmongers. The subscribers, with one share each, are: H. R. Hartley, F. Dawkins, H. H. A. Herwig, C. Darch, E. E. Culley, T. R. Bastard, and J. Baxter.

NEW PHONOPORE TELEPHONE COMPANY (LIMITED).—This Company was registered on July 19th with a capital of £10,000, in 9,000 Ordinary and 1,000 Founders' shares of £1 each, to purchase or otherwise acquire any patents, licences or concessions conferring an exclusive or limited right to use any invention or improvements in telephones, or in telephonic, telegraphic or other electrical apparatus, and in particular to enter into an agreement for the acquisition of the benefit of certain existing inventions mentioned in an agreement to be made between the Phonopore Company (Limited), and this Company or its representative, and to use, exercise, develop, grant licences in respect of or otherwise turn to account any such patents, licenses or concessions. The subscribers, with one share each, are H. Seebohm, M. Mocatta, T. J. Nash, C. E. Spagnoletti (electrical engineer), J. G. Chappell, W. F. Liddell, and Charles Isaac, of Faraday House, Charing Cross-road, London, W.C. (secretary).

RECOVERED RUBBER WORKS (LIMITED).—This Company has been registered with a capital of £20,000, in £10 shares, to acquire the business now carried on by Messrs. Grimshaw Brothers at Clayton, Manchester, and to carry on the business of rubber dealers.

J. E. H. ANDREW AND COMPANY (LIMITED).—The annual return to May 29th has been filed. The nominal capital is £40,000, in £20 shares. 1,465 of these have been taken up, 300 have been issued as fully paid, and the full amount has been called on the remainder.

HASTINGS AND ST. LEONARDS-ON-SEA ELECTRIC LIGHT COMPANY (LIMITED).—The annual return to June 6th has been filed. The capital is £50,000, in £10 shares, and 2,722 have been allotted, and the full amount has been called thereon. £5 has been paid on five forfeited shares.

J. H. PICKUP AND CO. (LIMITED).—The annual return to May 31st has been filed. The whole nominal capital of £15,000, in £5 shares, has been taken up, and of these 800 have been issued as fully paid. £3 per share has been called on the remaining shares.

REUTER'S TELEGRAM COMPANY (LIMITED).—The annual return to June 12th has been filed. Out of a nominal capital of £100,000, in £8 shares, 11,839 have been allotted, and the full amount has been paid thereon.

SAXBY AND FARMER (LIMITED).—The annual return to April 15th has been filed. The capital is £25,000, in £10 shares, of which 2,021 have been taken up. Of these 1,800 have been issued as fully paid, and the full amount has been paid on the remainder. Mr. Correll Farmer, of Boxwood, Billingshurst, holds 1,948 of these shares.

SHEFFIELD ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return to April 18th has been filed. The nominal capital is £98,000, in £7 shares, of which 8,625 have been taken up. Of these, 4,000 have been issued with £5 per share considered as paid, and a call of £2 per share has been made on the whole on them.

SINGLE-WIRE MULTIPLE TELEPHONE SIGNAL COMPANY (LIMITED).—The annual return to June 14th has been filed. The nominal capital is £5,000, in £10 shares, and 254 have been taken up. The full amount has been called and paid.

CITY NOTES.

CAPE TOWN AND SUBURBAN ELECTRIC LIGHTING SYNDICATE (LIMITED).—The second annual general meeting of this Syndicate was recently held at Cape Town, Mr. R. S. Solomon presiding. The Chairman, in moving the adoption of the report and accounts, congratulated the shareholders on the increasing prosperity of the Syndicate. They had very few hitches during the past year, there had been no serious complaints, and people were very pleased with the light. They had spent some £300 or £400 in extending their mains, and had issued the remainder of their capital for the new plant, which had now been ordered. At present all their power was taken up, and in order to meet the increased winter demand they were obliged to have recourse to a temporary plant. To show the steady increase in the demand for current, the Chairman said they started last year with 857 lamps, this year they had 2,580, and over 300 were waiting to be installed. Their success had been very great, and he thought their future was assured. Their engineers were to be congratulated on the results of their labours. A dividend at the rate of 7 per cent. per annum was declared, which would take £1,281; a sum of £151 was allotted as Directors' fees, and a balance of £2. 10s. 10d. was carried forward out of a total net profit of £1,433. 11s. 10d. The additional plant which was now on order would cost about £7,000, and this would more than double the capacity of the present plant, and enable the Syndicate to considerably extend its operations. 7,000 shares had been issued by the Directors to provide for the purchase of this new plant, and they had experienced no difficulty in placing these shares at par amongst the existing shareholders. The report and accounts were adopted.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended July 21st were £831, against £839 in the corresponding week of 1894, a decrease of £8. The total receipts for the half-year amount to £2,594, against £2,600 for the corresponding period of 1894, a decrease of £6.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The warrants for the interim dividend on this Company's Six per Cent. Preference shares have been posted.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have resolved, after providing for the dividend on the Preference shares, to recommend the payment of a dividend on the Ordinary shares at the rate of 8 per cent. per annum, free of income tax, for the half-year ended June 30th. This dividend is at the same rate as last year.

DETROIT CITIZENS' STREET RAILWAY.—The *Western Electrician* states that this Company has equipped the whole of its lines for working by electricity.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announce that the coupons on their Five per Cent. Debentures, due August 1st next, will be paid on and after that date at the banking house of Messrs. Glyn, Mills, Currie and Co., 67, Lombard-street, E.C. Coupons to be left three days for examination.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY (LIMITED).—This Company announce the payment by warrants on August 1st next of interest for the half-year ending July 31st on their Four per Cent. Mortgage Debentures. The transfer books will be closed from July 28th to August 1st inclusive.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The accounts of this Company for the past half-year show an available balance of £8,076, and the Directors have decided to recommend the payment of a dividend of 5 per cent. per annum on the Preference shares, and 2¼ per cent. per annum on the Ordinary shares, as against 1 per cent. per annum on the Ordinary shares for the corresponding period last year. The balance carried forward is £1,302, against £1,248. The traffic receipts of this railway for the week ended 21st inst. amounted to £1,226, against £1,034 in the corresponding week last year; increase, £192.

REDUCTION OF CAPITAL.—A petition for sanction to reduce the capital of the Phosphor-Bronze Company came before Mr. Justice Kekewich in the Chancery Division on Saturday last. The capital of the Company is £150,000, but, owing to commercial depression and trade competition (in respect of which £25,000 had been written off), and especially owing to the expiry of all the patents save one, which were purchased some years ago at a cost of £70,000, the Company asked for a reduction to £90,000. The judge, after a careful examination of all the items in respect of which depreciation was pleaded, gave his consent as asked for.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY (LIMITED).—The share transfer books of this Company will be closed from July 24th to August 7th inclusive, preparatory to the payment of interim dividends on the Ordinary and Preference shares for the half-year ended June 30th.

SOCIETE ANONYME DES TRAMWAYS DU CAIRE.—This is the title of a Company just formed in Paris. The Company, which has a capital of £160,000, is to acquire a 50-years concession recently granted by the Egyptian Government for the construction and exploitation of about 12 miles of electric tramways on the Thomson-Houston overhead system in Cairo.

THE AMERICAN WESTINGHOUSE COMPANY.—In the report just issued, this Company estimates that the net returns for the past year were less than half what they would have been had business not been interrupted by the removal of their plant.

VENEZUELA TELEPHONE AND ELECTRICAL APPLIANCES COMPANY (LIMITED).—Coupon No. 10 of the Five per Cent. First Mortgage Debentures of this Company, due 31st inst., will be paid after that date, at the Consolidated Bank, Threadneedle-street, London, E.C., or at Messrs. Westendorp and Co.'s Bank, Amsterdam.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended July 19th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,078.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LIMITED).—The Directors of this Company have declared an interim dividend for the half-year ended June 30th at the rate of 5 per cent. The dividend is payable on September 1st next.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, July 17.		Price Wednesday, July 24.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending July 24. Highest	Lowest
			TELEGRAPHS					£ s. d.			
£1,012,880	Stock	10/0	Anglo-American	47	49	47	49	4 1 8	Jan., Apr., July, Oct.	47	..
£2,993,560	Stock	20/0	Do. Preferred	88½	89½	88½	89½	4 9 8	" "	89½	88¾
£2,993,560	Stock	5/0	Do. Deferred	8¼	8¾	8¼	8¾	..	" "	8¾	8½
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 16 4	January and July	104½	..
130,000	£10	3/0	Brazilian Submarine	13½	14	13½	14	4 12 10	Mar., June, Oct., Dec.	14	13¾
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 7 2	June and December	..	..
10,000,000	$100	1¾%	Commercial Cable Capital Stock	160	165	160	165	4 4 10	Jan., Apr., July, Oct.	161	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	—	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	3½	4½	3½	4½	4 8 11	April and October	..	—
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10¼	9¾	10¼	4 7 7	" "	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	" "	104½	—
60,710	20	2/0	Direct United States Cable, 1877	9¼	9¾	9¼	9¾	4 0 5	Jan., Apr., July, Oct.	..	..
400,000	10	2/6	Eastern	16¾	17	16¾	17¼	3 15 8	" "	17⅛	16 15/16
70,000	10	6%	Do. 6 per Cent. Preference	17½	18	17¾	18¼	3 5 9	" "	18	17¾
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	125	128	126	129	3 2 0	May and November	127	126½
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	107	110	107	110	4 13 0	February & August	..	..
250,000	10	2/6	Eastern Extension	17¼	17½	17¼	17½	4 0 0	Jan., Apr., July, Oct.	17½	17¼
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	126	129	127	130	3 1 7	February & August	128½	128
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	102	106	102	106	4 14 7	January and July	103	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	102	106	102	106	4 14 7	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	107	110	107	110	3 11 1	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	112%	115%	3 10 2	May and November	111½	..
180,227	10	2/3	Globe Telegraph and Trust	10⅛	10⅜	10⅛	10⅜	4 7 0	Jan., Apr., July, Oct.	10⅜	10⅛
180,042	10	6%	Do. 6 per Cent. Preference	17	17½	17	17½	3 9 7	" "	17 3/16	17
150,000	10	5/0	Great Northern	21¾	22¼	21¾	22¼	3 16 3	Jan., April, and July	21¾	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	..	..
17,000	25	37/6	Indo-European	49	52	49	52	4 16 2	May and November	51½	50
37,548	10	2/6	London Platino-Brazilian	5	7	5	7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	107	111	107	111	5 10 7	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	107	110	107	110	3 12 11	—	—	..
11,839	8	4/0	Reuter's	3½	4½	3½	4½	..	April and October	..	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	123	128	124	129	4 13 0	" "	127½	125
15,609	10	5/0	West African Telegraph	5½	6½	5½	6½	..	January and July	..	—
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	104	107	104	107	4 13 6	March & September	..	—
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	104	99	104	7 13 10	June and December	..	..
88,321	10	6d.	West India and Panama	¾	1	¾	1	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10	10½	5 14 3	May and November	..	10½
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	6 13 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110	113	110	113	4 8 8	June and December	[illegible]	..
64,242	15	6/0	Western and Brazilian	10¾	11¼	10½	11	4 1 11	May and November	6¾	..
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	—	..	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4½	5	4¼	4¾	..	—	..	..
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	104	108	104	108	5 14 3	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	104	108	104	108	5 14 3	" "	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	6 0 5	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 18 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	—	..	—	..
224,850	10/0	1½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	—	May and November	..	—
171,504	£1	8·215d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	..	..
484,597	5	2/6	National	5¾	6	5⅞	6⅛	4 1 8	June and December	6⅛	5⅞
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	16	17	16	17	3 10 7	" "	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	" "	15⅞	15½
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅞	6⅜	5⅞	6⅜	4 1 8	—	6 1/16	..
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	105	107	105	107	3 5 7	January and July	106	105
58,000	5	3/0	United River Plate	2½	3	2½	3	..	" "	—	..
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	92	97	92	97	5 3 1	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	14½	15½	14	15	1 13 4	—	14½	14½
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	16	17	16	17	3 10 7	—	16⅝	16½
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	131	134	131	134	3 12 9	June and December	133	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	—	5⅝	5 9/16
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	..
8,322	£5	..	House-to-House Electric	—		—		..	—	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	—		—		..	—	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	—	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7⅝	7¾	7⅝	7¾	..	—	..	..
111,000	5	..	London Electric Supply	..		..		..	—	..	—
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	10½	11	10½	11	2 14 7	..	11	10¾
£150,000	Stock	4½%	* Do. 4½% Debs.	116	119	116	119	3 15 9	June and December	..	..
6,452	£10	2/0	Notting Hill Electric	8¼	8¾	8¼	8¾	..	—	..	—
19,980	£5	4/6	St. James and Pall Mall	8	8½	8	8½	..	—	8 5/16	..
20,000	£5	7%	Do. 7 per Cent. Preference	9	9½	9	9½	3 13 8	—	9½	..
59,900	5	3%	Westminster Electric Supply (fully paid)	7¾	8	7¾	8¼	3 0 7	—	7 15/16	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2¼	2½	2⅛	2⅜	6 6 2	—	2⅜	2 3/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	—	2¼	2⅛
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	112	115	112	115	3 19 8	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2	2½	2	2½	..	January and July	..	—
12,139	5	..	Edison and Swan United	1¾	2¼	2	2½	..	..	2¼	2 1/16
£100,000	Stock	4½%	Do. 4% Mortgage Debenture Stock	104	107	104	107	4 4 1	..	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		..		..	..	—	..
120,000	2	..	Electric Construction	⅝	⅞	¾	1	..	..	15/16	⅞
12,845	2	2/9½	Do. 7 per Cent. Cumulative Pref.	2	2½	2	2½	..	..	—	..
91,195	2	10/0	Elmore's Patent Copper Depositing	⅞	1⅛	⅞	1⅛	..	..	15/16	..
20,000	5	..	Fowler-Waring Cables (fully paid)	¼	¾	¼	¾	..	..	..	..
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	19	21	19	21	4 15 3	February & August	20	19½
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 7 10	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..	—	..	..
16,000	£10	..	Do. 8 per Cent. Preference	—		..		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)		⅛		⅛	..	..	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	43	45	43	45	5 6 8	March and July	44½	43½
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	4 13 6	January and July	..	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,870	10	12/0	W. T. Henley's Telegraph Works Ordinary	10½	11½	10½	11½	5 4 4	..	..	..
£30,000	10	7%	Do. 7 per Cent. Preference	14	15	14	15	4 13 4	..	14⅞	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock	104	107	104	107	1 4 1	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1½%	City and South London Railway	42	44	41	44	2 16 10	May and November	42	—
7,000	10	5%	Do. 5% Perpetual Preference	14	15	14½	15½	3 4 6	..	15½	—
£67,130	Stock	4%	Do. 4% Perpetual Debenture	133	135	133	135	2 19 3	May and November	134½	..
37,500	£10	2%	Liverpool Overhead Railway	10 7/16	10 9/16	10⅜	10¾	1 17 3	—	..	..
6,295	10	5%	Do. 5% Preference	14¾	15¼	14¾	15¼	3 5 7	..	..	—
125,000	Stock	4%	Do. 4% Debenture	110	112	110	112	3 11 5	January and July	—	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 898. [No. 14. Vol. XXXV.] FRIDAY, AUGUST 2, 1895. PRICE SIXPENCE.

NOTES.

Amidst the serried columns devoted in this issue to reports of speeches made by the Chairmen of various companies to their respective shareholders, none will be found more worthy of perusal than the four columns occupied by the remarks of Mr. James Staats Forbes at the meeting of the shareholders of the National Telephone Company on Friday last. The commander-in-chief of our only telephone company takes the perennial grumbling of the British public, the surrender of the trunk-wires to the Post Office, and the Telephone Committee in very good part; and well he may, for notwithstanding them all the telephone business has increased, is increasing, and does not seem likely to diminish. The growth of telephony in the United Kingdom cannot be better shown than by the statement that within the last six months nearly £150,000 has been spent on exchange extensions, and over 4,000 new lines have been erected. Londoners especially will be glad to hear that the annoyances inevitable to a change over from single-wire to double-wire circuits are nearing their end; by the close of the year the whole of London will be metallic-circuited.

From the strategic point of view there can be no denying that the National Telephone Company suffered a severe loss in being obliged to hand over its trunk system to the Post Office, though we suspect that these interurban wires, however profitable indirectly as a means of attracting subscribers, and knocking the bottom out of competitive schemes, were not in themselves particularly remunerative. This suspicion is strengthened by the cheery philosophy with which the President of the Company treats the loss of this branch of the business. At the same time we cannot help thinking that the astute controller of the fortunes of the National Telephone Company would have done well to have dissembled his joy a little more. The terms of the Agreement will, Mr. Forbes thinks, "prove to be extremely good terms, . . . because the Post Office are enabled to take risks in respect of the extension of this system which we should not have been inclined to take, but of which we shall have the benefit, while we shall be left free to develop what is our more special business—the conduct of this exchange work in the great areas. There is a great deal less risk in this work than in the expenditure necessary on great trunk lines. That is what the Government have to do . . .," and Mr. Forbes, not unnaturally, thinks it is "very wise" of the Government to undertake that part of the work. No doubt. This candid way of putting the matter does not tend to make us lament our persistent advocacy of Government purchase of the entire business when that course first became possible in December, 1890. Neither does it tend to lessen our regret that the case for municipal telephony was so inadequately placed before the Telephone Committee, the major portion of the anti-National Telephone Company evidence being, as Mr. Forbes contemptuously expresses it, given "in a considerably florid way."

The tale told by Mr. Mott to the shareholders of the City and South London Railway Company was of the customary character—reduced expenses, increased receipts, increased dividend; but all of microscopic proportions. The locomotive expenses per train mile are now 6·1d. as against 6·22d.; the receipts per train mile have grown from 2s. 1$\frac{1}{2}$d. to 2s. 2$\frac{2}{5}$d. Although the continued decrease in working expenses and the continued increase of income is a healthy sign, the rate at which the improvement takes place is so small that a 5 per cent. dividend would seem to be beyond the reach of any of the shareholders now living. It is therefore satisfactory, both on account of the shareholders and of the future of electric railways in this country—a future intimately connected with the degree of financial success attained by the pioneer enterprise—to learn that the northern extension of this line is under weigh, although at the present moment Finsbury Circus, and not the "Angel," Islington, will be the terminus. One result of this extension will be the running of heavier trains, and no further progress with motor-car trains has therefore been made, since motors which would suffice for the existing trains would probably not be equal to drawing the new ones. The lighting of the carriages is also to be improved—there is plenty of room for it. The fact that the increase of passenger traffic observable at the beginning of the year was immediately checked, and ultimately converted into a decrease by the advent of what the Americans call a hot-wave, seems to point also to the desirability of some improvement in the ventilating arrangements. A tunnel railway 50ft. to 80ft. below the surface has a natural tendency to be cool in summer and warm in winter. The problem of how to make the atmosphere in the tunnels and stations sweet and fresh should not, in view of the absence of smoke, steam, and fumes, be beyond solution.

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The nervous and anxious state which for some time past has been apparent among the leaders of magnetic science may be taken as an indication that they perceive both the need for setting their house in order and the difficulty of the task. When physical science, by the unanimity of its disciples, has already pinned itself to the C.G.S. system, it would seem that there should be no uncertainty in the course to be taken in formulating the mathematics of magnetic science, were it not, on the one hand, that magnetism has its supremely important commercial applications, in which the scientific beauties of the offspring of that triangular parentage, C., G. and S., are of microscopic importance compared to the practical considerations of the draughting and workshop departments; and, on the other hand, that magnetic science has suffered from the mistakes of its partisans. In this last-named matter, troubles have arisen chiefly on account of misconceptions of and confusions between **B** and **H**; and there seemed to be some possibility of an unscientific system of magnetic units being foisted upon the electrical profession by those who had not sufficiently discriminated between these two things. But the matter of the settlement between commercial and scientific interests is more far-reaching, and less likely to be disposed of easily. There are three chief stumbling-blocks in the way of reconciliation: the ampere-turn, the terrible π and the British system of weights and measures. To the last of these no quarter need be given; many engineering firms have already replaced it, and it may be anticipated that in due time the replacement will become universal. As to π—that mathematical bogey—students of magnetic science must extract what consolation they can from the certainty that it will turn up either on its head or its heels, either in the numerator or the denominator; and the units of magnetic quantities may be arranged so that it will turn up with the minimum of inconvenience.

But the ampere-turn is the crux of the difficulty. Practical men have grown to regard this quantity as a very real and fundamental unit; while scientists must look upon it as a complex thing, only to be connected to their rational systems by a linkage of coefficients and equations. Yet we doubt if the practical man will ever surrender his ampere-turn; and the best that can be done is to adopt a system of units which will make those coefficients and equations least troublesome. Some suggestions towards a reconciliation, and the construction of a rational magnetic system, have been carefully compiled by Prof. Oliver Lodge, at the request of the Electrical Standards Committee of the British Association; and these we are able to publish this week. Prof. Lodge has proposed two alternative systems, and invites comment and criticism. Speaking briefly, and for ourselves, we should wish, with Mr. Baily, to see the unit of magneto-motive force made equal to one ampere-turn, even though at the cost of saddling μ with π. This would be of immense value to practical men; and it should seem of but trifling importance to theorists. In regard to the size of the units, the only practicable settlement will be to introduce a number of multiple and sub-multiple units for practical use.

The *Journal of Gas Lighting*, in a recent issue, expresses its conviction that "there seems to be a deplorable waste of power in electrical tramway systems, which requires stopping before this means of working can claim to be economical." The particular example of electrical tramway traction which has given rise to this sweeping statement is that which, after one year's working by the contractors, is now passing into the hands of the Municipality of Brussels. And the "deplorable waste" which our contemporary alludes to is thought by it to arise from the fact that a car which "a pair of Flemish horses could easily run away with" requires much more than two horse-power of engine plant to be allotted to it. Our contemporary has fallen into the common error, at one time more common than it is now, of supposing that in an economical system of electrical traction the amount of horse-power of engine plant ought to be comparable with the number of horses which would be required to keep the cars moving. There is, in reality, no sort of connection between the two things, as our gas friends would pretty soon discover if they tried to run the cars with gas engines. "What an enormous surplusage of electrical power, as compared with horseflesh, marks this installation!" cries our contemporary. Quite so. But it by no means follows that that surplusage is always in actual use, and it is quite erroneous to suppose there "must be something very crude about a system which needs 900 indicated horse-power to keep 22 tramcars moving." This power is not required to keep them *moving*; it is mostly a reserve to start them. Besides, while the "pair of Flemish horses" are running away with the car, there is, it must not be forgotten, a "surplusage" of several horses eating their heads off in the stables.

Cable Interruptions.—There are again no cable interruptions to report this week. The last interruption recorded occurred on June 13th last.

Regent Street Polytechnic.—Courses in Electrical, Marine, Civil and Mechanical Engineering at the Polytechnic School of Engineering, Regent-street, commenced July 17th.

Terrestrial Magnetism.—The Meteorological Institute of Utrecht has sent two of its members to the St. Gotthard to study the influence of height above the sea level on the terrestrial magnetism.

Electric Traction in Germany.—Plans, it is stated, have been prepared by the Union Electricitäts Gesellschaft for the conversion of the Hamburg-Harburg section of the Prussian State railways into an electric line.

Telephonic Communication between Germany and Belgium.—Arrangements for the establishment of telephonic communication between Brussels and Antwerp on the one side and Cologne and Aix-la-Chapelle on the other are now said to be practically completed.

Electric Traction in Austria and Hungary.—It is proposed to convert the Schwabenberg Mountain Rack Railway into an electric line, and to extend it from Budakesz as far as Anwinkel. Plans have been prepared for an electric local railway between Budapest, Foch, Wartzer and Hartyan.

Intrinsic Brilliancies of the Welsbach Mantle and Glow Lamp Filament.—According to Von Oechelhäuser, says the *Gas World*, a Welsbach lamp gives one candle for every 33 sq. mm. of its area. According to Bernstein, an electric glow-lamp filament gives off the same for each 4 sq. mm.

Electrical Utilisation of Water Power in Italy.—Messrs. Schuckert and Co., of Nuremburg, have submitted plans for the establishment of a central station, having a capacity of 1,500 H.P., in the important town of Bergamo, about 30 miles from Milan. The water power of the River Brembo would be utilised.

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Oil Fuel.—According to an article in *Electrical Engineering*, by Mr. C. O. Billow, who was in charge of the fuel oil department at the Chicago Exposition, the average evaporation of the boiler plant was 98·99lb. of water per gallon of oil, the evaporation being from a hot water temperature of 212deg. to steam at 125lb. pressure.

A New Chair of Physics.—The trustees of the late Miss Margaret Harris have allocated a number of securities, valued at nearly £14,000, to establish a chair of Physics at University College, Dundee. The Council have resolved to immediately institute a chair of Natural Philosophy, and an appointment will be made before the beginning of next session.

A Student-built Engine.—It is reported, says the *Engineer*, that Messrs. Hall and Treat, two students of Cornell University, have built a quadruple-expansion engine, constructed for regular working at 500lb., but which has been worked up to 600lb. per square inch. The reported consumption is something under 10lb. of steam per horse-power per hour.

Evaporative Power of Refuse in Destructors.—Messrs. T. S. M'Callum and W. Naylor have recently published particulars of a trial of the evaporative power of town refuse at the Royton sewage works. The amount of ash and clinker formed during the trial was 46 per cent. of the weight of the refuse consumed, while the evaporation was only 0·40lb. of water per pound of refuse.

Public Telephone Stations for Berlin.—According to the *Berliner Tageblatt*, the Berlin Town Council has received an application for a concession to erect public telephone stations in different parts of the town. These stations are to take the form of small pavilions, containing several compartments fitted with telephones, and to be at the disposal of the public for a small fee.

Effect of Slow-Speed Street Cars in Brooklyn.—One effect, says the *Street Railway Journal*, of the reduced speed on the Brooklyn trolley roads has been an increase of traffic on the elevated roads of that city, and as a result, the wages of the employés of the Brooklyn elevated system (with the exception of the engineers and office clerks), which were reduced 10 per cent. in October, 1893, on account of the competition of the trolley roads, were restored to the old rates on June 1st.

Gas Engine Central Station in Chicago.—According to the *Western Electrician* of Chicago, the central station of the American Gas Engine Electric Company at Clark and Lake streets, Chicago, is nearing completion. This station contains gas engines of 400 I.H.P., directly belted to dynamos. The largest unit will be a 200 H.P. tandem engine, similar to those in the station at Belfast, which were described and illustrated in *The Electrician* of July 26th.

Curious Behaviour of an Electric Meter.—A curious phenomenon has, according to an American contemporary, lately been noticed in an alternating-current meter of well-known make. It was noticed that when the lamp load was off, the meter ran backward at a very slow rate, deducting about 200 watt-hours during a night's run. Complaint was made to the manufacturers, who stated that they had discovered this defect, and "that it was due to the case."

Appointment.—Since the death of Mr. F. N. Gisborne in August, 1892, the office of General Superintendent of the Canadian Government Telegraph Service, has remained nominally vacant, although Mr. D. H. Keeley has performed the duties of the office. By order of the Minister of Public Works the office has now been definitely filled by the appointment of Mr. Keeley, who thus becomes head of a department in which he has worked under his old chief for a very lengthened period.

Destruction of a Power House at Seattle, U.S.A.—By a fire which broke out on June 20th a considerable proportion of the buildings, machinery and rolling stock of the Consolidated Street Railway Company, at Seattle, U.S.A., were destroyed. The loss, which is estimated at between £15,000 and £20,000, comprises the whole of the rolling stock and supplies, and from 15 to 20 per cent. of the generating machinery, besides a substantial brick structure 250ft. in length and 60ft. wide. The origin of the fire is still undetermined.

Electricity for Californian Mines.—One of the most interesting features of the Grass Valley (California) electric transmission plant, says the *Engineering and Mining Journal* of New York, is the means thus furnished for operating a large number of mines which have been shut down for some time owing to excessive cost of power. Within a distance of from three to nine miles of the power plant are located 63 mining plants, requiring over 4,000 H.P. More than one-quarter of these are idle at the present time and will be largely benefited by this new enterprise.

German Wiring Rules.—At the recent annual meeting of the Verband Deutscher Electrotechniker, at Munich, the proposed wiring rules, of which we published an abstract in *The Electrician* of May 24th, p. 116, were referred to a special committee, consisting of representatives of the Reichanstalt, the Imperial Telegraph Department, the Vienna Association of Electrical Engineers, the Association of German Supply Stations, and several of the more important electrotechnical societies and fire offices. At the same meeting, the proposal for the introduction of uniformity in the matter of contact areas of fuses, and the screws for same, was accepted.

An Acetylene Standard of Light.—M. Violle has recently been engaged in a series of researches on acetylene which have led to the construction of a standard of light. He burns acetylene under a somewhat strong pressure in a burner to which air has easy access, and which gives a broad flame. M. Violle has, in this way, obtained a very steady brilliant white light. Before the flame he places a screen pierced with an opening of a given size, and in this way he considers that he has obtained a standard of light which for constancy, whiteness and brilliancy is comparable to his absolute platinum standard, and which ought, he thinks, make a safe and convenient secondary standard.

City and Guilds of London Institute.—The diploma of "Associate of the City and Guilds of London Institute" has been conferred by the Council of the Institute upon the following matriculated students who have this year successfully completed the full course of instruction at the Central Technical College:—Civil and Mechanical Engineering: H. S. Andrewes, F. G. Arnould, J. E. Chapman, H. E. Fenwick, C. S. Hainworth, E. W. Hainworth, B. H. M. Hewett, E. W. Hummel, F. T. W. Lewis, F. E. Morgan, R. E. Reeves, H. Robinson. Applied Physics and Electrical Engineering: J. M. Barr, S. Beeton, C. Brandeis, W. M. Carver, A. D. Constable, S. Gilford, F. S. Grogan, A. C. Hanson, G. S. Hewett, C. D. Le Maistre, P. G. Phelps, W. Reilly, W. Roberts, H. G. Solomon, R. J. J. Swann, C. P. Taylor, E. L. Thorp, E. L. Webb, N. J. Wilson. Applied Chemistry: W. G. Bennett, W. A. Davis, W. T. Gidden, C. Revis, E. M. Rich, P. Spencer.

Damage by Lightning.—During a thunderstorm on Friday last at Loftus, Cleveland, eight sheep were killed by lightning.—At Coble Dene, on Saturday last, a house was struck by lightning, the chimney being destroyed, part of the roof ripped up, and much damage done to the interior.—Violent storms occurred last week in many places in France. At Tours the lightning struck a house adjoining the post and telegraph office, and several of the telegraph and telephone wires were melted. The tower of the Convent of Breteche was struck by lightning. At the same moment, says the correspondent of the *Standard*, "an intensely strong spray of electric light" traversed the workshop of M. Bouyer, situated just opposite the convent, but on the other side of the Loire. Three women lost consciousness, and one of them remained in that condition two hours, while the two others were for some time paralysed in the right leg and side. The neighbourhood of Orleans suffered greatly from violent storms. The church tower of Saint Jean de Brayn was struck by lightning on Friday last, and a man was killed at Clery.

Electric Supply Meter Competition.—At a recent meeting of the Edinburgh Society of Arts the Society approved of a proposal by the Council to offer for competition a Keith prize of £50 for improvements in electric energy meters for domestic supply. Competitors will be expected to submit, in addition to a descriptive Paper, accompanied by detailed drawings, a

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working meter adjusted for a mean pressure of 115 volts, and suitable for a house in which the minimum number of watts being taken at any time is 4,000. Special importance will be attached to the minimum load at which the meter can register correctly, and to the energy absorbed by the meter when the consumer is using a light load, or when no energy is being taken. Conditions of the competition were discussed and adjusted, and it was agreed that the award should be made during the session of 1896, the Society reserving right to withhold the prize in the event of there being nothing deserving the award. Alternatively, the Society may award a smaller amount should anything meritorious, but not deserving the full prize, be sent in.

The Overhead Conductor of the Baltimore Belt Line Tunnel.—The conductor of this line, which came into operation a short time ago, is simply a reversed iron conduit or trough erected overhead on trusses in the open and in the tunnel attached to the crown of the arch. In the open the conductor is directly over the centre of the track; in the tunnel over the centre line of the space between the tracks. The conductor consists of two 3-inch iron Z bars three-eighths of an inch thick, riveted to a cover plate, and is constructed in sections 30ft. long. It weighs about 30 pounds per foot. The height of the conductors above the level of the top of the rails is 17ft. 6in. in the tunnel. Outside the tunnel the height of the conductors above the rails is increased to 22ft. The supporting structure in the open consists of longitudinal catenaries of two chains of iron rods, having a span of 150ft., suspended from transverse trusses, supported by columns of latticed steel channels erected on either side of the double track. From the joints in the catenaries vertical rods are dropped at intervals of 15ft. to support the electrical conductors. Upon the straight track the conductors are suspended from single catenaries, while upon the curves a double catenary is employed.

Electric Lighting Provisional Orders.—In the Report, dated June 25th, made to Parliament by the Board of Trade respecting applications for and grants of Electric Lighting Provisional Orders since last summer, it is stated that in all 29 applications came before the Board of Trade, 14 being from Local Authorities and 15 from companies; 23 of these have been granted as follows:—Alderley Edge (L. A.), Bootle (L. A.), Carlisle (L. A), Leigh (L. A.), Liverpool (Co.), Llandudno (L. A.), Luton (L. A.). LONDON: Notting Hill (Co.), St. Olave (Co.), Strand (Co.), Motherwell (L. A.), Pontypool (Co.), Prescot (Co.), Radcliffe (L. A.), Salisbury (Co.), Southampton (Co.), Stirling (L. A.), Swindon (L. A.), Walthamstow (L. A.), Winchester (L. A.), Windermere (Co.), Windsor (L. A.), Worthing (L. A.). The total number of Provisional Orders in existence in the United Kingdom now amounts to 210, of which no less than 142, or 67 per cent., are held by Local Authorities. The total number of electric light undertakings actually at work or in progress amounts to 112. It must be remembered in this connection that one single undertaking has in some instances more than one Order. The Metropolitan Electric Supply Company, for instance, possesses three, covering Mid-London, West London and Paddington respectively. There are only seven Orders dating from 1883 still operative, and these relate to Bradford, Brighton, Bristol, Nelson, Richmond, St. Pancras, and Greenock, all of which, with the exception of the last, have been made use of. None of the 23 Orders granted this year have as yet received Royal Assent.

Telegraphic Communication with Fastnet Lighthouse.—The Fastnet Lighthouse has been placed in electric communication with the mainland. Some 10 years ago an attempt was made to place the Fastnet in electrical communication with the shore, but the cable would not stand the wash against the rocks. Taught by experience, the Royal Commission appointed to inquire into the matter of telegraphic communication between our outlying lighthouses and the shore decided to try the discontinuous cable method introduced by the late Mr. Willoughby Smith, and modified by his son, Mr. Willoughby S. Smith, and Mr. W. P. Granville. The laying of the cable was undertaken by the Post Office authorities, and the Telegraph Construction and Maintenance Company undertook the electrical arrangements. H.M. telegraph steamer "Monarch" arrived at Crookhaven on the 16th inst. On the 18th Mr. Lumsden, chief of the cable-laying department of the Post Office, made an early start, and before the day was out the cable was laid. Immediately all was completed Mr. W. Granville landed on the rock, and made the necessary electrical arrangements. The conductor of the cable ends in a heavy copper "mushroom" 30 or 40 fathoms from the rock, and a bare copper wire attached to an earth plate dips into the sea on one side of the rock, while the lightning protector makes earth on the other. Telegraph communication was soon opened up, many messages being sent to and fro between the Fastnet and the mainland. The apparatus on the rock is only temporary, and it will be two or three weeks before the permanent work there is completed.

The Incandescent Gas Burner and Street Vibration.—Referring to the use of the Welsbach light for street purposes, the *Gas World* remarks in a recent issue that "The general opinion among Continental engineers appears to be that while the gas consumption is lessened the cost of renewing mantles more than counterbalances the saving in gas: they admit the better light but recognise no monetary advantage. This may be quite true; and if it is, then what has to be done to make the Welsbach an economical street illuminator is to insure a longer life for the mantles. This might be done in two ways—either by making the mantle less fragile than it is at present, or by introducing some contrivance that would protect it from the vibration inseparable from our public streets; or it may be that the end may be attained partly in the one way and partly in the other. A few weeks ago we briefly described a contrivance introduced by the Incandescent Gas Light Company with the object of protecting the mantle from vibration, the device consisting of carrying the mantle gallery upon three springs. That device, as we then showed, had given very promising results, reducing the mantle breakages by 90 per cent. But even after that great reduction the breakages in the particular case referred to were very heavy, amounting, as our correspondent, 'A Northern Subscriber,' pointed out last week, to almost 29 mantles per annum. To renew a mantle 29 times in the course of a year would, it need hardly be said, be a very heavy burden upon the system. This week we have seen another vibration-absorbing device which promises to give still better results."

Niagara.—"While the Niagara power plant has not yet entered into commercial operation, the tests thus far made have," says the *Electrical World*, "demonstrated its entire success, and the engineers who have had part in this magnificent achievement may well be gratified at the result. . . . One of the most interesting sights to visitors at Niagara who descended into the pit was that of the 38in. vertical shaft tube, with its short 11in. solid sections at bearings, the whole having little indeed in common with the usual idea of shafting. While much admired by the electrical engineers inspecting it, the paradox of this mechanical transmission forming part of an electrical transmission plant was frequently referred to, and we are inclined to believe that few were satisfied with the reasons offered as to why the generators were located at the top of the pit instead of at the bottom. That the shafting is an element of weakness would be true if merely the questions of bearings and complication entailed were considered, but, in addition, there must be added the influence of the vibrations due to the water impact on the turbine blades. Here marine practice, with its almost uniform torque, does not apply, and the deafening sound in the pit due to the effect referred to left a disturbing thought in the minds of many. It was naturally in the generator that most interest was shown, and there was a noticeable indication of the professional pride felt by the visiting electrical engineers when they viewed this finest example yet furnished of the capabilities of their art. For their benefit loads were varied and thrown on and off, and once during the meeting a load of 5,300 H.P. was carried, the machine always running without a tremor, and with an appearance of ease, and even grace, that speaks highly for the design of its mechanical features."

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NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(Continued from page 395.)

49. Clark's Fall of Potential Test.—This test for the localisation of faults making partial earth has long been known, but hitherto has not been much relied upon owing to the impracticability of measuring potentials accurately on board ship by the usual methods.

There are three measurements of potential to be made, two at one end and one at the other. As the usual methods involved reading deflections or throws, it was customary to make the single measurement on board and the other two on shore, where they could be made with greater convenience and exactness. Now, however, null methods have been devised for all three measurements, and they can be made as easily on shipboard as on shore, and very accurately. Consequently the test can be reversed, either end freeing in turn and taking the single potential while the other takes the two potentials. This test is therefore brought in line with those most useful in localising partial earth faults, and it will probably be found of special use in difficult high-resistance faults.

The theory and connections of the Clark test may be briefly stated as follows. A battery and known resistance R (Fig. 150) are connected to the end A of a cable the other end B of which is freed. The potential at P falls proportionately to p at the junction of the resistance and cable and to p_1 at the fault C. The fall from this point to zero potential takes place over the

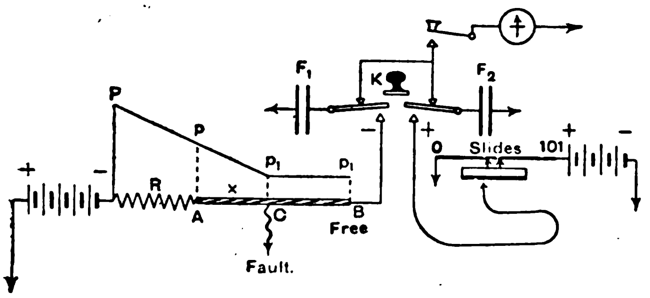

Fig. 150.

resistance of the fault itself and the return circuit, but there is no fall over the remaining part C B of the cable, because the end at B is free. The potentials P and p are measured at one end and p_1 at the other. We then have, by Ohm's law,

$$\frac{x}{R} = \frac{p - p_1}{P - p},$$

whence the resistance (x) from A to C is equal to

$$R\,\frac{p - p_1}{P - p} \text{ ohms.}$$

Mr. J. Rymer-Jones has devised a convenient method for the single potential reading (p_1) on board ship (described in the *Electrical Review* of September 7th, 1894). This is an ingenious adaptation of the mixed-charge test, and admits of great accuracy. Two standard condensers are connected as shown in Fig. 150 to the mixing key (either Lambert's or Silvertown pattern, described above), the lower contacts of which are in connection with the free end of the cable and the travelling contact of the slides respectively.

At the shore end the testing battery is connected up (zinc to line) through the resistance R for a pre-arranged number of minutes. This makes the potential p_1 negative. The battery on the slides is connected copper to slides and zinc to earth, thus giving a positive potential to the travelling contact. The charges given simultaneously to condensers F_1 and F_2 (on pressing down K and closing the charging keys) are, therefore, of opposite sign. If, now, the condensers are of equal capacity, and there is no deflection on the galvanometer after K has been raised and the charges mixed, it follows that they have both been charged to the same potential, or in other words that the potential on the slides at the travelling contact is equal to the potential at the end of the cable. Should the capacities F_1 and F_2 of the condensers not be exactly equal, the slide reading (after balance is obtained on the galvanometer) must be multiplied by the ratio

$$\frac{F_2}{F_1}.$$

We have, therefore, the potential p_1 expressed as a slide reading. The potential measurements at both ends must be reduced to the same units, and the simplest way to do this is to express them in volts. For this purpose, so far as the slide reading taken on the ship is concerned, it is only necessary to calibrate the slides with a standard cell in the manner described in the last paragraph. For example, say the slide reading is 950 divisions with a standard cell of 1·45 volts, and the reading obtained with potential p_1 is 3,603. The potential p_1 is then

$$\frac{1{\cdot}45}{950} \times 3{,}603 = 5{\cdot}5 \text{ volts.}$$

As regards the shore measurements, if these are taken by the method of charging a condenser and observing the discharge throws on the galvanometer, the actual value in volts can be determined directly by comparison with the throw produced by a standard cell with the same condenser and galvanometer. The E.M.F. of the standard cells used must be corrected for temperature, but no correction is required for

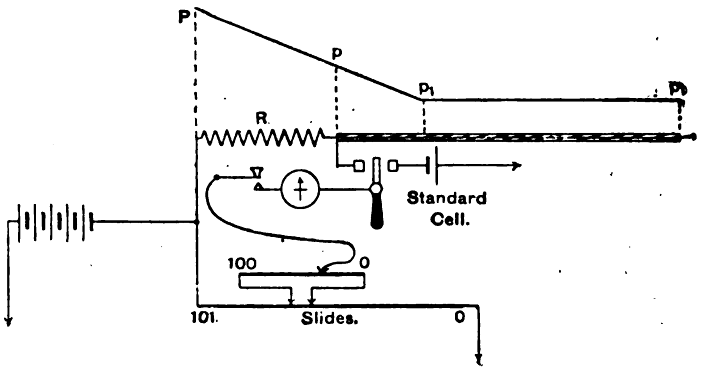

Fig. 151.

any difference in the E.M.F. of the standard cells used on the ship and on shore, as the measurements at both ends are absolute, and therefore entirely independent.

In the ordinary course the shore informs the ship of the added resistance in ohms and the two potentials in volts, and the ship works out the distance of the fault from the shore by the formula given above. When condenser throws are taken on shore it is advisable to make the added resistance about the same as the resistance x of cable up to fault plus the resistance of the fault. This makes sufficient difference in the two throws to minimise any error in reading a few divisions out. The approximate values of x and the fault will in all probability be known from shore tests taken before ship cuts in, but in any case the first rough test will show if R is too large or too little for getting convenient throws.

In place of the condenser throw method for measuring the two potentials on shore the author has devised a simple null method with the slides, by which there are only two balances to zero to be obtained in place of three condenser discharges. The slides are connected as shown in Fig. 151, and are balanced to zero by the potential p. By means of the two-way switch shown the standard cell is then put in circuit with the galvanometer, and a balance obtained by means of which the slides are calibrated. For example, say the slide reading is 816 with a standard cell of 1·42 volts, and 7,180 divisions with the potential p. This potential is then equivalent to

$$\frac{1{\cdot}42}{816} \times 7{,}180 = 12{\cdot}5 \text{ volts.}$$

The potential P is proportional to the total number of divisions to the slides, and therefore no observation of this is necessary. The number of volts per division, multiplied by

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the total number of divisions, gives at once this potential in volts as follows :—

$$\frac{1 \cdot 42}{816} \times 10{,}000 = 17 \cdot 4 \text{ volts.}$$

The measurements taken are now

By ship $p_1 = 5 \cdot 5$ volts.
By shore $P = 17 \cdot 4$ „
and $p = 12 \cdot 5$ „

$$p - p_1 = 7$$
$$P - p = 4 \cdot 9$$
$$R = 350$$

Distance of fault $= 350 \times \frac{7}{4 \cdot 9} = 500$ ohms.

Standard cells of different E.M.F. have been taken as instances in the above example to show that no correction has to be applied in consequence of ship using a standard cell of different E.M.F. to that used by shore.

We have, therefore, *null* methods throughout for this test. The single potential measured on board is a balance to zero on the slides according to the adaptation of the mixed-charge method by Mr. Rymer-Jones as above referred to, and the two potentials measured on shore are also taken by balances to zero on the slides. These facilities make the test a very convenient and easy one to make, and for this reason capable of considerable accuracy.

Again, the readings being all by balances to zero, the test can be easily reversed—that is, the ship can add the resistance to the cable and measure the two potentials in the manner just described, the shore measuring the single potential at the other end. Again, the shore potential can be measured by the mixed-charge method given above; but, as the conditions on shore are favourable for getting a good condenser discharge throw, it would probably be found more convenient to measure the potential in that way by comparison with a standard cell.

It will be seen that the slides are connected up exactly as in a bridge test, and when the balance is obtained with the potential p the ratio

$$\frac{R s}{10{,}000 - s}$$

gives the resistance of cable up to fault plus the fault, s being slide reading at balance. It is useful to bear this in mind, as the resistance of the fault (always a desirable item to be placed on record, although not necessary in this test for localising its position) can be afterwards obtained by deducting its distance in ohms, as obtained by the potential method, from the above result calculated from the slide reading, considered as a bridge balance.

In this case the resistance of cable up to fault plus fault is

$$\frac{350 \times 7{,}180}{10{,}000 - 7{,}180} = 891 \text{ ohms.}$$

Deducting the cable resistance to fault above determined, viz., 500 ohms, we have 391 ohms as the resistance of the fault The same result is also obtained from the potential readings By Ohm's law the potential p_1 in volts divided by the current in amperes gives the resistance of the fault. The current is

$$\frac{P - p}{R} \text{ amperes,}$$

therefore the resistance of fault is equal to

$$R \frac{p_1}{P - p} \text{ ohms,}$$

that is, $350 \times \frac{5 \cdot 5}{17 \cdot 4 - 12 \cdot 5} = 392$ ohms.

In the fall of potential test described the resistance of the fault is neatly eliminated, but the potentials observed will be affected by the variation in resistance of the fault. For this reason it is better for shore to put zinc to line as stated above, so as to lessen the probability of the fault sealing up. If the fault resistance increases the potentials will all increase, and *vice versâ*, the variation being shown most on the smaller potentials p_1 and p, but very little on the larger one P. It is advisable therefore that the slide reading on board (p_1) and the throw (or balance) equivalent to p (taken on shore) should be repeated until the results are steady and reliable.

(To be continued.)

HIGH-SPEED CABLE SIGNALLING.

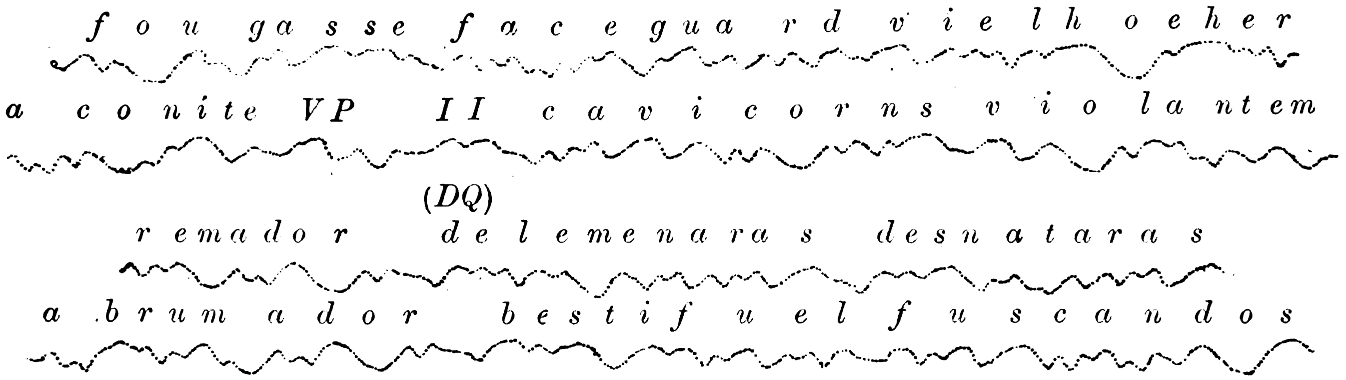
BY PATRICK B. DELANY.

In a Note on Cable Signalling which appeared in *The Electrician* of November 30, 1894, I gave the speed attained with regular traffic by my system of automatic transmission over the Anglo-American cables. These figures were not correct, as they were based upon an erroneous computation of spaces used between words by the Anglo-American Company. As stated in the article, *three* spaces are employed, and that number should have been reckoned in arriving at the speed for each cable; but only two were taken into account, therefore the speeds should read as in the following table.

It should be remembered that in this instance spaces are credited to words of *seven* letters, not five, as is usual in computing speeds; and furthermore, that these speeds were carefully checked at Valentia and Heart's Content by officials of the Company.

Cable.	Letters per Minute.
1873	153
1874	153
1880	133
1894	251

In an editorial comment on the article at the time you stated that it would have been more interesting had I supplied



Delany Transmitter. 1894 Anglo-American Cable. September 16, 1894. 247 letters per minute.

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facsimiles of the signals at these high speeds. Absence from the country has prevented earlier response to that suggestion, and even now I am unable to supply facsimiles of these highest speeds, they having been reached with regular traffic; and as the Company paste the strip on forms instead of translating and copying, none of that strip is available. I submit, however, facsimiles of Code messages sent experimentally on Sunday, September 16, 1894, over the 1894 cable at a speed of 247 letters per minute according to careful official timing at both ends of the cable.

The speed of 251 letters with regular traffic on September 26th was maintained for half an hour constant working.

MUIRHEAD IMPROVED FORM OF SIPHON RECORDER.

The component parts of Dr. Alexander Muirhead's improved Siphon Recorder are so arranged that the various adjustments of it can be considerably more readily effected than hitherto, and the signal coil and other working parts of the instrument can be more readily removed in case of accident, damage, or when otherwise required. The magnet, between the poles of which the rectangular signal coil moves, is built up of a number of flat horseshoe-shaped permanent magnets of a special quality of steel, and is provided with adjustable pole-pieces. The signal coil is suspended by fibres, and is mounted, together with a fixed soft-iron core, on a brass plate affixed to a rack with which a pinion operated by a milled head screw engages. On the brass plate there is an arm carrying the bridge wire or fibre which carries the aluminium siphon cradle. On this bridge is also mounted the electromagnet forming part of the "vibrator" arrangement, to its hinged armature one end of the stretched wire carrying the siphon is fastened. On the left side of the framework of the instrument (*see* Fig. 1) are placed the interruptor of the vibrator, a set of slide resistances for the purpose of regulating the strength of the current flowing through the interruptor, and the small electromagnet in connection therewith. On the other side of the framework are placed the slide resistances for regulating the current flowing through the coils of the mousemill motor and the usual "receiving" shunts to the signal coil. In this instrument the ink box is also made adjustable, being carried by an arm attached to a pillar provided with a rack with which a pinion operated by a milled head screw engages. The motor is usually supported on a platform at the back of the instrument, and its driving wheel connected to the shaft of the paper roller by means of a spirally-wound steel band.

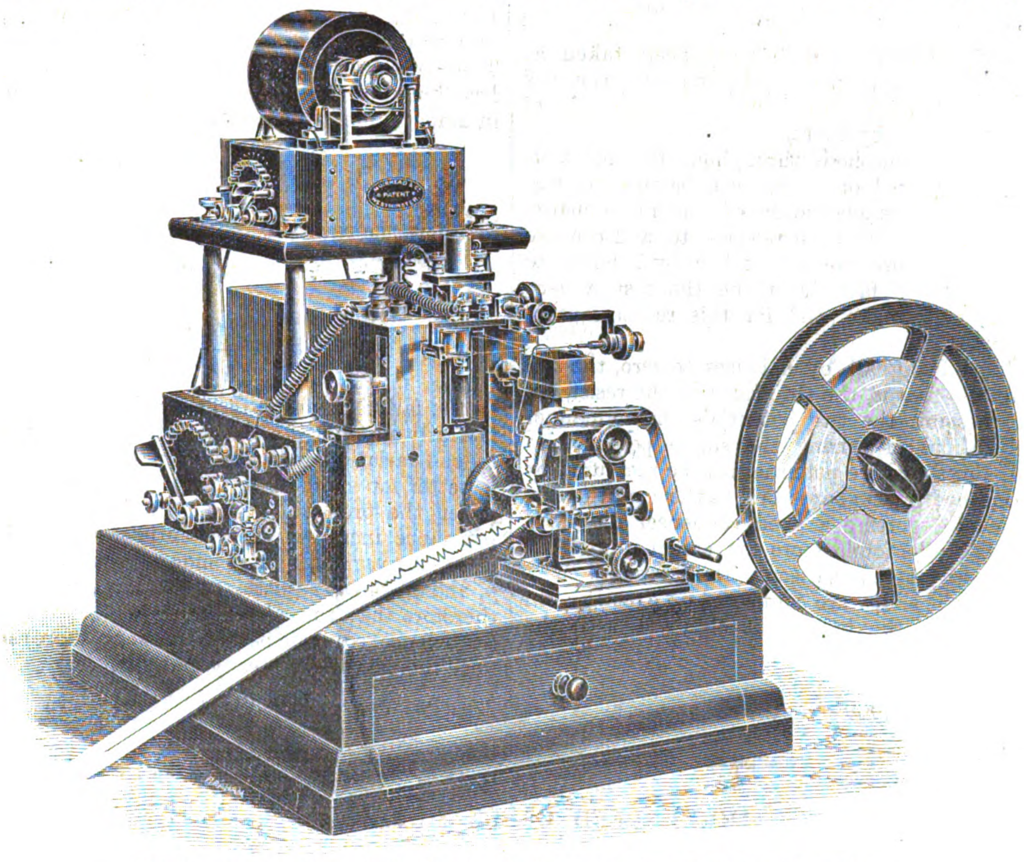

Fig. 1.—General View of Dr. Muirhead's Improved Form of Siphon Recorder.

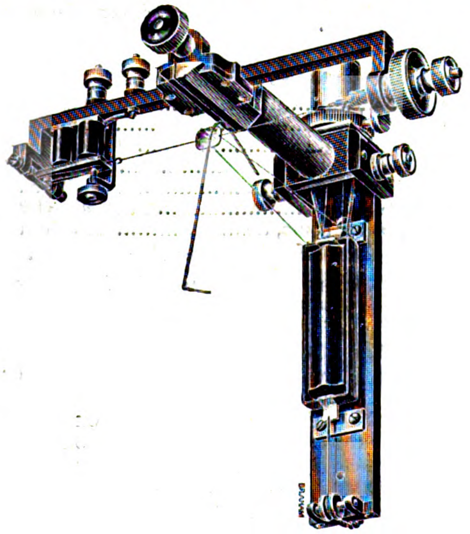

Fig. 2.—Details of Suspension of Dr. Muirhead's Improved Form of Siphon Recorder.

Perhaps the most novel feature of Dr. Muirhead's improved form of Siphon Recorder is in the suspension piece shown in Fig. 2, where it will be seen that the suspended coil is connected by means of two fibres attached at one end to a light arm fixed on the coil, and at the other end to the aluminium cradle to which the glass siphon is cemented. One of the

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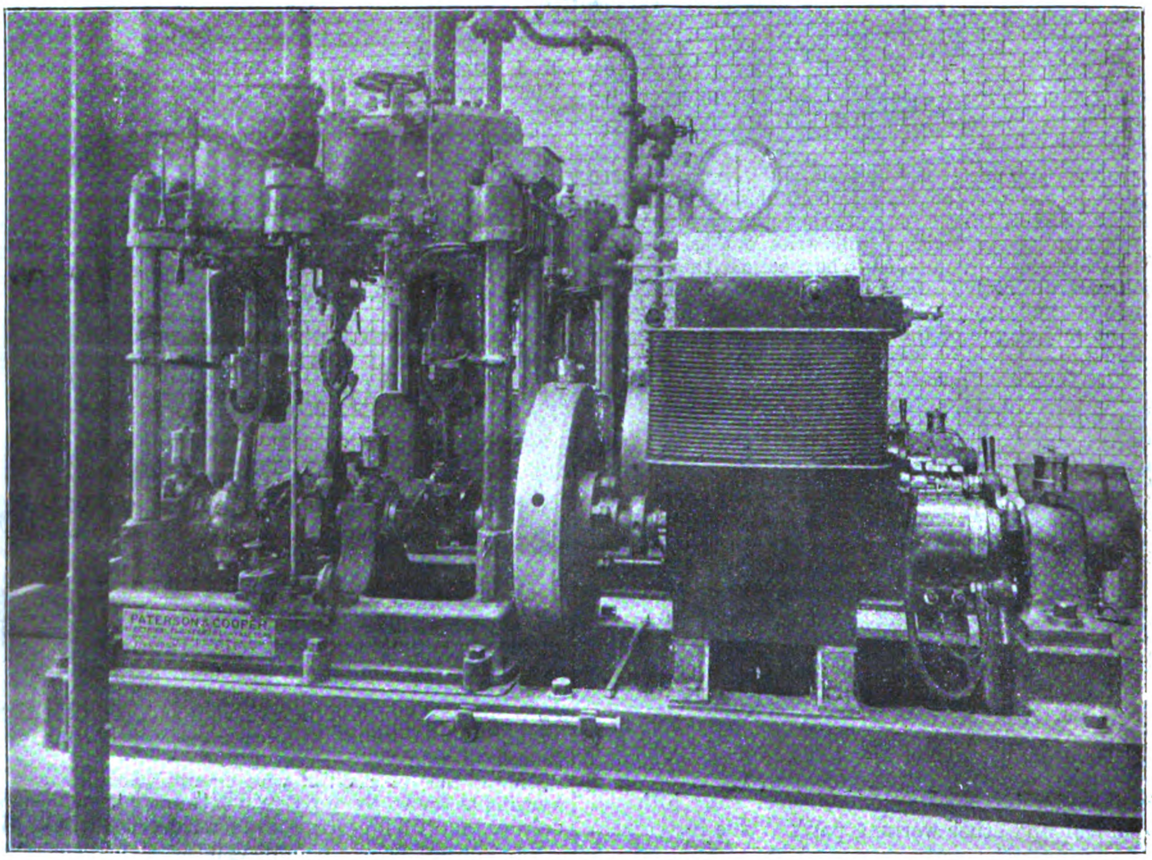
fibres is tied, or otherwise fastened, to a part of this aluminium cradle above the stretched wire or phosphor-bronze strip which carries the cradle, and the other fibre is similarly secured to a part of the cradle below each wire. The torsion of the stretched wire and the two fibres give directive force to the coil.

ELECTRIC LIGHTING OF GLASGOW HARBOUR TUNNEL.

The need for greater facilities of communication between the north and south sides of the Clyde at Glasgow Harbour has long been experienced, and various schemes have been proposed from time to time to meet the keenly-felt wants. It occurred to Messrs. Simpson and Wilson, a well-known Glasgow firm of civil engineers, who have had much experience in cutting underground railways, to accomplish the end desired by tunnelling under the river towards the lower end of the harbour, where the expected traffic, both foot and vehicular, would be greatest. A public company was formed to provide the necessary capital for the undertaking, and after the scheme had been thoroughly matured Parliamentary powers for carrying it out were obtained. That was in 1890. The work has now been finished, and the tunnel has been opened for public use. It should rather be said that the scheme embraces three tunnels—two for vehicular traffic and one for foot passengers.

Messrs. Simpson and Wilson's scheme has as its special feature two hoisting and lowering shafts, 76ft. in diameter and 75ft. deep, and in both cases they have been sunk within very short distances of the harbour walls. It was early resolved that the tunnels should be electrically lighted, as also the above-ground premises and the upper portions of the shafts. The engineers laid down the conditions on which electric lighting plans should be designed, and the offer that most satisfactorily commended itself to them was that of Messrs. Paterson and Cooper. One of the points which the engineers had in view in placing the contract for the lighting was that the installation should be of such a nature that the damp and moisture that would have to be contended with should do no damage to the leads, &c. The usual methods that have met with more or less success were suggested, such as lead-covered cables, cables in iron pipes, &c., but Messrs. Paterson and Cooper suggested the "Brookes" oil system.

The plant that has been installed and brought into use for doing the lighting of the three tunnels consists of three sets of direct-coupled engines and dynamos—two of them being equal to an output of about 20 kilowatts each, and the other a small auxiliary set of 6 kilowatts output. This plant is placed in the main engine house, which also contains the pumping and hoisting machinery, and is situated on the south side of the river. The two large sets of plant consist of inverted-type dynamos coupled on to compound engines of Messrs. G. H. Belliss and Co.'s make (*see* accompanying illustration). The Belliss central-valve engines have cylinders of 8½in. and 13in. diameter respectively, with stroke of 6in. They indicate 34 H.P., with a steam pressure of 95lb. The governor is fitted direct on to the crankshaft and controls the throttle, and is easily adjusted while the engine is running. A variation of less than two volts only is experienced between full and no load. Special precautions have been taken to ensure that the steam is dry, drip pipes being fitted directly above each engine, in addition to those on the main branches. The small dynamo is exactly similar in construction to the two large ones, and the engine which drives it is also of Belliss and Co.'s make, but is only a single-cylinder engine. Tachometers are fitted on each set.



Belliss Engine and Paterson & Cooper 20 kilowatt Dynamo.

The lights are distributed as follows:—

North shaft	10 arc lamps.
South shaft	10 arc lamps.
Foot Tunnel	50 32 c.p. lamps.
East Wheel Tunnel	25 32 c.p. lamps.
West Wheel Tunnel	25 32 c.p. lamps.
Engine room	2 arc lamps.
Pay boxes, boiler house, &c.	10 32 c.p. lamps.

Total—22 arc lamps, 110 32 c.p. incandescents.

The lamps are of Messrs. Paterson and Cooper's well-known "Phœnix" type, and are arranged to work two in series on the 110-volt circuit. The mains for the arc lamps in the north shaft are laid under the floor of the passenger tunnel in a 3in. iron pipe, filled with resin oil. The oil-insulated mains in both shafts run to a terminal box placed about 12ft. above the ground level on the side of the shaft. From the terminal boxes ordinary 600-megohm vulcanised rubber-covered cables, fixed on porcelain insulators, run to the various lamps. In the footway tunnel the 50 lamps are arranged along the centre line of the roof, the alternate lamps being on separate circuits. In the wheel tunnels the lamps are arranged alternately on either side, and in all the tunnels the lamps are enclosed in heavy enamelled cast-iron fittings with brass fronts and flint glasses, the whole being made water-tight by means of rubber washers. These fittings have special joint-boxes of malleable iron attached to them, through which the main pipes run, a specially packed gland being fitted close to the lamp-holder to keep back the resin oil. Special bends, fuse-boxes, &c., are

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fitted to meet the requirements of the special form of insulation used.

It ought here to be mentioned that the tunnels are all 16ft. in internal diameter, and rather over 700ft. in length from shaft to shaft, and the shafts, like the tunnels, are quite circular in sectional area. The walls of the passenger tunnel are lined over a large portion of their surface by white enamelled tiles, so as to reflect as much light as possible upon the footway.

The electrical work was designed and carried out under the direct superintendence of Mr. E. George Tidd, A.M.Inst.C.E., Messrs. Paterson and Cooper's engineer and manager for Scotland.

MAGNETIC UNITS.

At the Oxford (1894) meeting of the British Association, Prof. Oliver Lodge, at the request of the Electrical Standards Committee, undertook to draft for future discussion a Paper on Magnetic Units. This Paper has been circulated among the members of this Committee, and with a view of obtaining opinions on this subject from those who are not members we have been desired to give space to Prof. Lodge's Paper in the columns of *The Electrician*.

Believing that the Committee is impressed with the convenience of affixing names to some of the more important units connected with the magnetic circuit, I beg to suggest the following considerations and recommendations, which I will write out as briefly as possible. The statements are intended to be precise in their terms; but in several cases alternative forms of definition are given.

1. That the unit coefficient of self-induction, though frequently useful, is by no means one of the most fundamental units, but should be defined in a suitably subordinate manner, with reference to other and more important quantities.

2. That it would be a mistake so to define it as to discourage the employment of the same term for as many other quantities of the same "dimensions" as possible; especially for the unit coefficient of mutual induction, and for unit "permeance."

3. That the essentially different quantities commonly called H and B should be carefully kept distinct, although their measures in air have been conventionally so arranged as to be numerically equal.

[*Summary of known facts and definitions.*—H being the intensity of magnetic force at a point, or the slope of magnetic potential (ω),

$$\omega_a - \omega_b = \int_a^b \mathrm{H}\,ds, \text{ along any length } ab;$$

and in a closed magnetic circuit the circuitation of H is equal to 4π times the total electric current through the area bounded by the magnetic circuit; or,

$$\text{cycle}\int \mathrm{H}\,ds = \text{circuitation of } \mathrm{H} = \iint 4\pi c\,d\mathrm{S} = 4\pi \mathrm{C},$$

or, at any point of space,

$$\text{curl } \mathrm{H} = \mathrm{V}\nabla\mathrm{H} = 4\pi c,$$

where c is current density.

If the electric circuit consists of n turns of wire threading the magnetic circuit, and each conveying the current C_1, then $\mathrm{C} = n\,\mathrm{C}_1$.]

First Quantity to be Named.

4. The first thing requiring a name is this quantity *magnetic potential*, sometimes called *magneto-motive force*, a quantity spoken of and measured, not inconveniently but with insufficient generality, by electrical engineers as ampere-turns. It has been proposed (by Mr. Heaviside, for instance) that it be called *gaussage*, and that its C.G.S. unit be one *gauss*.

5. The circuital gaussage round a closed curve is 4π times the total electric current through the area bounded by that curve.

In the case of a magnetic circuit wound with wire the gaussage is $1\frac{1}{4}$ times $\left(\frac{4\pi}{10} \text{ or } 1{\cdot}2566\right)$ the ampere-turns threading that circuit.

NOTE.—It *may* be best to retain the word "gaussage" for the whole of a closed circuit only, and to speak of the difference of magnetic potential between two points as the fall of gausses or the "gauss-fall" from a to b.

6. The gaussage, or gauss-fall, in any portion ab of a magnetic circuit, is measured by the change in the potential energy of a unit pole as it moves from a to b by any path which involves neither the cutting of magnetic layers nor the encircling of currents (a long channel being imagined for its motion through solid material if necessary). Or, more practically, it is measured by the induction through a long narrow tube whose ends are at a and b respectively, divided by the permeance of that tube. (*Cf.* Chattock on a magnetic potentiometer, *Phil. Mag.*, July, 1887).

In practice, however, gaussage is frequently calculable from the ampere-turns to which it is due.

7. Intensity of magnetic force, or H, will be naturally expressed as gauss-fall per centimetre, or the *gauss-gradient*. For instance, the earth's horizontal intensity at some place is 0·18 gauss per linear centimetre, or 5·4 gausses per foot.

NOTE.—H should not (strictly speaking) be expressed as so many lines per square centimetre; that mode of expression should be reserved for induction-density B. H is the cause, and should be thought of as the slope of magnetic potential, B is the effect. In a medium of so-called unit permeability the two quantities are numerically equal, but they should not be confounded; any more than the slope of electric potential, or electric-intensity (e), should be thought of as identical with current-density, even in a medium of unit conductivity.

8. The gauss-gradient inside a long or closed magnetic solenoid of length l, wound uniformly with n turns of wire each conveying the current C_1, is $4\pi n\,\mathrm{C}_1/l = 4\pi n_1\,\mathrm{C}_1$, where n_1 is the total number of turns of wire (in all the layers) to the linear centimetre.

This is the measure of H in the interior of such a solenoid, quite irrespective of the material with which it may happen to be filled.

Second Quantity to be Named.

9. The second quantity requiring a name is the *total induction* in a magnetic circuit, also called "total flux," "total lines," "electromagnetic momentum," and "electrotonic state." It is the quantity whose time-rate of variation gives the voltage induced in an electric circuit surrounding it once. It is proposed that its practical unit be called a "weber," and be defined as equal to 10^8 C.G.S. lines (or unit tubes) of induction.

(Denote the quantity for the present by N, and its density by B.)

[*Summary of Known Facts.*—e being the intensity of electric force, or the slope of electric potential, or the volt-gradient at a point; the circuitation of e = the induced E.M.F. in a closed circuit = the rate of change of induction through it;

or,
$$\text{cycle}\int e\,ds = \mathrm{E} = -\dot{\mathrm{N}} = -\iint \dot{\mathrm{B}}\,d\mathrm{S};$$

or, at any point of space,

$$\dot{\mathrm{B}} = -\text{curl } e = -\mathrm{V}\nabla e.$$

Through a simple closed electric circuit of constant resistance,

$$\mathrm{N} = -\int \mathrm{E}\,dt = \int \mathrm{R}\mathrm{C}\,dt = \mathrm{R}\mathrm{Q}.]$$

10. The total induction through any area may be practically measured by suddenly surrounding it with a closed wire circuit of n turns connecting the terminals of a ballistic galvanometer, and measuring the quantity of electricity thereby impelled through the galvanometer. The induction is equal to the quantity so impelled, divided by n times the resistance of the circuit. If the quantity is 1 coulomb, and the resistance 1 ohm, the induction is $1/n$th of a weber.

Or, otherwise, if the induction through any boundary changes at the rate of 1 weber per second, the E.M.F. excited in that boundary is 1 volt.

In the case of a spiral wire circuit through which induction is varying at the rate of a weber per second, 1 volt is excited *in each turn* of the wire.

11. *Another* mode of measuring the total induction through an area is to surround that area with a movable electric circuit of n turns of wire conveying a known current, and to measure the potential (or mechanical) energy of the circuit under those conditions. The induction is equal to the potential energy of the circuit divided by n times the current circulating in each turn of wire.

Or, if the induction through a simple circuit carrying 1 ampere is 1 weber, the potential energy of the circuit is 1 joule.

Derived Quantities.

12. Induction density, or B, may be expressed as so many webers per unit area—say per square centimetre or per square inch, or whatever is preferred for practical purposes.

For instance, the earth's horizontal induction density at some place is 0·18 C.G.S. unit $= 0{\cdot}18 \times 10^{8}$ weber per square centimetre = 18 microwebers per square metre.

13. The inductivity (μ), or absolute permeability of a medium at any point under specified circumstances, is the ratio of B to H at that point, and under those circumstances. In many substances this ratio is far from constant. [It may be expressed in terms of henries or other units of permeance per unit length (see below), instead of in C.G.S. units, if convenient. For example, the inductivity of air is $\frac{1}{100}$th of a microhenry per centimetre, or one millihenry per kilometre.] More explicitly it is measured by the webers per unit area divided by the gauss-fall per unit length; in other words, by the ratio of the weber-density to the gauss-gradient.

14. The relative inductivity of a substance as compared with that of empty space (μ/μ_0) may be called simply its "permeability" as at present, and is a mere number.

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(Its electrical analogue is specific inductive capacity (K/K_0), as contrasted with absolute electric inductivity (K); which latter could be defined in practical units as the ratio of the coulombs displaced per unit area to the volt-gradient.)

Third Quantity to be Named.

The third quantity for whose unit a name is required is some form of ratio between the two fundamental quantities whose units are here named after Weber and Gauss respectively. It has been practically decided in America that this unit shall be named after Prof. Henry, of Washington, but the precise definition has not yet been agreed upon.

There are two quantities of the same physical dimensions to which the name is applicable, viz., the coefficient of self or mutual induction of a coil or coils of wire, and the permeance or inverse reluctance of a magnetic circuit.

The most logical order is to define permeance first, as the ratio of the webers of induction to the exciting gaussage, and then to say that the inductance of a coil of n turns of wire is n^2 or $4\pi n^2$ or $0{\cdot}4\pi n^2$ times the permeance of the magnetic circuit which it embraces, according to the units of gaussage and current which have been decided on.

If the units of gaussage and current are both the C.G.S. units, then $4\pi n^2$ is the numerical factor connecting inductance with permeance.

If the C.G.S. unit of gaussage is adopted along with the ampere current, then $0{\cdot}4\pi n^2$ is the factor.

But if the circulation of H due to *one ampere-turn* is adopted as the practical unit of gaussage, then n^2 is the factor; and the permeance of a cylinder, instead of being simply $\frac{\mu A}{l}$, is $\frac{4\pi\mu A}{10 l}$.

The apparent simplicity of this last system has much to recommend it for commercial use, though it will complicate the specification not only of permeance, but also of magnetic fields and potentials; but *some* inconvenience, due to the unfortunate definition of the unit pole, and the only less unfortunate definition of the practical unit of current, cannot be avoided; and our aim must be to place the inconvenience where least likely to be felt in everyday work.

First System.

We will begin with the more logical system, and with general statements which apply to both.

15. In a complete magnetic circuit the ratio of the total induction to the corresponding gaussage under specified conditions is called the "permeance" of that circuit under those conditions. It is not in general constant.

Or, the permeance of any solenoidal portion of a magnetic circuit, if free from intrinsic magnetomotive force or magnetic boundary layers, is the webers through it divided by the gausses between its ends.

16. The practical unit of permeance is that of a circuit in which a weber is excited by a gauss. Its reciprocal is the unit of reluctance. The practical unit so defined is 10^8 C.G.S. units.

Examples.—The permeance of a cubic metre of air to parallel induction from one face to the opposite is 1 microweber per gauss.

Under circumstances such that the permeability of iron is 400 times that of air, the permeance of an iron ring of one decimetre cross-section and 1 metre in mean diameter is $\frac{400\pi r^2}{2\pi R} = 20r =$ 100 C.G.S. = again 1 microweber per gauss.

It is, perhaps, a question whether this amount of permeance could be called a "microhenry" without confusion.

[*Explanation.*—The inductance (or self-induction coefficient) of an electric circuit consisting of n turns of wire, so far as it is constant, is defined to be equal to n times the induction produced through it by a current of 1 ampere in each turn. But the gaussage due to n ampere-turns is $\frac{4\pi n}{10}$ or $0{\cdot}4\pi n$; hence the inductance of a wire coil is $0{\cdot}4\pi n^2$ times the webers caused by each gauss in the magnetic circuit surrounded by it; *i.e.*, is $0{\cdot}4\pi n^2$ times the permeance of that circuit considered as constant.]

17. A coil of wire threading n times a complete magnetic circuit of unit permeance under any given circumstances is said to have $0{\cdot}4\pi n^2$ units of inductance under those circumstances; and in general the inductance of a coil of n turns is $0{\cdot}4\pi n^2$ times the permeance (as above defined) of the magnetic solenoid enclosed by it. (The permeance may here be considered variable.)

[With the ampere-turn as unit gaussage the $0{\cdot}4\pi$ is prefixed similarly to both inductance and permeance, so that only the factor n^2 is needed to convert one into the other. See below.]

18. The C.G.S. unit of inductance is equal to n times the induction excited through a coil per C.G.S. unit of current in every turn of wire; whereas the practical unit of inductance is n times the webers excited per ampere; hence the practical unit of inductance is 10^9 times the C.G.S. unit.

The practical unit is called a "henry." (It has also been called secohm and quadrant.)

Example.—If the above iron ring were wound closely with 1,000 turns of wire, the coil would have a coefficient of self-induction equal to $\frac{4\pi}{10}$ or $1\frac{1}{4}$ henries whenever the permeability of the iron was 400.

A coil of 20,000 turns of wire, wound closely on the same core, would have an inductance of $1\frac{1}{4}$ henries if it contained air or other non-magnetic substance.

Alternative Mode of Definition of Inductance on First System.

In view of one of the above practical methods of measuring induction experimentally, the inductance of coils of wire, both self and mutual, may be defined more directly thus:—

19. When of two simple circuits one conveys a current, the other in general has induction caused through it; and the ratio of the induction through either to the inducing current in the other is called the mutual inductance of the circuits.

20. Of two coils, with n and n' turns respectivel, the total mutual inductance is to be reckoned for every turn of wire on each coil, and is therefore $n n'$ times the inductance of the meant urn of one coil on the mean turn of the other.

21. The mutual inductance of two coils is $4\pi n n'$ times the permeance of the largest magnetic solenoid which threads both. For if every turn of one conveys a current C, while every turn of the other surrounds an induction N' in consequence, the permeance of the magnetic solenoid threading the second coil is $P = N'/4\pi n C$; but the total effective mutual induction, M C, through all the turns is $n' N'$; hence $M = 4\pi n n' P$.

22. When two coils each conveying one ampere are constantly connected by one henry of mutual inductance, the kinetic energy of the field due to their mutual action is one joule.

23. If the *self*-induction coefficient of a coil is being considered, its total inductance may be taken as n^2 times the inductance of the mean turn; that is n times the total induction through it divided by the inducing current. Or the weber-turns per ampere give the self-inductance in henries.

24. The practical unit of inductance, whether self or mutual, is called a henry; and a coil of n turns has a henry of inductance, on itself or on another of n' turns, when an ampere in one maintains $1/n'$ weber of induction (through itself or) through the other.

25. When the induction through a coil varies for any reason at the rate of one weber per second, the E.M.F. generated in each turn is one volt.

26. When the inductance of a coil is one henry, on itself or on another, a small variation of current in it at the rate of one ampere per second induces an E.M.F. of one volt in itself or in the other.

27. When the inductance of a coil conveying one ampere varies at the rate of a henry per second, the induced E.M.F. is one volt.

28. When the self-inductance of a coil is constantly, or on the average, one henry, while an ampere current is generated in it, the kinetic energy of the field due to that ampere is half a joule.

Second System.

29. If instead of taking a gauss as equal to a C.G.S. unit of magnetic potential, we take the circulation of H caused by one ampere-turn as the practical unit of magneto-motive force, we shall have 1 ampere-turn $= \frac{10}{4\pi}$ C.G.S. units of gaussage.

30. The practical unit of permeance will then be that in which a weber of total induction is excited by each ampere-turn; in other words, it will be $4\pi \times 10^7$ C.G.S. units of permeance.

31. And the practical unit of inductance will be that of a coil in which an ampere in every turn excites $\frac{1}{n}$th of a weber through every turn; that is to say, the inductance of a coil will be n^2 times the permeance of the magnetic circuit surrounded by it.

32. The difference between inductance and permeance is only one of reckoning. Permeance is webers per ampere-turn. Inductance is weber-turns per ampere.

Summary of the Advantages of this Sort of Mode of Defining Unit Inductance.

The special feature of this mode of defining the "henry" is that it makes inductance depend on the simple ratio N/C, or weber-turns per ampere, instead of on something more complicated.

It might possibly be defined as the ratio dN/dC, that is, as proportional to the tangent of the slope of the B : H curve; and such a definition would emphasise its variability; but certain practical advantages would be lacking, because it would be detached from any connection with the *permeance* of the circuit. The N/C ratio on the other hand instantly connects itself with permeance, and represents the slope of the secant drawn from the origin to any point of the B : H curve. It exhibits the variability sufficiently; making the inductance reach a maximum at the shoulder of the curve, and then slowly decrease as saturation sets in.

It is sometimes said—but the mode of expression is, to say the least, very inconvenient—that there are three different principles

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on which to define L, all leading to a different result, viz., numbering them inversely but giving them in their usual order :—

(3) Energy .... $W = \frac{1}{2} L C^2$,
(2) E.M.F. .... $E = L\, dC/dt$,
(1) Total induction $N = LC$.

But the real facts to be expressed are not here exhibited. The real facts are

$$(1)\ N = LC,$$
$$(2)\ E = dN/dt,$$
$$(3)\ dW = C\, dN.$$

The essential thing to name is, therefore, N; and if 10^8 C.G.S. lines or unit tubes be called a "weber," or a "weber-turn," then a volt is a weber or a weber-turn per second, and a joule is a weber-ampere-turn. Nothing can be handier than that; and a henry can be defined as a weber-turn per ampere.

Instead of saying, as above, that there are three ways of defining L, the simplest thing is to say that two of the three equations as first given above are incorrect, except for the special and, in practice, comparatively rare cases when L is constant. Written out correctly they stand as follows :—

$$(1)\ N = LC,$$
$$(2)\ E = L\frac{dC}{dt} + C\frac{dL}{dt},$$
$$(3)\ W = \tfrac{1}{2} L C^2 + \tfrac{1}{2}\int_0^C C^2\, dL.$$

It is then obvious that (2) and (3) are too complicated to base a definition upon, and that the first alone gives a feasible system.

The fact that L is decidedly not in general constant deprives the henry of any such importance as the ohm possesses; moreover it refers explicitly to rather a special thing, viz., a coil of wire, and that under specified conditions if it contain iron; hence it would be rather absurd to name this alone of all magnetic units. In the above communication, in addition to a certain mode of defining the henry, it is urged that unit total induction be named too; for this is the quantity which is of real engineering importance—this is the quantity to attain which field-magnets are built, and in the midst of which armatures are spun.

It is also urged that it would be convenient if unit magnetic potential could likewise be named, since electrical engineers have shown that they have need of some such unit for the exciting cause of induction by their practical employment of the phrase "ampere-turns." The introduction of a gauss unit, in some form not too obviously limited to the case of a wire-wound coil, would assist teaching and would clarify magnetic ideas.

The present writer does not presume to decide between the two alternative systems of defining "the gauss" as given above: viz., the C.G.S. unit on the one hand, and the ampere-turn on the other.

APPENDIX I.

It need hardly be said that in the last resort it rests with practical men to employ or decline any suggested system of units. Those who daily deal with the quantities under consideration are the best judges of the utility or otherwise of a suggested unit, provided always that they take the trouble to give it a fair trial, and see how it works in practice. It may be hoped that the above or similar suggestions will meet with criticism at the hands of such men, and in order to make a beginning of criticism I asked the Departmental Lecturer on Electrotechnics at University College, Liverpool (Mr. F. G. Baily), to consider them with special reference to

(1) The large size of the weber and henry units;
(2) The handiest definition of the gauss; and
(3) The least troublesome mode of bringing in the 4π.

His reply, which is annexed, covers these points, and also incidentally refers to the quantity called I or intensity of magnetisation.

Now, as must often have been pointed out, the equation $B = H + 4\pi I$ is a barbarous one, involving as it does quantities of different dimensions in one equation. Its true meaning is, of course, $B = \mu_0 H + (\mu - \mu_0) H$; which, although algebraically only a roundabout method of writing $B = \mu H$, is yet convenient, as exhibiting separately the part of the induction due to the Ether and the part due to a material medium.

The customary convention of further denoting $(\mu - \mu_0)/\mu_0$ by the symbol $4\pi\kappa$ (or κ), and then christening κH as the magnetisation I, is likewise convenient. With this definition κ is a pure number, and I is a gauss-gradient or field-intensity. Another, but on the whole less satisfactory, definition, viz., the omission of μ_0 from the denominator, would make κ of the same dimension as μ, and I an induction-density.

The pull between two parallel magnetised surfaces of area A is $\frac{1}{2} A B H \div 4\pi$, that is to say, $N H / 8\pi$, and is therefore measured in webers multiplied by the gauss-gradient, or in joules per centimetre. But to maintain an induction density B in air requires a gauss-gradient B/μ_0, hence we might write the pull across an air-gap as $N^2 \div 8\pi\mu_0 A$. If the induction-density across an air-gap is expressed in microwebers per square centimetre the tension there comes out in units of which 2,500 would make an atmosphere; or, roughly, in pounds per square foot.

As for the strength of a magnetic pole—a quantity which, though fundamental in one sense, is seldom really dealt with—it will naturally be expressed in ergs per gauss, or in joules per gauss if it is very strong.

Mr. Baily's chief practical suggestions are first that a special unit of permeance, other than the henry, is desirable; and next that the $4\pi/10$ had best be thrown on to the μ, so as to keep the gauss equal to one ampere-turn. The fact that the inductivity of air will then cease to appear in its artificial garb of unity may even be regarded as a positive advantage, because its existence will then be less likely to be ignored. But I much fear that the ampere-turn as unit of gaussage, so near the C.G.S. unit in size and yet not equal to it, will be awkward and may lead to mistakes.

O. J. L.

University College, Liverpool, January 15, 1895.

Dear Professor Lodge,—In reference to the sizes of the magnetic units proposed by you, I find that the weber 10^8 C.G.S. would only be used in fractions. The largest dynamo that I know of has a magnetic flux, or, as you propose to call it, an induction of 0 5 weber. From this the value will go down to about 0·01 in small motors. These figures are, however, by no means inconvenient.

Transformers will be rather smaller. In these the weber-turn is a convenient size and an interesting quantity, as it is given by $\frac{1}{4}$ *of the mean volts per cycle*, or, more accurately expressed, *mean volts per unit frequency* ÷ 4. Its numerical value will lie between, say, $\frac{1}{4}$ and 50, according to the volts and the frequency; but it gives no indication of the size of the transformer.

The henry 10^9 C.G.S. is also large. The inductance of choking coils would in general be fractions of a henry. The inductance of the winding of a transformer has no very important meaning, but it has a convenient size. Measuring it as *mean volts per unit frequency ÷ four times the open circuit current in amperes*, the inductance of the primary coil on a 2 H.P. closed magnetic circuit 1,000-volt transformer would be about 40 henries.

The inductance of pairs of cables would run from 100 to 1,000 microhenries per kilometre, but the value would vary with the arrangement.

The induction per unit area is good; having a value in practical work from 1,000 to 20,000 C.G.S. units, it is given by 10 to 200 microwebers per sq. cm.

Gaussage would be about 50 in small transformers, up to 40,000 in large dynamos. The latter could be conveniently reckoned in kilogausses. To make the gauss = 1 ampere-turn appears to have great advantages in practice, and connects it directly with its usual source.

The idea of permeance is very useful, and the identification of its dimensions with those of inductance is neat. But I think it is liable to cause confusion, for the permeance of the core of a coil will be a different number of henries from the inductance of its wire. Moreover, the argument as to identical dimensions might equally be applied to the case of amperes and gausses. I would therefore have a new unit strictly connected with the henry, so that inductance $= n^2 \times$ permeance in a coil of n turns.

As to the units of permeance: with the above meanings of gauss and weber the permeance of a circuit would be $4\pi\mu A / 10\, l$, as you point out, instead of $\mu A / l$. But I wish to suggest a change in the method of reckoning, namely, still to retain the value of the permeance as $\frac{\text{webers}}{\text{gausses}}$, and permeability as $\frac{\text{webers per sq.cm.}}{\text{gausses per cm.}}$, therein giving up the convention of unit permeability of space, and giving it the value $1{\cdot}2566 \times 10^{-8}$ unit of permeance for a unit cube. In this way both the troublesome 10^{-8} and $4\pi/10$ are dealt with in an easily intelligible way. To avoid the high power of 10 it may be measured in micro-units of permeance, so that permeability of space and air = 0 012566 micro-unit of permeance for a unit cube, and permeability of soft iron = up to 25 micro-units for a unit cube. Thus we have permeance $= A\mu / l$, where μ is to be obtained from tables of its value, which can easily be altered to this method. Inductance then becomes $\frac{\text{weber-turns}}{\text{amperes}}$, or $n^2 \frac{\text{webers}}{\text{gausses}} = n^2$ permeance.

[Of course your phrase "weber-turns per ampere" means the same as the above webers ÷ amperes, and does not necessarily mean the weber-turns caused by *one* ampere.]

It may be objected that the C.G.S. units of strength of field, unit magnetic pole and intensity of magnetisation do not bear any simple relation to these practical units. This is chiefly important in the use of the magneto-metric measurement of iron, and in the measurement of the mechanical form of attraction between two magnetic surfaces in contact. But the expressions are not in reality much complicated; *e.g.*, present C.G.S. unit of intensity of magnetisation is given by $4\pi I = (\mu - \mu_s) H$, where μ = permeability of space = 1, and H = C.G.S. unit of magnetic force. This becomes $4\pi I = (\mu' - \mu'\ ) H'\ 10^8$, where H' is the gauss-gradient in the magnetic

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substance, and $\mu'_s = 0{\cdot}012566$ micro-unit of permeance for a cubic centimetre.

As the single magnetic pole is unchanged, the force on it will be = strength of pole × gauss-gradient × 1·2566; but as this is not a calculation of frequent occurrence, except in magnetic surveys, the complication will not be serious. Other magnetic relationships are almost entirely of academic interest only, and would be carried out in C.G.S. units. Also the transition would present no difficulties to people with a little scientific knowledge.

I am of opinion also that as the legal volt has no direct connection with induction and velocity of motion, it is not necessary to define the practical units as they are defined absolutely. That is, ohm and ampere are the starting points, volt is obtained from them, weber from volt, gauss from ampere, permeance unit from weber and gauss, henry from weber and ampere or from permeance, and so on. This is much more easily explained to practical and unscientific men that the absolute derivations are, and it is the order in which they learn them.—Yours very truly,

FRANCIS G. BAILY.

APPENDIX II.

Another subject for discussion is whether L had better not be defined as dN/dC; with permeability as $\mu = dB/dH$ to correspond. This would make the three equations of page 7 stand thus:—

$$(1)\quad N = \int L\,dC,$$

$$(2)\quad E = L\dot{C},$$

$$(3)\quad W = C\dot{N}.$$

A letter just received from Mr. Heaviside indicates that he would probably favour this course, and there is evidently much to be said for it. I need hardly add that he contemns my temporising method of dealing with the 4π nuisance. O. J. L.

January 30, 1895.

According to the proposal of the Chicago Chamber of Delegates, the quantity which we call "inductance" and which is to be expressed in "henrys" is defined by the equation $E = L\,(dC)/(dt)$ for self-induction, or $E = M\,(dC)/(dt)$ for mutual induction, both being comprehended in one definition, the inductance L or M being calculated by dividing E in volts by $(dC)/(dt)$ in amperes per second. This implies that L or M is not to be defined as N/C, but as $(dN)/(dC)$.

I think names are desirable both for N/C and for $(dN)/(dC)$. I would suggest that the former be called "the total inductance" and the latter "the differential inductance." The distinction would be somewhat analogous to the distinction between the "mean specific heat from 0° to $t°$" and the "true specific heat at $t°$." Both total and differential inductance should be expressed in "henrys," for they are quantities of the same kind and when there is no iron, &c., in the field they are equal.

I think that the above mode of definition, involving as it does no magnitudes except current and time, is more readily comprehended than Dr. Lodge's proposed definition, in which the magnitudes involved are current, flux of induction, and the number of convolutions of the coil through which the flux passes. In the definition proposed by the Chicago Delegates, the consideration of the number of convolutions does not enter.

For a circuit or two circuits not having iron, &c., in the field, we may define inductance (in henrys) as the E.M.F. (in volts) due to variation of current at unit rate (one ampere per second). When the field is modified by the presence of magnetic material, the above will be the definition of "differential inductance."

The "total inductance" for any specified strength of current will be the mean value of differential inductance for equal increments of current from zero up to the specified strength.

I would suggest similar nomenclature in the case of permeability; $(dB)/(dH)$ should be called differential permeability, and B/H total permeability. In some respects "mean" or "average" would be a more correct designation than "total"; but these words would be liable to be misunderstood as referring to an average taken over the different parts of the body or circuit. "Total" is to be understood as standing for "calculated on totals."

As regards the magnitude of the unit of inductance, while I agree with Mr. Heaviside and Dr. Lodge that the unit pole ought to have been so defined that the mutual force between two poles is equal to their product divided by the surface of a sphere whose radius is their distance, a definition which would have made the line-integral of H due to a current C equal to C itself instead of to 4π C, I deprecate a mixing up of the two systems. So long as we employ our present unit of intensity of magnetic field, which results from our present definition of the unit pole, we cannot consistently reckon the line integral as equal to the ampere-turns. It must be reckoned as 4π times the ampere-turns, and the flux N must be reckoned as $4\pi\mu$ times the ampere-turns. The practical inconvenience of retaining the factor 4π cannot be considerable, for it is as easy to tabulate the values of $4\pi\mu$ as the values of μ.

Next as regards "permeance." I do not think it can conveniently be reckoned in henrys. I would rather reckon it in "webers per ampere-turn" which would be written "web. per amptu"; and there can be no possible doubt as to the meaning intended, when once we have fixed the magnitude of the "weber." There seems to be no difference of opinion as to what this magnitude should be. It is fixed by the relation $E = (dN)/(dt)$, E being in volts, N in webers and t in seconds. This is in accordance with Dr. Lodge's proposal, but Dr. Lodge has not explicitly recommended any name for the physical quantity which is measured in webers. Shall we call it "weberage"? It greatly needs a name; for "induction" may mean B instead of the surface integral of B, besides having many other meanings.

When permeance varies according to the strength of current, I would distinguish between "total permeance" N (n C) and "differential permeance" $\frac{1}{n}\frac{dN}{dC}$.

As regards "gaussage" and "gauss fall." I think the names will be convenient in the senses proposed by Dr. Lodge; but I cannot agree with his selection of a unit of measurement. The present definition of the unit pole (on which the present unit current is based) requires us to equate the line-integral in question to $4\pi n$C. To be consistent we must reckon "gaussage" as equal to 4π times the number of amptus. Dr. Lodge's proposal is to reckon C not in amperes but in C.G.S. units, thus introducing, as it appears to me, an awkward breach of continuity.

J. D. EVERETT.

THE OFFICIAL VOCABULARY OF CODE WORDS.*

The time which has elapsed since the publication of the Official Vocabulary of Code Words—compiled by the Berne International Telegraph Office, in accordance with the provisions of the regulations adopted by the Paris International Telegraph Convention—has permitted specialists to study and criticise it at leisure, and users of codes to give it a fair trial. It seems, therefore, desirable, under the present circumstances, and in view of the necessity of shortly taking action, to place before the readers of this *Journal*, and the commercial community at large, a record of the steps which the London Chamber of Commerce has taken in the matter, and a summary of the arguments and criticisms which have motived its opposition to the adoption of the Official Vocabulary in its present form.

In our January issue, when the official publication, which—unless the opposition to it is successful—is to become of compulsory use for all European code messages on January 1, 1898, was just being placed before the public, we took the opportunity of impressing upon our readers the importance of the change to the commercial community, and the necessity for users of codes to thoroughly test the new vocabulary for themselves, and not to take it upon trust. At the same time we invited communication of the results of those criticisms and tests. This article was followed almost immediately (January 28th), by the issue of a circular to members of the London Chamber, asking their opinion—

(*a*) As to the number of words in the vocabulary being sufficient or insufficient;

(*b*) The liability of error through too great similarity of words;

(*c*) the "delay" to be allowed before the compulsory application of the vocabulary.

As a result of the replies we received, and which not only expressed condemnation of the Official Vocabulary, but gave reasons for such condemnation, it was decided to approach foreign Chambers of Commerce, and to place before them certain objections to the vocabulary, in order to induce them to bring the matter under the notice of their respective Governments. The vocabulary being the result of an international understanding, no single Government can interfere with its application. It is only the authority which promulgated it, viz. the International Telegraph Conference, which can effect its postponement and order its revision—a course which, we may take it, will be followed only when the strongest case has been made out, and when sufficient pressure has been brought upon the constituent members of the Conference. With this object in view, a circular was issued to Foreign Chambers on March 25th last, in which, after a succinct statement of objections to the vocabulary, a request was made that the Chamber addressed should, either singly or in conjunction with other Chambers in the district, urge upon its Government the necessity of taking steps to procure the postponement of the date on which the vocabulary is to become obligatory, and a thorough revision, under competent direction, of the work of the Berne International Office. Replies were received from France,

* From the (London) *Chamber of Commerce Journal*.

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Germany, Austria-Hungary, Italy, Spain, Belgium, and Holland. The majority of the Chambers replying stated that they were communicating or had communicated with their Postal authorities, in accordance with the suggestion made to them. Germany and Austria Hungary seem to have taken more interest in the matter than other countries; but one of the most important French Chambers—viz., that of Havre—not satisfied with urging upon the French Government objections to the use of the vocabulary in its present form, issued a strong circular to the French Chambers, recommending concerted action in the sense of the London representations.

The views of London merchants having been ascertained, and a large body of foreign opinion having been collected, it is the intention of the London Chamber of Commerce shortly to place these before the Chambers of Commerce of the United Kingdom, and, strengthened with their support, to bring before the Postmaster-General a statement of the objections and demands of the commercial community, not only of this country, but also of the larger part of the Continent, in regard to the publication of the Berne International Office. The circumstances, as our readers will see by the criticism of the vocabulary which follows, require that no time should be lost, and that Her Majesty's Government be asked forthwith to take the matter in hand, to make representations to the proper quarters, and at the next International Telegraph Conference—which we understand is to be held in Buda-Pesth in 1896—to support, and if necessary to propose, the postponement of the compulsory use of the vocabulary until competent revision and proper augmentation of that work.

A study of the vocabulary reveals to us the fact that, as we say in common language, the International Telegraph Conference has not got what it bargained for. In the preface of the book, the necessary requirements of such a work are stated to be as follows:—

"In order to establish a complete typographic and telegraphic dissimilarity between the words, each word ought to differ from every other word by at least two letters and by three elementary Morse signals. . . . A certain number of words were allowed to pass which differed only by two telegraphic signs, but these words differ sufficiently in their typographical characters, and the telegraphic resemblance is only obtained by an artificial grouping of Morse signs." The compilers therefore claim that, with the above exception, they have adhered to the rule which they themselves laid down and recognised to be necessary, whilst such is emphatically not the case. If they had kept the promise of their preface, there would be little fault to find with the vocabulary, beyond the fact that the number of words contained in it is too small for commercial requirements. But the present work is not only insufficient; it is, above all, an unsafe and dangerous work.

In this vocabulary, in which all the words ought to differ from one another "by at least two letters *and* by three elementary Morse signals," we find on a hurried and cursory examination:—

A. *One hundred and forty-two* words, every one of which is the *actual telegraphic equivalent* of another word, or is transmitted by *identical signals*.
B. *One hundred and twenty-two* words, every one of which differs from another word by only *one signal*, either a dot or a dash, the accidental omission, or the transmutation into the other, of that one signal turning the word into another word which in a code would bear a different meaning.
C. *Two hundred and twenty-two* words, every one of which differs from another by *one letter* only.
D. *One hundred and fifty-two* words differing from another by *the prefix* only.
E. *Eighty-eight* words having only *two letters* different.
F. *Ten printer's errors* and *misplacements*.
G. *Thirty-seven* names of *common articles*.
H. *Twenty-five* names of *days* and *months*.
K. *Six* telegraphic *service* words.
L. *Thirteen* names of *coins* and *measures*.
M. *Thirty-eight* names of *numbers*.
N. *Twenty-four* names of *places* and *districts*.
O. *One hundred and eight* names of English firms, and *Fifty-three* names of foreign firms.

A tabular statement of the above errors then follows, which, it is stated, must not be taken as exhaustive.

In fact we have already in hand evidence that the list can be greatly extended, and those of the members of the London Chamber who have used the vocabulary are sending in numerous instances of hopeless equivocation, and pointing out numerous mistakes which had escaped attention.

And let it not be said that these are purely technical objections, which would not interfere with the value of the vocabulary when in general use.

As a practical illustration of the defects of the vocabulary *when in use*, we will quote extracts from letters sent to the London Chamber by, among others, three prominent London firms:—

"We may mention," writes one, referring to experiments with words from the vocabulary, "that *in twenty-six telegrams* received or dispatched by us during a given period, no less than *forty errors* occurred in transmission."

"Our experience with it" (the vocabulary), writes another, "has been of so unsatisfactory a nature that we now wish to entirely withdraw even the qualified approval which we had previously given. *More than half the words* have arrived in a mutilated condition—some have even been incorrectly repeated—and as the vocabulary contains no 'terminational order,' it has been impossible to arrive at the meaning of some of the telegrams sent in until receipt of mail advices. We have consequently been obliged to remodel our code so as to conform to other and older vocabularies, compared with which the 'Official Vocabulary' is worse than useless."

"We have," writes a third, "been using for some months the new Official Vocabulary; we have practically tested it, and there can be no doubt that, in several respects, it is inferior to some of the word-collections which we have been using, notably 'Whitelaw's.' The latter is much more comprehensive, the words are better selected, and it has the great advantage of being provided with detectors which render the rectification of mutilated words easy and expeditious, while with the Official Vocabulary, in the absence of such detectors, such rectification is almost a hopeless task."

The compilers boast in their preface that they "have been entirely independent of pre-existing works of the same kind." From the result, we have no difficulty in believing this assertion. It only shows the unwisdom of disdaining experience.

But even if the compilers of the Official Vocabulary had kept their promise in regard to the character of the words used, there would still be ground for complaint against the compulsory adoption of that publication on account of its smallness. Whitelaw's code contains more than 300,000 words, and we doubt, as a result of long experience, whether the test suggested by the Berne compilers in their preface would result in the elimination of any considerable number. The Official Vocabulary contains a maximum of 256,000 words, and, as appears from the above examination, a very large number of them will have to be erased as unsafe for use.

The advantage of substituting compulsorily, at a time when international trade is increasing, and when code telegraphy is coming more and more extensively into use, a less complete and more faulty vocabulary for the altogether superior ones now in use is not exactly obvious. The International Telegraph Conference, we dare say, never intended such a result. It is necessary, therefore, that its attention should, at the earliest possible moment, be called to the exact facts of the case. The necessity of having a vocabulary containing as large a number of words as possible will now be greater than ever, since the liberty of invention, which had free scope before, will henceforward be effectively curtailed, and the commercial world will be strictly and compulsorily limited, in the compilation of their codes, to the actual words inserted in the Official Vocabulary, a very large number of which, as we have just shown, is altogether unsafe for use. After all, if the compilers of Whitelaw's code, whilst debarred from using geographical and proper names, have been able to arrange a code of over 300,000 words, coming up to the standard laid down by the Berne compilers, it is not very plain to us why the Berne compilers, with the help of such geographical names as Himalaya, Illyricum, &c., and of such proper names as Erasmus, &c., could not put together 256,000 words coming up to their own standard, unless we come to the sad conclusion that those experts were not as great experts in the art of vocabulary making as they might have been, and as the International Conference and the commercial world at large—considering that the result of their work would be its compulsory adoption—had a right to expect they should be.

We have said enough to show that the interests of European commerce demand a thorough revision of the Official Vocabulary before it becomes obligatory even for European telegraphy, and we trust that H.M. Government, when the question is brought before them, will not fail to pay heed to the results of commercial experience up to date, and will do their utmost to secure the postponement of the compulsory adoption of the vocabulary, and its revision at leisure under the direction of competent experts, who will not disdain experience, and will not make a point of being "independent of pre-existing works of the same kind."

Electric Transmission of Power in Egypt.—Certain American capitalists, says *Engineering*, associated with the General Electric Company, have taken steps to carry out Mr. Cope Whitehouse's plans for the development of electrical energy by water power in the North-East Fayoum. They have applied to the Egyptian Government, through the Department of State, to further their efforts, which aim at securing a concession for a trolley line from the Fayoum to Gizeh and Cairo, and the distribution of electric power for manufacturing purposes.

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The Oldest Electrical Journal, 1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "Coutts and Co."

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THE PAST SESSION AT THE INSTITUTION OF ELECTRICAL ENGINEERS.

Whatever difference of opinion there may be as to the success of the past session of the Institution of Electrical Engineers, there can be no gainsaying the fact that it has been remarkable for the great variety of the subjects dealt with in the course of the sixteen meetings that were held between the beginning of November and the end of May. The first four Papers of the session related to electric traction. These were followed at the beginning of the year by a Presidential Address on electric supply problems, and by a Paper on the telephone switchboard. The extremely rare phenomenon of a telephone Paper, although due to a practical telephonist, was not, indeed, a product of the concentrated wisdom of the staff of the National Telephone Company; but it is possible that the next session of the Institution may bring forth a Paper which will confound the critics of this Company, and vindicate the scientific ability of those who have for so many years been in sole possession of the exchange work of the Kingdom. Following on Mr. KINGSBURY's welcome contribution to contemporary telephony came a Paper on dynamo design by Mr. W. B. SAYERS. Of the five remaining Papers, two of unusual interest and importance dealt with magnetism, one with the electrolysis of gold, one with the electric lighting of railway stations and goods yards, the last Paper of the session being Mr. MARK ROBINSON's much-discussed sketch of the constructional progress of the Willans engine. A session in which there were subjects of interest for electric traction men, telephonists, dynamo designers, transformer makers, electro-chemists, engine builders and users, and those practically engaged in the illumination of open spaces and large buildings, can scarcely be adjudged a failure

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if tried by the "greatest happiness of the greatest number" test. Another noteworthy feature of the past session has been the advent of a large number of new speakers. The discussions at the Institution, it used to be said, were in the hands of a select few, and the man who really knew what he was talking about was unable to get in a word, even edgeways. That this was a fact cannot, we think, be disputed; but there is this much to be said in defence of those too frequent contributors to the Institution debates: without them there would in many instances have been no discussion at all, and if the remarks made did not add greatly to the store of floating knowledge, they rarely failed to be entertaining—no mean achievement in a gas-laden atmosphere and with no better material to work with than, let us say, the relative merits of half-a-dozen strictly similar rail bonds. The Papers and discussions of the 1894-95 session should in a measure also silence the complaint of those who thirst after practicality, but could in old days never get a sight of it on a Thursday evening at 25, Great George-street. For our own part, whilst fully admitting the need for a still more practical tone being given to the Institution debates, we trust that scientific theory, and those who expound it, may not be entirely banished to make room for buyers and sellers, contractors and manufacturers. Practical electrical engineering has benefited to an incalculable degree by the close union with scientific theory that has hitherto characterised it. We cannot too strongly combat the policy of those misguided separatists who are for ever urging the professor to stick to the lecture-room and the engineer to the workshop, with a view of bringing about that complete separation between these two factors of progress which so many engineers of the old school consider altogether natural and desirable.

An engineering journal, in a revolutionary moment, recently propounded the startling doctrine that the lecture was "an example of an absurd conservative adherence to an antique system." Emboldened by the example of our staid contemporary, we venture, not for the first time, to apply much the same language to the system of reading Papers, which still holds it own. The absurdity of the custom has been frequently exposed in these columns, and the Institution of Electrical Engineers might for once lead the way in so sensible a reform. Papers are presumably intended to be both understood and discussed. How can either end be attained by the authors getting up and running through their Papers with lightning-like rapidity and irritating inaudibility, and then sitting down with a satisfied sigh to await the comments of the audience, the majority of whom have never seen the Papers in print, and even the more favoured of whom have probably received them without diagrams and only a day or two before the date of reading? If it were a regular custom, as in all well-managed institutions it certainly should be, to send out proofs of all Papers complete with diagrams a week or ten days before the meeting, that perfunctory performance of reading the entire lucubration becomes mere wanton waste of time. If, on the other hand, the audience is left to gather what it can concerning the Paper from its *viva voce* delivery, then every care should be taken to ensure that the Paper is read in a suitable manner; an end that is best attained by entrusting the task of reading to some official accustomed to the work.

A final suggestion and we have done. We have of late had frequent occasion to bring to the notice of our readers the advance which is being made in electro-chemistry, both on the Continent and in the United States, and to regret that a subject, day by day becoming of more and more industrial importance, should find so little encouragement in this country. In the last session of the Institution of Electrical Engineers there was indeed one electrolytic Paper read, and this led to a discussion which should encourage those responsible to see that this branch of applied electricity is still better represented in the future. Both in Germany and in the United States special societies for the reading and discussion of Papers dealing with electro-chemical subjects have been formed. The formation of specialist societies is not, however, to be encouraged; more good will accrue from the fuller development of existing institutions. At present those engaged in electro-chemical work range from men on the one hand who are very well qualified as electrical engineers, but who have small knowledge of chemistry, to men who are well-trained chemists, but whose electrical knowledge is weak. Both these classes would benefit by mixing more with each other and interchanging views. There is also a large number of electrical engineers and of chemists who take an interest in electro-chemical questions, though not actually themselves engaged in any electro-chemical industry. In these circumstances there is, it seems to us, more to be gained by a greater freedom of intercourse between electrical engineers and chemists than by starting an Electro-Chemical Society, which would tend to the narrowness inseparable from specialism. The arrangements made by the Royal Society on the occasion of the reading of the Paper on "Argon" by Lord Rayleigh and Prof. Ramsay are an illustration of a course which might well be more frequently adopted. For instance, when an electrolytic Paper is to be brought before the Institution of Electrical Engineers, special notice of the date of the meeting might be sent to the Chemical Societies, and *vice versâ*. As it is, the secretaries of the various societies already send invitations to men belonging to other societies whom they are informed are interested in the subject down for discussion, but the invitation not being, as a rule, addressed to a society as a whole, only certain men get invited, and not always those who have most to gain by attendance. So far as the chemists are concerned, there is little difficulty, as there is only one electrical society, namely, the Institution of Electrical Engineers, to which the dates of meetings would have to be communicated; but when we come to arrangements between electrical engineers and chemists the case is different, for there is not only the Chemical Society, but also the Society of Chemical Industry and the Society of Public Analysts. However, as all these three societies are represented on the Council of the Institute of Chemistry, the notification to the chemical profession at large might, without much difficulty, be made through that body.

If the programme for the ensuing session of the Institution comprises a somewhat larger proportion of Papers dealing with electro-chemistry, together with a Paper or two on central station management, and perhaps one dealing in a broad philosophic manner with the design and manufacture of electrical measuring instruments, no important section of the electrical industry will have been neglected. An engineering society should, of course, exist for other purposes than the reading and printing of Papers and the origination of discussions. The initiation and carrying out of tests and trials, the results of which would be of the greatest value to the industry at large, though beyond the province of any individual member of it; the exercise of some degree of censorship over professional conduct, are matters well worth the attention of an institution which has been nearly a quarter of a century in existence and which represents a profession where the calling of consulting engineer's canvasser flourishes like the proverbial green-bay tree and where a perplexing variety of functions is too often performed by one and the same versatile individual.

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REVIEWS.

Petroleum: Its Development and Uses. By R. Nelson Boyd. (London: Whittaker and Co. 1895.)

In this handy little brochure of some 85 pages the author has put together a considerable amount of interesting information, relative to the occurrence, commercial preparation and uses of petroleum. No attempt to compile a formal treatise or text-book has been made; but as text-books on petroleum, of a very voluminous nature, are following one another rapidly into the market, the author has probably not erred in making his book small and placing it within the reach of everyone. The author has something to say about most of the modern applications of petroleum; but he does not appear to have made himself as sure of some of his facts as might be desired, and there is a looseness or vagueness about much of his writing which is apt to leave the reader in doubt. For example, in referring to the use of petroleum refuse as liquid fuel, he says:

"Considering that liquid fuel, if properly consumed in a locomotive, does not emit either smoke or noxious vapours, it seems surprising that it has not been adopted on our underground railways. There might be some reason for this; perhaps the frequent stoppages may be supposed to interfere with the combustion, and yet one would think that any mechanical difficulties could be overcome. It is certain that if a smokeless fuel could be adopted in the tunnels of the underground railways instead of the sulphurous coke at present used, it would be a great comfort to the millions of passengers who travel by these lines."

Now, if the author had taken the trouble to ascertain the price of a ton of petroleum refuse on the underground locomotives, he would have seen at a glance why this fuel is not used; while if he had pushed his inquiries further, and investigated the apparatus employed on Russian and other oil-driven locomotives, he would not have suspected that the "frequent stoppages" would be more troublesome with oil fuel than with coal, nor that there were any mechanical difficulties yet to be overcome in this respect. It is not improbable that the market price of astatki will in time become considerably reduced, and in that happy future we may see, not only underground locomotives, but steam boilers of every class fired by this pliant and economical liquid fuel.

In a short but interesting chapter the author summarises the various theories of the origin of petroleum which have been advanced by experts. Mr. Boyd strongly inclines to the hypothesis of organic origin, a view which has received tremendous support in Dr. Engler's successful production of artificial petroleum by the distillation of animal fats and oils at a moderate temperature and under great pressure. A contemporary has recently stated that "a hundred thousand whales would be required to supply as much oil as Baku exports yearly"; but this does not by any means reduce the organic hypothesis to an absurdity; for, as Mr. Boyd shows, "oil is frequently found in strata devoid of any trace of past animal life; but it is well known that petroleum flows for long distances from the point of its production or storage in the earth." The products of many hundreds of square miles of natural manufacture may conceivably be collected and tapped under a very small area of actual petroleum field. Moreover, there is no need to hypothecate great whales, for there is or has been at some time an enormous amount of microscopic organic matter in sedimentary rock; a fact, which a careful examination of drift is sufficient to explain, or which is readily accounted for by the processes by which sedimentary rocks are formed.

We can recommend this little book to anyone who wishes to learn a few general facts about petroleum.

Extracts from the Private Letters of the late Sir William Fothergill Cooke, 1836-9, relating to the Invention and Development of the Electric Telegraph. Also a Memoir by Latimer Clark, Esq., F.R.S., Past President Institution E.E. Edited by F. H. Webb, Secretary. (E. and F. N. Spon, London and New York.)

The publication of these letters, previously accessible only in the library of the Institution of Electrical Engineers, will be welcomed by everybody interested in the early history of electric telegraphy, and perhaps hardly less so by the student of human nature as exemplified in the personalities of Messrs. Cooke and Wheatstone. The question as to the relative claims of these two inventors is pretty well settled by this correspondence, which of itself is a remarkable proof of Cooke's foresight and business capacity. The letters are addressed to his mother chiefly, while his experiments were in process, and describe with more or less circumstantiality the progress he makes in constructing a practical working electric signalling system; and this avowedly with the object of establishing the facts in writing, on paper bearing the date stamp impression of the post office, in case his claims to priority of invention should be subsequently challenged. But it by no means follows that we need attempt the apportionment of these respective claims; posterity will do that. Suffice it, that Cooke had the insight to perceive the enormous value of the invention, and the energy to push it into complete realisation. He had also the proverbial good luck which favours all capable men, and had barely shaped out his project before meeting with "a Mr. Wheatstone," who in a scientific way had been experimenting on similar lines. The relations of these two men are most interesting as illustrating the inevitable friction where high science and the practical mind come into close contact. It is instructive, also, to note that even Faraday shook his head over Cooke's grand schemes, and would say nothing to lead him to expend time and money on what might prove a profitless quest. But Wheatstone, besides being a chemist, was a mechanist of singular ingenuity, and whatever may be said as to his share in originating the electric telegraph his fame will ever be associated with the perfection of the appliances which have made it what it is to-day. It is curious, however, to note in these pages that the man who subsequently made one wire do the work of 10 or 15, was originally engaged in the problem of how to make almost as many wires answer a purpose which one would have served quite as well. In Cooke's and in Wheatstone's hands alike the invention was singularly immature at first. But the time was ripe; railways, then rapidly developing, greatly needed assistance of this kind; and perhaps the most remarkable feature about the telegraph is the short space of time it took to grow to maturity. All this is told in the brief pages which Mr. F. H. Webb has edited with admirable taste by permission of the Institution of which he is the secretary. An excellent portrait of Sir W. F. Cooke and some fac simile letters adorn the booklet; and a memoir by Mr. Latimer Clark, reprinted from the Institution *Journal*, fittingly completes a worthy memento of the origin of, perhaps, the greatest invention of the age.

Lehrbuch der Experimentalphysik. By Adolph Wüllner. Vol. I., General Physics and Acoustics. (Teubner, Leipzig. 12s.). Fifth Edition.

The first volume of the new edition of this well-known work is brought up to date as far as the end of 1892. As before, a few references are given in the text, and a summary of the literature is placed at the end of some of the most important sections. The peculiar, and for some readers the most valuable, feature of this work is that it introduces the higher mathematics into the discussion of physical problems where necessary, while an admirable introductory chapter on the chief theorems and operations of the calculus enables the reader to follow these discussions without the necessity of a close acquaintance with higher methods. At the same time, the book seems to take nothing for granted in the way of physical science, and the most elementary instruments and problems are effectively dealt with. The subject of the dimensions of physical quantities is just touched upon, and might have been treated a good deal more fully with advantage. In the chapter on the conservation of "work" the term "energy" should have been substituted, and the designation of $\frac{1}{2}mv^2$ as *vis viva* is rather more erroneous than antiquated. The chapter on the mechanical properties of solids is satisfactory, and under Friction we find Boltzmann's theory of the internal friction of solids fully dealt with. The same may be said of the chapter on Liquids, which includes such subjects as drops and surface tension, and is quite up to date. Considering the great progress recently made with mercurial air pumps, the section dealing with these is somewhat meagre, but allowance should be made for an *embarras de richesse* in this field, and the

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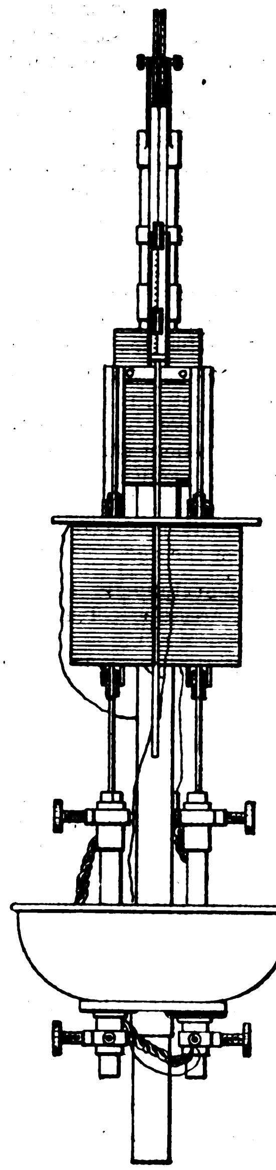
chapters on diffusion and the kinetic theory of liquids afford some compensation. The section on wave motion is perhaps the best in the whole book, and forms a valuable introduction to the theory of sound, which makes up the second part of this volume. The beautiful experiments of Krigar-Menzel and Raps on the mode of vibration of bowed strings meet with the notice they deserve, and the curious phenomenon of the uniform velocity of the centre is brought out well by the photographic traces. Altogether, the subject of sound is about as fully dealt with as lovers of this rather neglected field of physics can well expect nowadays. Taking the volume as a whole, we may say that it is a good combination of high-class subject matter and excellent illustration. The binding is, as usual, faulty, but the print, in the Roman letters now almost universally adopted in German scientific books, leaves nothing to be desired.

THE GWYNNE DOUBLE-CARBON PHOTOGRAPHIC ARC LAMP.

We were afforded, a few days ago, an opportunity of inspecting a new double-carbon photographic arc lamp which is being put on

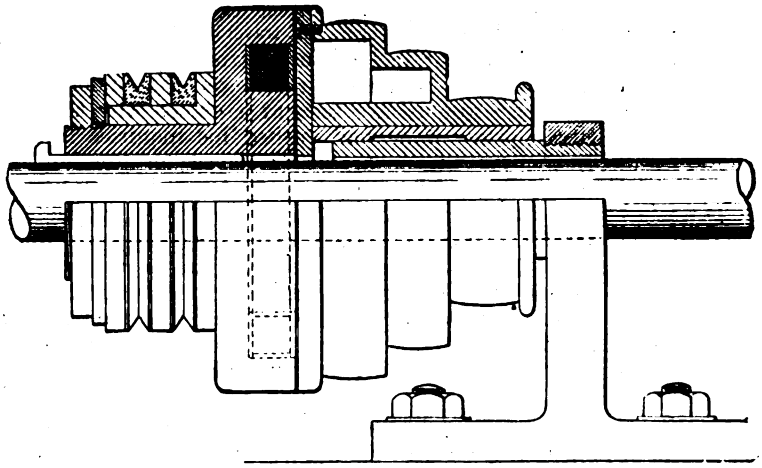


Gwynne Double-Carbon Photographic Arc Lamp.

the market by Messrs. Gwynne and Co., of Brook-street Works, Holborn. The great advantage of a double-carbon lamp over one with a single-carbon is the saving of current to the photographer, since for photographic purposes as good if not a better light is obtained with this arrangement with a total current of 25 amperes than with a single pair of carbons taking 50 amperes. Then, again, the roaring that accompanies a large current lamp when first switched on, is practically done away with. Photographers have also experienced considerable difficulty in getting so large a current as 50 amperes, and in many cases they have had to do without the electric light altogether, because the supply companies cannot have so large a current switched on and off upsetting the rest of their circuit. The accompanying illustration shows the working parts of this lamp.

THE HOLDEN MAGNETIC CLUTCH.

The accompanying illustration represents a magnetic clutch devised by Major Holden, and which has been found to be a great convenience at Woolwich Arsenal, where it has been tried practically for some time past. Now that the advantages of electrical transmission of power in workshops in place of heavy belting and gearing have been recognised, the field for magnetic clutches is likely to become a wide one, as the most economical results will probably be obtained from a motor of fair size driving a short line of countershaft from which the various machines are run. A clutch of the size represented is capable of transmitting at 350 revolutions 3 H.P. in regular work, the expenditure of electrical energy during the time that the clutch is in action being less than 20 watts. Simple forms of switch have been devised for starting and stopping, one form being similar to the arrangement in ordinary



Holden Magnetic Clutch.

use with fast and loose pulleys, where pulling one cord starts, and the other stops the machine, and another form which is actuated by one cord only, the switch being put on and off by alternate pulls of the cord. Messrs. Drake and Gorham are joint patentees with Major Holden.

LONDON COUNTY COUNCIL.

LOANS FOR MUNICIPAL ELECTRIC LIGHTING.

At the usual weekly meeting of the London County Council, held last Tuesday at the County Hall, Spring-gardens, Sir Arthur Arnold presiding, the Finance Committee reported that they had considered an application from the St. Pancras Vestry for a further loan of £75,000 for electric light purposes. As would be in the recollection of the Council, the Vestry had already established an electric light station in Stanhope-street, had laid mains in various streets, and had built battery sub-stations in High-street, Camden Town, and in Regent's Park-road. On those various works the Council had already advanced or sanctioned loans to the extent of £107,700, and the Vestry finding that the demand for electricity was increasing beyond the capacity of the Stanhope-street station, and also to assist in disposing of the parish refuse, now proposed to construct a combined electric lighting station and refuse destructor, for which the present loan was required. The Vestry had acquired certain premises in King's-road, Camden Town, for a central lighting station, for £8,592, and Bangor Wharf, in connection with the collection, removal and disposal of house and street refuse (to be used in connection with the electric station for £9,924.) The building and works were estimated to cost £27,201, and contracts had been entered into for about £25,000 of that amount. The cost of the necessary engines, dynamos, boilers, switchboards, mains, &c., was

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estimated at £35,569, in respect of which contracts had already been entered into for £32,092. In addition to the electric lighting machinery there was an engine and boiler, two mortar mills, stone breaker, fans, and other appliances intended for use with the refuse destructor, in respect of which contracts had been taken for £1,100, making, with professional and other charges, a total of £34,760. The Vestry asked that the whole cost might be treated as a loan for electric lighting purposes, and spread over 42 years, but the Committee were of opinion that the cost in connection with the removal and disposal of the street and house refuse must be treated separately, and regard had to the life of that part of the outlay. As the Vestry did not require to take up the whole of the £75,000 at once, they considered that the loan should be limited to the amount at present required, viz., £56,100, and made subject to a restriction as to further borrowing to supply any necessary replacement of plant and machinery until the amount raised had been paid off, any plant requiring to be renewed in the interim being defrayed out of a sinking fund for renewals or from maintenance account. They accordingly made recommendations to this effect, which were agreed to.

The Committee also presented an urgency report, in which they stated that they had again had under consideration the application of the Vestry of Islington for a loan of £51,000 for the purposes of electric lighting. On January 22nd last they recommended the Council to sanction a loan of £18,000 towards the cost of erecting a central station at Eden-grove, Holloway, repayable in 50 years, and of £33,000 to provide the necessary plant and machinery, mains and pipes, repayable in 20 years. The consideration of the matter was adjourned by the Council from the 22nd to January the 29th, when the recommendation was withdrawn on the implied understanding that a further representation should be made to the Treasury with a view to obtaining an alteration in the periods to be allowed for repayment of loans for the initial cost of electric lighting installations. Their further correspondence with the Treasury having been communicated to the Vestry, the Committee informed them of their willingness to recommend the Council to sanction the borrowing of the £51,000 on the terms set out by the Treasury, either for 42 years for the whole amount, or divided into terms of 50 and 20 years. The Vestry replied that they were not prepared to accept the terms offered, and asked the Council to sanction the borrowing of the sum required, unconditionally, the loan to be repaid as provided by Section 190 of the Metropolis Management Act, 1855. In making that request it did not appear to the Committee that the Vestry had sufficiently recognised the fact that it was the duty of the Council not only to see that loans were required for the purposes authorised by the statute, but to safeguard the interest of future ratepayers by not allowing any burthen of debt to be placed on them which should be borne by the present occupiers. In offering the Islington Vestry the same terms as St. Pancras—who accepted them—the Committee thought they had gone as far as the Council could reasonably be asked to go in facilitating the borrowing of money, and therefore they could not advise the Council to give an unconditional sanction to the Vestry borrowing the £51,000. The Vestry had since reconsidered the matter, and now asked the Council to sanction the borrowing of the £51,000, and also to lend the money at £2. 17s. 6d. per cent., the loan to be repayable in 42 years on the annuity system. That request might now be complied with, subject to a restriction as to further borrowing to supply any necessary replacement to plant and machinery until the amount raised had been paid off.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *July 20, 1895.*

New Problems in Electric Traction.—That the transmission of several thousand amperes of current by means of a sliding contact trolley is not a simple matter has been demonstrated in the recent trials of the 96-ton electric locomotive at Baltimore. When the channel in which the sliding trolley shoe runs is clean, no particular trouble is experienced; but, unfortunately, the dampness of the tunnel causes rust to quickly gather, which in turn sets up "fireworks" of considerable magnitude upon the passage of the shoe. Several weeks ago this resulted in the shoe becoming red hot and wedged or welded into the channel while a heavy train was being moved, and now a cleaning arrangement run by an electric motor is employed to keep the contact surfaces clean. In some recent high-speed electric trials at Nantasket Beach, Mass., it was demonstrated that the ordinary trolley line is unsuited for such work. At high speeds the trolley wheel was thrown off in passing under trolley-hangers, and the flashes from the sparks kept up a continuous illumination above the car.

Electric Railway Law Suits.—In a few months the principal case relating to the invention of the trolley will come up for trial, and in view of a recent decision the outcome is a matter of some doubt, notwithstanding that numerous forms of trolleys had been patented years ago for transmitting telegraph currents to moving trains. In a patent suit decided several weeks ago the Court took the position that the inventor, whose patent for a combination of a trolley, trolley support and overhead turn-out switch was sustained, had accomplished by his labours the solution of the electric railway problem, and therefore should be treated in the most liberal spirit. As the judges who decide patent questions in United States courts are entirely ignorant of the technical matters entering, and many apparently cannot grasp the simplest technical ideas, they are very prone to raise general issues or adduce "broad principles," and upon these base their decisions. Unfortunately, they are as apt to go astray in this direction as in the other, as shown in a number of instances. In the feeder-and-main suit, for example, a learned judge established the principle that without Edison's discovery involved in the patent, incandescent lighting from central stations would have been impossible, and in the recent railway suit the judge was apparently of the opinion that, notwithstanding what he believed to be superhuman efforts on the part of inventors throughout the world, electric traction remained impossible until Van Depoele invented some trolley details and a turn-out switch. All of which goes to show the necessity of patent courts with judges competent to consider technical issues.

LEGAL INTELLIGENCE.

Wandsworth District Board of Works v. The County of London and Brush Provincial Electric Lighting Company (Limited).

Mr. Channell, Q.C., with whom was Mr. Chubb, applied to Mr. Justice Stirling, in the Chancery Division, on Tuesday last, on behalf of the plaintiffs in this case, that the defendants, their servants and agents, be restrained by order and injunction from "excavating or constructing or placing in or under any highway within the district of and vested in the plaintiffs' Board any transforming or converting stations, or other chambers or receptacles, for the purpose of containing transformers or other apparatus for the purpose of transforming or converting electrical energy at a high pressure to energy at a low pressure, and from constructing or placing in or under any such highway any other chambers or stations, not being street boxes authorised by Clause 12 of the Provisional Order granted by the Board of Trade in respect to Wandsworth, and scheduled to the Electric Light Orders Confirmation (No. 5) Act, 1892, and from using any boxes constructed by the defendants under the powers of the said Act for the purpose of transforming electrical energy as aforesaid or for any other purposes not authorised by the said Clause 12."

The learned COUNSEL stated that the question for his Lordship was whether what the defendants were proposing to do came within the powers conferred upon them by their Provisional Order. The matter turned really upon Section 12 of the Order. Under Section 11, the undertakers were bound to supply the electrical energy by a system approved by the Board of Trade, and subject to such regulations as the Board might make. By Section 12 the undertakers were authorised, subject to the provisions of the Order and the principal Act, and any regulations made under the Order, to "construct in any street such boxes as may be necessary for purposes in connection with the supply of energy." Section 12 provides that "No such box shall be placed above ground without the consent of the Local Authority, and every such box shall be used by the undertakers only for the purpose of leading off service lines and other distributing conductors, or for examining, testing, regulating, measuring, directing, or controlling the supply of energy, or for examining or testing the condition of the mains or other portions of the works, or for other like purposes connected with the undertaking, and the undertakers are authorised to place therein meters, switches, and any other suitable and proper apparatus for any of the above purposes. Having provided that the undertakers might construct "boxes," the section proceeded to limit the use of these boxes. His case was a double one: first, that these were not "boxes" within the meaning of the word as here used; and, secondly, that if they could be so construed, the use which it was proposed to make of them did not come within the second part of the clause. The electric power was to be transformed from a higher to a lower pressure. At first it was the universal practice to have a separate transformer for each customer upon his own premises, but it had since been found more economical to have the transformer transform the current at a particular point, and to use the conductors of secondary current to supply a number of houses within a limited area. It appeared

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from the affidavits that the area most economical to supply in that way was one about 200 yards from the transformer, and the system had been introduced into America and recently into this country. There then arose the question as to where those transformers were to be placed. The undertakers here claimed the right, as a right, under their compulsory powers, to place them under the street. What the defendant Company desired in the present case was to make chambers of considerable size—10ft. 3in. deep, 7ft. 6in. long, and 5ft. 6in. wide. The Board of Trade had certain powers in the matter, and there had been proceedings and objections and discussions before the Board, by means of a reference. Sir Courtenay Boyle, when this particular point arose, pointed out that it was a question for the Courts and not for him, as it was a question of the construction of an Act of Parliament, and therefore not within the jurisdiction of the Board of Trade. Thereafter the defendant Company altered their phraseology considerably. They (the defendants) gave the plaintiffs, when they went before the Board of Trade, a plan of what they wanted to do, and they then rightly called these "transforming chambers," but they now called it a box which was to contain transformers—a manhole and ventilating apparatus. One of the regulations made by the Board of Trade for supply in this case, was that the converting stations were to be street boxes of sufficient size and suitable construction to contain several transformers, room to be provided to enable a man to enter the box and conveniently examine the transforming and controlling apparatus; but the Board had propounded these regulations upon the assumption that it was within the power of the undertakers to do that, the legality of which the plaintiffs now asked this Court to determine on the interpretation of the Act of Parliament. It was extremely inconvenient to the public, and for the public purposes for which the streets were vested in the Local Board, that these large chambers should be constructed under the streets. The Board based their action upon that consideration, and also upon the consideration of the public safety, for there had been recent instances of serious accidents occurring through the presence of these chambers in the streets. Mr. Channell then read the evidence of Mr. Crompton, an electrical engineer, who declared that "street boxes" had a well-known meaning, and applied to the small boxes beneath the pavement used to get access to the wires for testing and for leading off branches, and the word could not be reasonably construed to include transforming or converting chambers. Mr. Channell here added that the question was whether these undertakers were to have the right to get this use of the public streets without payment, or whether they were to construct these chambers in cellars or upon other private property which they could have for a small additional payment. The next affidavit read by the learned Counsel was made by Dr. John Hopkinson, whose evidence was on the same lines as that of Mr. Crompton.

Mr. GRAHAM HASTINGS then read the affidavit of Prof. Silvanus P. Thompson, who differed from the opinion of the plaintiffs' experts, and said that if the boxes were on private property they could not be so well looked after or kept sufficiently dry. He found that Clause 12 of the Act said that the boxes were to be such as were necessary for the purposes in connection with the supply of energy, including apparatus for the proper ventilation of the boxes; and all the apparatus which the undertakers proposed to place in the street boxes fell within that description. Affidavits which had been made by Sir F. Bramwell, Dr. J. A. Fleming, and Mr. Lawson, the defendant Company's manager, were also read.

Mr. CHANNELL submitted that the evidence showed that street boxes had all along been understood to be a very different thing from transforming chambers. When they wanted a place such as the defendants here contemplated, they called it a chamber and not a box, and his affidavits were precise to the effect that, until the present case, "street boxes" were never used for such purposes as the defendants had in view. But assuming it to be only a box, there was statutory prohibition of the use of such boxes, for their use was restricted to certain specified purposes. "Transforming" was a thoroughly well-known operation which had its known name. If it had been intended that operation should be carried on in these boxes, it would have been inserted in the clause in question.

Mr. CHUBB, on the same side, contended that Parliament had never considered the question of allowing transforming sub-stations to be formed under the public streets, and the defendants here were trying by means of a back door to secure that.

Mr. GRAHAM HASTINGS, Q.C., with whom was Mr. Cripps, Q.C., Mr. Shand and Mr. Braithwaite, for the defendants, said that the only question the Court had to determine was the construction of the 12th clause, and in approaching an Act of Parliament like that one had to consider what it was for and what the state of circumstances were at the time the Act was passed. The object of the Act was to enable the Company to supply electricity to a certain district, so that one would suppose that they would have all the necessary powers to enable them to carry out those objects. Also, one would expect to find, having regard to the fact that science was extending itself—and especially electrical science, which was supposed to have been in its infancy at that time—that the Legislature would have been very careful not to do anything which might preclude the Company from availing itself of any improvements conferred in carrying it into effect. Therefore one would expect to find—which he submitted they did plainly find—that the Legislature would have been careful not to introduce any word of art in the particular portion of the clause which was under consideration. He thought that it was impossible to read the terms of the 12th section without coming to the conclusion that every word used for that purpose was a word of ordinary and general signification in the English language, and not in any sense used in a technical way. It really seemed to him that inconvenience had nothing to do with the case. If the Company had got the power to do it, it was immaterial what the plaintiffs thought or felt. Mr. Channell's first point was, that what the defendants were proposing to construct was not a box at all. The first observation he had to make was that the word "box" was a most generic expression, and it might be applied to a species of infinite variety.

His LORDSHIP: Including coffins!

Mr. HASTINGS agreed. He submitted that the Legislature had chosen an expression with the widest possible meaning. He contended that the intention of the Legislature was that they would not use any words which should have any limitations. There was no limitation as to size or materials. Subject to the satisfaction of the Board of Trade, who had the public to watch over, they might make a box of any materials they liked—of brick, wood or iron; but it was not any the less a box in its generic sense, and there was nothing in that clause which said it was to be of any particular kind or description. The only thing was that it was to be for purposes in connection with the supply of energy.

Mr. CRIPPS, following on the same side, submitted with regard to Section 12 that there was no word of art at all in it, and said that all the affidavits, except so far as regarded mere questions of fact, were practically and substantially immaterial. The only question of fact which was material was in Mr. Lawson's affidavit as to the system in work in the City of London. His Lordship was aware that the defendants had power to enter upon and break up the street, and the only question was whether, in carrying out that power, they had authority to make this particular form of "street box."

His LORDSHIP intimated that he would reserve judgment, and judgment was reserved accordingly.

British Insulated Wire Company v. The Prescot Urban District Council.

This case came before Mr. Baron Pollock and Mr. Justice Wright on Monday last in the form of a special case, raising the point whether a contract without providing for a pecuniary penalty was void or not as construed by the Public Health Act, 1875, Section 174, Sub-section 2, by which it is provided as follows:—"Every such contract . . . . shall specify some pecuniary penalty to be paid in case the terms of the contract are not duly performed." The original action was commenced on May 18th last, and the questions of law arising therein were raised for the opinion of the Court by order of Mr. Justice Day.

On November 12, 1892, the plaintiffs and the Prescot Local Board entered into an arrangement whereby it was agreed that the Company should efficiently light the streets within the district of the Local Board, in terms fully set out.

After setting out that the agreement was sealed by both parties, the special case stated that the plaintiffs carried out the agreement by supplying the electric light from January 1, 1893, until March 31, 1895, and had been paid the amounts payable in accordance with the terms of the agreement for the supply of light to the end of the quarter ending June 30, 1894, and that the action was brought to recover £278. 9s. 9d., which included three quarterly payments of £87. 10s. respectively for October 1, 1894, January 1, 1895, and April 1, 1895, the balance being made up of three sums for extra lamps.

The question for the opinion of the Court was whether the agreement was void, or not binding upon, or not enforceable against, the defendants by reason that the agreement did not specify some pecuniary penalty to be paid in case the terms of the contract were not duly performed.

Mr. ARKLE, for the plaintiffs, said that the facts had been agreed, and the only point between the parties was whether the absence of a penalty clause in the contract vitiated it under the substitution. He contended that the clause in the Act regarding this was merely directory, and he cited the cases of "Young v. the Mayor of Leamington," "Melliss v. the Shirley Local Board," and "Noel v. Worcester" in support of his contention.

Mr. Baron POLLOCK, without calling upon counsel for the defendants, said that he was of opinion that the agreement was not binding, and Mr. Justice WRIGHT concurring, judgment was entered for the defendants, with costs.

Shelfer v. The City of London Electric Lighting Company (Limited) and Meux's Brewery Company (Limited) v. The City of London Electric Lighting Company (Limited).

On Wednesday last these cases came before the Court of Appeal, composed of Lords Justices Lindley, Lopes, and Rigby, it being the application of the defendants that the restraint imposed by the order of the Court on December 18th last might be suspended until the second motion day in next sittings.

It will be remembered that this was a case in which an injunction was granted against the defendants in respect of vibration caused to a neighbouring public-house.

It was ultimately arranged that the matter should stand over till next Wednesday, the time enlarged till then, with liberty to apply.

Edison and Swan United Electric Light Company (Limited) v. Gustav Strauss.

In the Chancery Division, on Tuesday, Mr. Graham asked leave of Mr. Justice Stirling to mention a motion in this case. The learned Counsel said that it was an action to restrain two kinds of infringement of a patent. The defendant was willing to submit to an order as to the first infringement, but was prepared to contest the other. He (Mr. Graham) therefore asked, in terms which had been egreed, an injunction to restrain Mr. Strauss from continuing the first infringement, and that the motion with regard to the second infringement should stand till the hearing of the action, the costs being reserved.

His Lordship made the order on the terms asked for.

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Wood v. Woodhouse and Rawson United (Limited).

On Wednesday, Mr. HOWARD WRIGHT, on behalf of the Official Receiver and liquidator in this matter, stated that in regard to his Lordship's recent order that a meeting of the debenture-holders of the Company should be held with a view to ascertaining whether they were in favour of instituting proceedings against certain officers of the Company, a majority of the Six per Cent. Debenture-holders and a majority of the Five and a-Half per Cent. Debenture-holders (having only a second floating charge) were against the proposed proceedings, and the Ten per Cent. Debenture stockholders, who had a security on specific assets, were unanimously against the proceedings.

Mr. Justice VAUGHAN WILLIAMS asked what were the motives which had induced them to come to that view. Did they dissent from counsel's opinion on the subject, or think the suggested proceedings too risky, or that the people to be proceeded against were not worth powder and shot?

Mr. MACNAGHTEN, for some of the debenture-holders, said all these views had influenced the meetings. Those who wished to go on would have had to subscribe the necessary funds to enable the action to be taken.

Mr. CARTMELL said that a minority of the Five and a-Half per Cent. Debenture-holders wished proceedings to be taken, but did not want to be put to any expense in the matter.

Mr. Justice VAUGHAN WILLIAMS directed a further meeting of all three classes of debenture-holders to be held, in order to ascertain whether those who did not wish to go on were willing to give up all claims to any assets which might be produced by the proceedings in favour of those who wanted the proceedings to be taken.

CORRESPONDENCE.

SHIPBOARD GALVANOMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to that portion of Mr. Rymer-Jones's letter (see *The Electrician*, July 26th, p. 428) dealing with the figure of merit of my galvanometer when suspended for sea use, perhaps you will allow me to mention that for this purpose the suspending wires must necessarily be of sufficient strength and rigidity to prevent sagging of the coil from side to side and end to end as the vessel rolls and pitches.

For measurements on shore, however, sensibility can be augmented some five-fold by more finely suspending the coil, and nearly as much as ten-fold by also letting it swing freely from above, the current being led away below by a fine non-torsional wire spiral. It is simply a question of suspension, but except for very delicate laboratory observations, the ordinary plan of a top and bottom suspension is preferable, as this secures greater freedom from vibration, without a masonry pillar or other special support for the instrument. I may say that Messrs. Elliott Brothers supply coils wound and suspended for all requirements. You will oblige me greatly by inserting this letter in your columns.—Yours, &c.,

H. W. SULLIVAN.

BOOKS RECEIVED.

Transactions of the American Institute of Electrical Engineers. Vol. XI. 1894.

"Solution and Electrolysis." By W. C. D. Whetham. (London: C. J. Clay and Sons).

"Record of Transactions of the Junior Engineering Society." Vol. IV., 1893-4. Edited by Walter T. Dunn. Published by the Society.

Journal of the Institution of Electrical Engineers. No. 118. Vol. XXIV. Edited by F. H. Webb. London: E. and F. N. Spon. Price, 5s.

Accident Insurance Law in Germany.—A recent German legal decision is to the effect that an accident insurance policy does not cover death from chemical but only from mechanical causes. The question arose upon the policy of a Dr. Oergel, who died last year, says the *Gas World*, from accidentally getting cholera-material into his system. The Court decided that the action of this is chemical, not mechanical. It is pointed out that the same argument would apply to sulphuric acid or soda acid; that even a fatal scald from a burst boiler or a burn from an exploding lamp produces death not through mechanical but through chemico-physiological action.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices:—*

LABORATORY NOTES AND FORMS.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett (*now ready*). Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s. —each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

A SHEET TABLE showing Total Capital Outlay and Receipts and Expenditure for the year 1894 of the Statutory Electric Supply Undertakings of the Metropolis is now ready, printed on thick paper, price 6d. each.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. nett, is now ready.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson, price 6s. 6d., post free.

TENDERS INVITED.—The Corporation of Brighton require tenders for the supply and erection, at their electricity works, North-road, of evaporative brass tube surface condensers, electrically-driven air pumps, and exhaust and condenser pipings. Tenders must be in before 10 o'clock August 10th.

——— Tenders are invited by the Vestry of Hammersmith, London, W., for complete schemes for public and private lighting, and for the supply of motor power in the compulsory area of the Vestry's Provisional Order. Further information can be obtained of Mr. H. Mair, Surveyor to the Vestry. Tenders have to be sent in by 6:30 p.m. of Wednesday, September 4th.

——— The Electric Lighting Committee of the Wakefield Corporation invite tenders for the supply and erection of (*a*) boiler and fittings, mechanical stokers and engine, economiser, feed pump, injector, &c.; (*b*) steam alternators, condensers, oil filter, fittings, &c., steam, exhaust, feed, blow-off and sundry pipes, valves and water tank, &c.; (*c*) main switchboard and instruments; (*d*) cables, junction boxes, culverts, and trenching, &c.; (*e*) transformers and switchboard, &c.; (*f*) arc lamps and posts; (*g*) meters, and (*h*) overhead crane. Plans and specifications may be obtained from Mr. Robert Hammond, the consulting engineer, Ormond House, Great Trinity-lane, London, E.C., after Friday next, August 2nd, and tenders, addressed to the Town Clerk (Mr. Chas. Jas. Hudson), Town Hall, Wakefield, must be in by 2 p.m. on Saturday, August 24th. Some further particulars appear in our advertisement columns.

——— The Corporation of Cardiff require tenders for wiring and supplying and fixing of fittings for the electric light for the new bath in Guildford-crescent, Cardiff. Particulars of the Borough Engineer. Tenders to be in by 9:30 Wednesday, August 7th.

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Tenders Invited.—Tenders are invited for the electric lighting of the King's Cross Constitutional Club, Halifax. Tenders by the 5th instant to the Chairman of the House Committee.

——— The Lord Provost, Magistrates, and Council of Edinburgh require tenders for the supply of (1) insulated concentric cable for high-pressure alternating current, and (2) for transformers. Specifications may be obtained from the Resident Electrical Engineer (Mr. E. W. Monkhouse), 5, Dewar-place, and tenders must be sent in to the Town Clerk (Mr. Thomas Hunter, W.S.), City Chambers, Edinburgh, by 10 a.m. on Friday next, the 9th inst. Additional particulars appear in our advertisement columns.

——— The General Direction of French Posts and Telegraphs is inviting tenders for the construction and equipment of a head telephone office in the Rue Chaudron, Paris. Tenders to the Direction Générale des Postes et des Télégraphes, 103, Rue de Grenelle, Paris, by the 8th instant.

——— The Blackpool Corporation are willing to receive tenders for the right of user for a period of seven years of the electric tramways in Lytham-road, and which extend northwards from the southern boundary of the borough for about two miles. An approved overhead wire and trolley system is to be used for a portion of the route, and for the remainder the conduit or central channel system now laid down by the Corporation under the roadway. All particulars can be obtained of the Town Clerk, to whom tenders have to be sent in by August 17th before 12 noon.

——— The Vienna (Austria) Municipal Authorities invite tenders for a railway system worked by electric power in the municipal district of Vienna. The Municipality itself acquires the concession for the building and working of the track. Competition is now open for the execution of the plans, and tenders are invited for the construction and working of the lines. An official notice states that direct communication is to be facilitated between the centre of the first district and the outlying districts and summer resorts. The lines are to pass as near as possible certain important spots, and must in addition touch the principal railway systems of the city. For this purpose both radiating and circular lines will be necessary. Some portion of the line will have to be worked underground, and facilities will be offered for overhead running for the other portions. Firms tendering will be required to specify the gauge, curves and gradients, the positions of the distributing stations, types of cars and all other essential details. The track is to be uniform throughout the municipal district, with a uniform tariff, to be regulated under conditions which are set out in the forms of tender. Tenders have to be sent in to the Wiener Stadt Bauamt, Rathaus, Vienna, not later than November 4, 1895. Further full information can be obtained at the same address from the Mayor.

Tenders Accepted.—For the electric lighting of part of the St. James's Club, 106, Piccadilly, London, W. (Mr. W. Howard Tasker, M.Inst.E.E., 12, Pembroke-road, Kensington, W., consulting engineer).

The following tenders were received :—

Belshaw and Co. (accepted)	£467	14	9
Verity and Sons	432	10	0
Moody Bros.	475	5	0
Drake and Gorham	518	18	0
Clarke and Co.	536	6	0
Crompton and Co.	573	10	0

——— The following tenders were received for the lighting by electricity of the Dewsbury Pioneers' Industrial Society's premises :—

G. A. Steinthal, 41, Piccadilly, Bradford, (accepted conditionally)	£730	0	0
Electrical and Mechanical Supply Company, Leeds	1,580	0	0
Lowcock, Hill and Co., Manchester	1,250	0	0
J. A. Edmondson, Leeds	1,185	5	1
S. J. Waring and Son, Manchester	1,075	0	0
Rhodes and Webster, Bradford	990	0	0
H. F. Joel and Co., London	952	17	0
Paterson and Cooper, London	932	0	0
Crompton and Co., London	915	0	0
Thorpe and Waring, London	900	0	0
C. A. Parsons and Co., Newcastle	865	0	0
Graham, Chapman and Co., Morley	829	15	0
A. Hirst and Son, Dewsbury	777	0	0*
Manchester Edison-Swan Company (Limited)	743	0	0*
Bennett and Druce, Preston	739	0	0
Nunns and Sykes, Halifax	735	0	0
Maunsell Mercier and Co., Manchester	727	0	0
Electrical and Gen. Engineering Company, London	720	0	0
A. R. Turner, Dewsbury	713	10	0
Ullathorne and Hartley, Bradford	709	7	0
A. Sykes, Huddersfield	667	10	0
Sharp and Kent, London	616	0	0*
B. Verity and Sons, Manchester	610	0	0*

*The supply of electroliers is not included in these quotations.

Tenders Accepted.—The St. Giles's Board of Works, London, W.C., has accepted the tender of Messrs. Pontifex and Sons for the installation of the electric light in the offices of the Board for the sum of £96.

——— The Salford School Board have decided to accept the tender of Messrs. B. Verity and Sons for wiring and fitting the new offices of the Board for the electric light, and for fixing electric bells and speaking tubes. The amount of the tender is £221.

——— The Electric Lighting Committee of the Portsmouth Town Council have decided to recommend the following tenders for cables for acceptance by the Council :—

For conduits and I.R.-covered mains (W. T. Glover and Co.)	£12,357
For compound-covered mains (British Insulated Wire Company)	486

Tenders Received.—The Electric Lighting Committee of the Shoreditch Vestry, London, E.C., have recommended the acceptance of the tender of Messrs. Manlove, Alliott and Co. (Limited), 57, Gracechurch-street, London, and Nottingham, for the erection of a chimney shaft at the electricity works for the sum of £2,683. This was the lowest of four tenders sent in, the highest of which was £3,420.

Sale by Auction.—Messrs. Wheatley Kirk, Price and Goulty will sell by public auction on Thursday, the 15th inst. (at 10 for 11 o'clock) the entire contents of the turbine works of Mr. C. L. Hett, of Brigg (who is declining the business). Included in the sale are a Marshall steam engine, lathes, planing machines, loose plant and utensils, several finished and many unfinished turbines of various types, centrifugal pumps, &c. Illustrated catalogues and all particulars may be had of Mr. Chas. Louis Hett, Turbine Foundry, Foundry-lane, Brigg, Lincs., and from the auctioneers, Messrs. Wheatley Kirk, Price and Goulty, 49, Queen Victoria-street, London, E.C., and Albert-square, Manchester. Some further information is given in our advertisement columns.

Appointments.—The Gas and Electricity Supply Committee of the Bradford Corporation have appointed, subject to the approval of the Council, Mr. A. H. Gibbings electrical engineer at the Corporation electricity works, in succession to Mr. S. W. Baynes, who was recently appointed electrical engineer to the St. Pancras Vestry. Mr. A. H. Gibbings has been electrical engineer to the Hull Corporation for the past two years, and had previously held a similar appointment with the Hove Improvement Commissioners. The salary at Bradford commences at £300 per annum.

——— Mr. Wm. Smith, who was for some time engineer at the Asylum at Claybury, Essex, has been appointed electrical engineer at the Municipal Technical School, Birmingham.

Appointments Vacant.—The Governors of the Woolwich Polytechnic are willing to receive applications for the posts of lecturer in physics (salary £110 for a session of about eight months) and lecturer in mechanics (salary £70 for a session of about eight months). Some further particulars are given in our advertisement columns, and applications must be sent in by the 23rd inst.

——— The Governing Body of the Northampton Institute, Clerkenwell, E.C., are prepared to receive applications for the appointment of a principal. The salary attached to the office has been fixed at £600 per annum. Applications must be sent in by September 4th to Mr. J. J. Lambert, 8, Dowgate-hill, Cannon-street, London, E.C.

Business Changes.—Messrs. Easton, Anderson and Goolden (Limited) notify us that their instrument department, carried on at Woodfield Works, Harrow-road, London, W., has been sold to Messrs. Evershed and Vignoles (Limited). It is pointed out that the management of this department has, ever since its commencement, been in Mr. Evershed's hands, and that Mr. Vignoles has been associated with him for the past six years. The existing orders and all trade liabilities are taken over by Messrs. Evershed and Vignoles as from January 1st last. The new firm notify that every effort will be made to maintain the reputation of the business originally founded by Messrs. Goolden and Trotter in 1886, and to turn out instruments of the highest class. The whole of the Evershed patents pass into the new firm's hands, including the Richards-Evershed system of electrical ships' telegraphs now being introduced into the Navy. No change in the general scope of the business is in contemplation, but the manufacture of electrical and kindred apparatus for the special requirements of the engineering industries continues to be an essential feature of the business. The Directors of the new Company are Prof. W. E. Ayrton and Messrs. H. M. Gregory, S. Evershed and E. B. Vignoles, and the manager of the factory is Mr. A. Schneider, M.A. The Company's telegraphic address is "Dorothea London." Mr. A. Montagu Shepherd, of 32, Albany-road, Ealing, W., represents Messrs. Evershed and Vignoles in London and district. Messrs. Easton, Anderson and Goolden are making further extensions to their shops at Erith (where the works are now concentrated) in order to expedite the carrying out of large contracts.

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DISSOLUTIONS OF PARTNERSHIP.—Messrs. R. P. Gerland and F. Tomlinson, carrying on business as electrical engineers and electro-platers under the style of Gerland, Tomlinson and Co., at Accrington, have dissolved partnership. Debts by Mr. R. P. Gerland.

——— The partnership hitherto existing between Messrs. Wm. Maxwell and John Samuel Ross, under the style of Maxwell, Ross and Co., telephone and electrical engineers, at Britannic Works, Bradmore-lane, King-street, Hammersmith, London, W., has been dissolved. Mr. W. Maxwell will continue to carry on the business on his own account at the same address, and Mr. J. S. Ross has established a similar business at Bath-street, Glasgow.

BANKRUPTCY.—Notice is given that the first meeting of creditors in the bankruptcy of Ronald A. Scott, electrical engineer, The Elms, Acton-hill, London, W., will take place on Wednesday next, the 7th inst., at the Official Receiver's office, 95, Temple-chambers, Temple-avenue, London, E.C., at 3 p.m. The examination takes place at the Town Hall, Brentford, on September 17th, at 2:15 p.m.

LIQUIDATION.—At a meeting on June 26th a resolution was passed that Armstrong's Glass Company (Limited), manufacturers of specialities in glass for electrical purposes, 26, Waterloo-street, Birmingham, be wound up. This resolution was confirmed on July 15th, when Mr. C. Butler, Brookleigh, Westfield-road, Edgbaston, Birmingham, was appointed liquidator.

"HELIOS" ARC LAMPS.—A new edition of the catalogue of the International Electric Company, which relates exclusively to arc lamps and accessories, has just been issued, and copies can be obtained by the trade from the Company's offices, 55, Red Cross-street, Barbican, London, E.C. The list is well printed, and contains a number of illustrations and particulars of these lamps, which are in use at the General Post Office and on a long list of circuits, the names of which are given. Included in the accessories are particulars of resistances, the "Helios" transformers, choking coils, suspensions, pole-arms and brackets, winches, &c., and lengthy directions are given for erecting and operating "Helios" lamps. A price list of "Phœnix" carbons is also included.

ENGINEERING MAGAZINE.—The July number of this magazine is now ready, and is a really fine example of high-class letterpress printing. The contents include: "The Signs of the Times," by Edward Atkinson; "The Trolley in Competition with Railroads," by Clarence Deming; "Uninhabitable Houses in City Slums," by Wm. Stevenson; "Improving the Delaware at Philadelphia," by John Birkinbine; "Is the Inventive Faculty a Myth?" by Wm. H. Smyth; "Illuminating Gas for Heating Purposes," by Frederick Siemens; "Robert Fulton and his Steamboats," by T. C. Purdy; "James Rumsey, Steamboat Inventor," by James Weir, jun.; "Business Opportunities in Colombia," by C. F. Z. Caracristi; "The Magnetic Separation of Iron Ores," by C. M. Ball; "Production up to the Power Limit," by H. L. Arnold; and the increasingly useful Review of the Industrial Press. The new number, and nearly all back issues, may be obtained at the offices of the European Edition, 1, 2 and 3, Salisbury-court, Fleet-street, London, E.C.

THE JOURNAL.—Part 118 is now ready of the *Journal* of the Institution of Electrical Engineers, containing Papers on "A Magnetic Tester for Measuring Hysteresis in Sheet Iron," by Prof. J. A. Ewing, F.R.S., and "On the Recent Development of the Single-acting High-Speed Engine for Central Station Work," by Mark Robinson, M.I.E.E., with the discussions thereupon; communications on "The Zero-Torque Electricity Meter," by Joseph Edmondson, and "Daily Insulation Testing of Telegraph Lines," by W. H. Preece, C.B., F.R.S.

TELEPHONE DIRECTORY.—A Supplement is just issued by the National Company to the Telephone Directory issued in May, 1894. This Supplement contains the names and addresses of subscribers added to the metropolitan exchange since the publication of the Directory, also additional call-rooms and a number of alterations and corrections.

ALDERLEY EDGE (MANCHESTER).—At the monthly meeting of the District Council on Monday last a letter was read from Mr. S. V. Clirehugh, electrical engineer, of Manchester, asking if the Alderley Council were prepared to dispose of their Provisional Electric Lighting Order. After discussion the Clerk was instructed to reply that the Council were prepared to dispose of the Order on adequate payment being made, and on an undertaking being given that the electric lighting would be carried out in accordance with the views of the Council.

BERLIN.—Messrs. Siemens and Halske have completed an extensive electric lighting installation at the Old Palace for the Emperor William. The plant includes a battery set, and steam power equal to 200 H.P. has been put down.

BIRMINGHAM.—Reports from this district state that an improvement in business is noticeable, more particularly in those branches of industry associated with the electrical trades, and especially in fittings, apparatus and accessories.

BIRMINGHAM MUNICIPAL TECHNICAL SCHOOL.—The Committee of this institution have instructed Mr. W. H. Whitehouse, who is lecturer on telegraphy and telephony at the institution, to provide a complete telephonic installation for the new Technical School. The work will comprise a double-cord (Western Electric Company's pattern) Standard switchboard, which is to be placed in the Curator's office, and instruments in the various Professors' rooms and laboratories, &c., with metallic circuits throughout. The system will thus be available for business purposes, as well as providing a complete working exchange for teaching and lecture demonstration.

BRADFORD.—The Gas and Electricity Committee of the Town Council have decided to put down new condensers at the electric supply works, at a cost of £2,200.

BRIGHTON.—The Brighton Borough Council have decided to provide an electrically-driven passenger lift for the Town Hall, at an estimated cost of £538.

BROMLEY (KENT).—At the last meeting of the District Council a letter was read from an electric lighting syndicate asking the assistance of the Council in introducing the electric light into the district, the Bromley Provisional Order having lapsed. The letter was referred to the Standing Orders Committee.

CHAPEL LIGHTING.—The new chapel at Berkhamsted School (Herts) is now complete, and is lighted throughout by electricity in a similar manner to the installation at the school.

CHURCH LIGHTING.—The Tayler Smith Electric Company have been entrusted with the order to instal the electric light at St. Mary's, Aldermanbury, in the City of London. About 200 incandescents of varying candle-powers will be used.

DEVONPORT.—At the last meeting of the Town Council two letters were received from electric lighting companies, notifying their intention of applying for Provisional Orders to supply electric current in the district. After a brief debate on the Streets and Highways Committee's report, when the electric lighting question was again discussed, the Town Clerk hoped that the Council would secure its own Provisional Order. Mr. Paris, on behalf of the Brush Provincial Company, attended before the Committee and explained the terms upon which the Company would, if successful in obtaining an Order, be prepared to hand over the undertaking to the Council after a certain period. The subject was referred back to the Committee.

DOVER.—The Dover Electricity Company propose to extend their electric lighting mains to the Maison Dieu-road, which is outside the area included in their original scheme, and the Town Council have sanctioned the proposal.

EDINBURGH.—On Wednesday evening the public electric lighting was extended as far east of the city as the foot of Canongate, and as far south as Hope Park. Under the presidency of Mr. Councillor Waterston, 200 residents assembled in the Canongate Institute for the purpose of inaugurating, as it were, the switching on of the current. Councillor Mackenzie, the convener of the Corporation Electric Lighting Committee, said that, so far as it had gone, the Edinburgh electrical installation had been one of the most successful that was to be seen anywhere. The light had never been out since it was turned on on April 11th last for a single second, nor had there been the slightest hitch of any kind. The switching on of the light at Canongate attracted a large crowd.

FAREHAM.—In regard to the litigation in progress between the District Council and the local Electric Light Company, the former at their last meeting decided to "brief" three counsel. Of course, an angry debate preceded the adoption of this heroic course.

FRENCH SUBMARINE TELEGRAPHS.—The French Press is anxious that no opportunity shall be missed of claiming at least a full share of submarine cable enterprise. The following is a *Times* clipping from the *Revue Scientifique*:—France has at the present time 5,330 miles of submarine cables belonging to 54 different lines, while there are three French companies possessing submarine cables, namely, the French Telegraph Company, from Paris to New York, with 4,080 miles; the Commercial Cable Company [!], with seven cables having a total length of 10,495 miles; and the French Society of Submarine Telegraphs, with 15 cables of a total length of 5,260 miles.

GLASGOW.—The report of the Electric Lighting Committee of the Town Council for the past year, to which reference was made in our last issue, states that the quantity of electricity sold during the past year to private consumers, irrespective of public lighting, was 713,916 Board of Trade units, being an increase over the preceding year of 31·43 per cent.

HACKNEY (LONDON, N.E.).—The Hackney Vestry have finally decided to adopt a combined electric lighting and refuse destructor scheme for the parish. Mr. F. H. Medhurst has been appointed consulting engineer for the scheme.

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List of Trunk Line Charges (Three Minutes' Conversation) to National Telephone Subscribers.

From	To: London.	Glasgow.	Edinburgh.	Dublin.	Belfast.	Cardiff.	Plymouth.	Exeter.	Nottingham.	Liverpool.	Bristol.	Leeds.	Birmingham.	Newport.	Swansea.	Newcastle.	Brighton.	Ipswich.	Colchester.	Chelmsford.	Sheffield.	Hull.	Manchester.	Leicester.	Hexham.	Morpeth.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
London	...	4 6	4 6	7 6	6 6	2 0	2 6	2 0	...	...	1 6	2 6	...	2 0	2 6	3 6	1 0	1 0	1 0	0 6	2 0	2 6	...	...	3 6	3 6
Glasgow	4 6	...	...	4 0	3 0	4 6	5 6	5 0	3 0	2 6	4 6	2 6	3 6	4 0	4 6	1 6	5 0	4 6	4 6	4 6	3 0	3 0	2 6	3 6	1 6	1 6
Edinburgh	4 6	...	...	4 6	3 6	4 0	5 6	5 0	3 0	2 6	4 0	2 6	3 6	4 0	4 0	1 6	5 0	4 6	4 6	4 6	2 6	2 6	2 6	3 6	1 0	1 0
Dublin	7 6	4 0	4 6	...	...	7 6	8 6	8 0	6 0	5 6	7 6	5 6	6 6	7 0	7 6	5 0	8 0	7 6	7 0	7 6	6 0	6 0	5 6	6 6	4 6	5 0
Belfast	6 6	3 0	3 6	...	...	6 0	7 6	7 0	5 0	4 6	6 0	4 6	5 6	6 0	6 0	4 0	7 0	6 6	6 6	6 6	4 6	5 0	4 6	5 6	3 6	4 0
Cardiff	2 0	4 6	4 0	7 6	6 0	...	2 0	1 6	2 0	2 0	1 0	2 6	1 6	...	...	3 6	2 0	2 6	2 6	2 6	2 0	3 0	2 0	1 6	3 6	3 6
Plymouth	2 6	5 6	5 6	8 6	7 6	2 0	...	...	3 0	3 0	1 6	3 6	2 6	2 0	2 6	4 6	2 6	3 6	3 6	3 0	3 6	4 0	3 6	3 0	4 6	4 6
Exeter	2 0	5 0	5 0	8 0	7 0	1 6	...	...	2 6	3 0	1 0	3 0	2 0	1 6	2 0	4 0	2 0	3 0	3 0	2 6	3 0	3 6	3 0	2 6	4 0	4 6
Nottingham	...	3 0	3 0	6 0	5 0	2 0	3 0	2 6	...	...	2 0	...	...	2 0	2 0	2 0	2 0	1 6	1 6	1 6	...	...	...	...	2 0	2 0
Liverpool	...	2 6	2 6	5 6	4 6	2 0	3 0	3 0	...	...	2 0	...	...	2 0	2 0	2 0	3 0	2 6	2 6	2 6	...	...	...	...	1 6	2 0
Bristol	1 6	4 6	4 0	7 6	6 0	1 0	1 6	1 0	2 0	2 0	...	2 6	1 0	1 0	1 6	3 6	1 6	2 6	2 0	2 0	2 0	2 6	2 0	1 6	3 6	3 6
Leeds	2 6	2 6	2 6	5 6	4 6	2 6	3 6	3 0	...	...	2 6	...	...	2 6	2 6	.	3 0	2 6	2 6	2 6	...	...	...	...	...	...
Birmingham	...	3 6	3 6	6 6	5 6	1 6	2 6	2 0	...	...	1 0	...	..	1 0	1 6	2 6	2 0	2 0	2 0	1 6	...	...	...	...	2 6	2 6
Newport	2 0	4 0	4 0	7 0	6 0	...	2 0	1 6	2 0	2 0	1 0	2 6	1 0	...	...	3 6	2 0	2 6	2 6	2 0	2 0	2 6	2 0	1 6	3 0	3 6
Swansea	2 6	4 6	4 0	7 6	6 0	...	2 6	2 0	2 0	2 0	1 6	2 6	1 6	...	...	3 6	2 6	3 0	3 0	2 6	2 0	3 0	2 0	2 0	3 6	3 6
Newcastle	3 6	1 6	1 6	5 0	4 0	3 6	4 6	4 0	2 0	2 0	3 6	...	2 6	3 6	3 6	...	4 0	3 0	3 6	3 6	...	...	1 6	2 6	..	...
Brighton	1 0	5 0	5 0	8 0	7 0	2 0	2 6	2 0	2 0	3 0	1 6	3 0	2 0	2 0	2 6	4 0	...	1 6	1 6	1 0	2 6	3 0	3 0	2 0	4 0	4 0
Ipswich	1 0	4 6	4 6	7 6	6 6	2 6	3 6	3 0	1 6	2 6	2 6	2 6	2 0	2 6	3 0	3 0	1 6	...	0 3	0 6	2 0	2 6	2 6	1 6	3 0	3 6
Colchester	1 0	4 6	4 6	7 6	6 6	2 6	3 6	3 0	1 6	2 6	2 0	2 6	2 0	2 6	3 0	3 6	1 6	0 3	...	0 6	2 0	2 6	2 6	1 6	3 6	3 6
Chelmsford	0 6	4 6	4 6	7 6	6 6	2 6	3 0	2 6	1 6	2 6	2 0	2 6	1 6	2 0	2 6	3 6	1 0	0 6	0 6	...	2 0	2 6	2 6	1 6	3 6	3 6
Sheffield	2 0	3 0	2 6	6 0	4 6	2 0	3 6	3 0	...	...	2 0	...	...	2 0	2 0	...	2 6	2 0	2 0	2 0	...	...	...	...	...	...
Hull	2 6	3 0	2 6	6 0	5 0	3 0	4 0	3 6	...	...	2 6	...	...	2 6	3 0	...	3 0	2 6	2 6	2 6	...	...	...	...	...	...
Manchester	...	2 6	2 6	5 6	4 6	2 0	3 6	3 0	...	...	2 0	...	...	2 0	2 0	1 6	3 0	2 6	2 6	2 6	...	...	...	..	1 6	1 6
Leicester	...	3 6	3 6	6 6	5 6	1 6	3 0	2 6	...	...	1 6	...	...	1 6	2 0	2 6	2 0	1 6	1 6	1 6	...	...	...	...	2 6	2 6
Hexham	3 6	1 6	1 0	4 6	3 6	3 6	4 6	4 0	2 0	1 6	3 6	...	2 6	3 0	3 6	...	4 0	3 0	3 6	3 6	...	...	1 6	2 6	...	...
Morpeth	3 6	1 6	1 0	5 0	4 0	3 6	4 0	4 6	2 0	2 0	3 6	...	2 6	3 6	3 6	...	4 0	3 6	3 6	3 6	...	...	1 6	2 6	...	...

Telephone Trunk Line Service.—A circular is issued by the National Telephone Company giving particulars of the extensions of trunk line service recently completed by the Post Office, and of which the National Company's subscribers have now the use at charges varying from 3d. to 8s. 6d. per conversation of three minutes' duration. The full list of towns between which trunk line communication is now possible, and the charges are set out fully in the table above.

Hampstead (London, N.W.).—The report of the Electric Lighting Committee presented at yesterday's meeting of the Vestry stated that there were on June 22nd last 11,000 8 c p. lamps connected to the Vestry's mains, and that owing to the large extensions now being made, and to the applications from new customers, they estimate that at least 20,000 8 c.p. lamps will be connected by Christmas next. As the total capacity of the present plant at the generating station is 12,000 8 c.p. lamps, the Committee recommend that additional plant be ordered at once, at an estimated cost of £2,200.

Leeds.—The Yorkshire House-to-House Company intend to extend their mains to Chapeltown, so that the residents in the district and occupiers of business and other premises along the important thoroughfares *en route* may be able to avail themselves of the advantages of the electric light. The existing mains terminate in New Briggate, and it is now intended to carry them along North-street and Chapeltown-road and Harrogate-road, as far as the tramway terminus. The work will be put in hand immediately, and it is expected that current will be available early in the autumn. Already a considerable number of residences and business establishments are being wired and fitted.

Liverpool.—Notice has been given of the calling of a special meeting of the City Council to finally consider the advisability of taking steps to obtain an Electric Lighting Provisional Order for the supply of electric current within the area of the City of Liverpool. The ultimate decision in this matter depends practically upon the result of the application to Parliament for power to extend the city boundaries.——The Howe Electrical Engineering Company have recently completed several large installations in and near this town, including the lighting of Thornton Hall, near Neston, Cheshire, and the Paddington Theatre of Varieties, Edge Hill. For the latter 580 16 c p. incandescents and 6 arcs are used. Engine power is supplied by a Crossley latest type gas engine, with a flywheel weighing nearly 4 tons. Messrs. Laurence, Scott and Co., of Norwich, for whom the Howe Company are sole agents in Liverpool and district, supplied the dynamo, which has a capacity at full load of 240 amperes at 110 volts. The switchboard and distribution boards were specially designed by the Howe Company to meet the special requirements of the theatre. It is possible to change the colour and control the lights on battens, flies, footlights, stage, and in the house from any section, and to graduate them from full intensity down to absolute extinction.

Metropolitan Asylums Board.—A special committee appointed in October, 1894, to consider and report as to whether the arrangements for advertising for and accepting tenders were capable of improvement, has just issued its report, and, in stating that, in their opinion, the existing practice was faulty, recommend, amongst other matters, that a list of manufacturers of and dealers in manufactured articles be established, and then any firms applying to be admitted to this list should furnish two satisfactory references; further, that clerks to Chambers of Commerce should be consulted as to the firms in their districts who may be likely to supply the manufactured articles; and also that the Contract Committee of the Board should not be obliged to advertise for tenders in all cases as at present, but should be authorised to obtain tenders from a limited number of firms selected from the specially-prepared list, or to make contracts with producers direct after reporting to the Board the course deemed best in each case.

Portsmouth.—An important communication from the National Company, on the subject of placing the telephone lines underground, was considered at the last meeting of the Town Council, and was ultimately referred to the Streets Committee for inquiry and report.

St. George's, Hanover Square (London, W.).—The Joint Vestry Hall Committee have presented a report recommending that the Board room and offices be lighted electrically at a cost of £150 each to the Guardians and Vestry, and on the consideration of this report at the last meeting of the Vestry Mr. Bromwich said that, while not hostile to the introduction of the electric light, he thought they should wait until they had all the figures before them, and he therefore moved the adjournment of the question. After discussion this suggestion was adopted.

St. Pancras (London, N.W.).—The Electricity Committee of the St. Pancras Vestry have declined to sanction the laying of mains by the London Hydraulic Power Company for the service of business premises in Charlotte-street, to extend along Tottenham Court-road, Windmill-street, and across Charlotte-street. The refusal is owing to the fact that the Committee view the Company as a possible competitor with their electricity works for the supply of motor power.

Poplar (London, E.).—The District Board of Works have received a communication from the Board of Trade intimating that they are prepared to defer the question of the revocation of the Provisional Electric Lighting Order for one year.

Sheffield.—The School of Art is to be lighted electrically. About 200 incandescents will be used. The local electric light company are busily engaged in extending their mains.

South African Imports.—For the period from June 26th to July 23rd the imports into South Africa from Great Britain of electric fittings amounted to £4,894; of telegraph material, £4,139.

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SOUTHAMPTON.—The Town Council intend to erect additional electric cranes at the Quay, and they have instructed the Wharfinger and Mr. J. G. W. Aldridge, their electrical engineer, to visit Rotterdam and other Continental ports, to inspect the most recent and improved types of electric cranes in work there. The Electrical Engineer and Surveyor have also been instructed to prepare plans, specifications and estimates for the proposed electric generating plant at the Town Quay. The Southampton Electric Light and Power Company are reducing the price of current from 8d. to 7d. per unit, with liberal discount to large consumers.

SOUTH RUSSIA.—German and Austrian firms are just now paying great attention to this district, where the question of the public lighting of several towns by electricity is under consideration by the authorities.

TELEPHONIC EXTENSION IN GERMANY.—A telephone line is being erected between Coblenz and Bingen, two important points on the Rhine.

TELEPHONE TRUNK LINE CHARGES.—A representation has been made to the Postmaster-General by the Leeds Chamber of Commerce, pointing out that many of the principal telephone subscribers would prefer to make an annual payment for the use of the trunk lines, in preference to separate payments for each use of the wires. A reply has been received to the effect that the present system has been adopted after mature consideration, and that, therefore, no hope is held out of any alteration being made.

TECHNICAL EDUCATION.—The *Technical Education Gazette*, which is the official circular of the Technical Education Board of the London County Council, in its July issue, contains a number of Examiners' Reports on the Intermediate Scholarships Examination in the awards of Intermediate County Scholarships. The examiners are able to report very satisfactory averages in Elementary Mathematics and Pure Mathematics. In Electricity and Magnetism Prof. H. Stroud reports : "The answers of the candidates were in nearly every case very satisfactory. With but one or two exceptions, the answers were expressed neatly and concisely, and showed a thoroughly intelligent appreciation of the fundamental principles of the subject. One very satisfactory feature of the examination is the evidence that the candidates give either of having witnessed the various experimental illustrations referred to, or of having performed the experiments themselves." In Heat and Light, Principal Tomlinson reports that four girls and 24 boys took this subject; the boys acquitted themselves satisfactorily, the girls unsatisfactorily. In Chemistry (Theoretical) the result of the examination was disappointing, better results being shown in the Practical Chemistry section.

THE ELECTIONS.—The return of members to Parliament is now practically complete, and it is satisfactory to record the fact that few candidates connected in any prominent manner with the electrical industries have proved unsuccessful in the contest. Amongst those who have secured election may be mentioned the Right Hon. D. R. Plunket, Q.C. ; Sir John Pender, G.C.M.G. ; Sir Albert K. Rollit, the Hon. W. St. John F. Brodrick, Messrs. Gerald W. Balfour, James Pender, J. W. Maclure, W. Cuthbert Quilter, E. Boulnois, W. Hayes-Fisher, and W. D. Cruddas, all of whom sit on the Government side of the House. The candidates who were rejected include the Right Hon. Arnold Morley, the Hon. Mark F. Napier, Sir H. E. Roscoe, Mr. J. Fletcher Moulton, Q.C., Messrs. R. Maguire, C. Burt, E. M. Underdown, Q.C., J. Seymour Keay, and E. H. Bayley. The rejected all sought election as supporters of the Opposition. Amongst the few instances where father and son both sit in the House of Commons may be mentioned that of Sir John Pender and Mr. James Pender.

TOXTETH PARK (LIVERPOOL).—The refuse destructor works recently erected by the District Council, and the approaches thereto, are now lighted electrically. The electrical installation has been carried out under the supervision of Mr. W. G. P. Macmuldrow, electrical inspector to the Liverpool Corporation, at a cost of £237. 10s.

WANDSWORTH (LONDON, S.W.).—The County of London Company have notified the District Board of Works of their intention to lay conduits for electric light mains in the Streatham High Road, and the Board have decided to offer no opposition to the laying of conduits in Putney-hill.

WESTERN AUSTRALIA.—A return recently prepared for the Minister in charge of the Post and Telegraph Department, gives comparative figures between the business done in the telegraph branch for the years 1887 and 1894. In 1887 telegrams transmitted numbered 114,116, for which revenue amounting to £12,702 was received. In 1894 the number of messages was 446,780, representing £37,483. In 1887 there were 2,821 miles of telegraphs erected, and 38 stations, and in 1894 a total length of 5,010 miles and 73 stations. For the last quarters of 1887 and 1894 the revenue was £3,259 and £12,578, from 41,095 and 127,486 messages respectively.

WIMBLEDON (SURREY).—The District Council considered the electric lighting question at their meeting on Wednesday, when, after a very lengthy discussion, it was decided to discontinue the present system of street illumination, and to light the whole town by electricity. The cost of the initial installation is estimated at £31,000, and the annual cost of maintenance at £3,750. The scheme is to provide for the erection of arc lamps in the main thoroughfares, and 1,000 32 c.p. incandescents in the remaining streets.

ANNUAL OUTING.—The employés of the Consolidated Telephone Construction and Manufacturing Company held their annual bean-feast on Saturday last at Box Hill, Dorking, and the day passed in good fellowship, to which all present contributed. The probability that this would be the last bean-feast from London (the works being removed to the country shortly) gave extra zest and kindredship to the proceedings. A cricket club has been established, and in the coming winter it is proposed to establish a football club, for which challenges are invited.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

July 12, 1895.

13,416. A. WALTERS. Manchester. Improvements in electric lamps for stage lighting.*

13,434. SIEMENS BROS. AND CO. (LIMITED.) London. Improvements in the electrolytical production of zinc from its ores and apparatus therefor. (Messrs. Siemens and Halske, Germany.)*

13,436. L. B. MILLER. London. Improvements in electric light suspension fittings.

13,444. O. MARCH. London. Improvements in electrical heating apparatus.

13,459. G. E. HEYL. London. Improvements in the manufacture and production of electric cables or conductors.

13,472. N. GLEBOFF. London. An improved electric lighting system for road and railway vehicles.

18,274A. J. BROCKIE. London. An improvement in electric arc lamps [Date claimed under Patents Rule 19, September 26, 1894.]

July 13, 1895.

13,483. C. RALEIGH. London. Improvements in dynamo-electric and electro-dynamic machines.

13,495. W. HOLLAND. Manchester. An improved electrically illuminated curtain or drop for theatrical purposes.

13,530. A. HAMM, G. BLANK, V. BRANDT, and G. KORMENDY. London. Improvements in telephones.

July 15, 1895.

13,542. A. MATUSH. London. Matush electric hair waver.

13,550. F. H. ROYCE and E. A. CLAREMONT. Chorlton-cum-Hardy. Improvements in dynamo-electric machinery.

13,564. W. V. BONSOR. London. Improvements in and relating to electric regulators.*

13,573. F. STOCK. London. Improvements in multiple switches for telephone exchanges.*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1895.

8,537. BOULT (Virginia Phosphate and Paint Co.) Insulating material.

9,132. DORMAN and ANOTHER. Electric ceiling and wall connectors.

9,217. VERITY. Electric cut-outs.

9,547. LAKE (Rodriguez and another). Attaching electric lamp to a cap.

10,052. MILLER, H. V. and A. C. Electric railway signals.

CROMPTON AND CO., LIMITED.—The report of the Directors of this Company, which will be presented to the meeting at Cannon-street Hotel, London, E.C., on Friday next at three o'clock, states that the net profits for the year to 31st March were £6,953. 10s. 11d., and net revenue, after providing for debenture interest, &c., £2,343. 15s. 9d. £1,000 is set aside for contingencies and doubtful debts, and £1,343. 15s. 9d. is carried forward. The agreements with Messrs. R. E. Crompton and J. F. Albright to act as Managing Directors of the Company having expired, the Board have made arrangements for a continuance of these gentlemen's services. The works at Chelmsford are kept extremely busy.

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COMPANIES' MEETINGS AND REPORTS.

City and South London Railway Company.

The twenty-second ordinary general meeting of the proprietors in this Company was held on Monday at Winchester House, Old Broad-street, under the presidency of Mr. Charles Grey Mott.

The SECRETARY (Mr. W. F. Knight) read the notice calling the meeting, the seal was affixed to the stock and share register, and the report of the Directors was taken as read.

The CHAIRMAN: It now becomes my duty to move—

"That the report and statement of accounts for the half-year ended June 30, 1895, now presented to the meeting, be received and adopted."

Although we are able to recommend the payment of a slightly increased dividend, the result of the working of the past half-year has been somewhat disappointing. We began the half-year very well. Our traffic showed a steady and regular increase, and we hoped that at the end of this half-year we should have a very satisfactory report to present to you, but, unfortunately, as soon as the hot weather set in, at the end of March, our traffics began to fall, and we suffered so much that at the end of the half-year very little of the improvement we had obtained in the first part of the period remained. We should be still more disappointed with this result if it had not been that the same fate has befallen nearly all the railways of this country. From one cause or another they have in the past half-year all, or nearly all, shown a very heavy decrease, while most of them are reporting decreased dividends. I am glad to say that that is not our case, but that, unsatisfactory as the half-year has been, we are able to propose a slightly increased dividend. If you will turn to the accounts you will see from the capital account that we have received from the issue of debenture stock a sum of £18,000, and a premium on the same of £5,426, making together £23,426. We have spent in the half-year on capital account £2,164, and have taken from the balance at our bank £2,275, and we have paid off £23,200 of the Five per Cent. Debentures. The expenditure on capital account has been on various small matters. Turning to the more interesting part of the accounts—the revenue account—the receipts from passengers other than season ticket holders show a decrease of £335, but the increased receipts from season tickets amount to £482, so that there is an increase in passenger receipts of £147. There have also been increases from parcels of £30, and in transfer fees of £8, making a total increase of £185; but, on the other hand, there are decreased rents £59, and a decrease in sundries of £20. Deducting these from the £185, there remains a net increase of £106. The decrease in rents arises from some empty properties, which we hope we shall let before long. With regard to the expenditure the outlay on maintenance shows a decrease of £35, locomotive expenses are £194 less, carriage repairs are £28 more, traffic expenses are £123 higher, the general charges show an increase of £48, and we have paid £106 more on account of passenger duty. There is a decrease of £4 in law charges and of £43 in rates and taxes. The total result is that there is a net increase in the expenses of £29, so that they are practically the same as they were a year ago. The decrease in the locomotive department and the increase in the traffic expenses are partly due to the different modes of charging the accounts. The large increase of £106 in passenger duty is owing to the fact that we raised the fares, as you know, from Stockwell, and the consequence was we became liable for passenger duty on those fares, whereas with the former fares we were not so liable. The fares to Stockwell have now been reduced, so that we are no longer liable for passenger duty on them. The result of the revenue account is that we have a balance to carry to net revenue account of £9,381, to which interest of £47 and the balance of £950 from the last account have to be added, making a total of £10,379. Debenture interest absorbs £3,959, and the Preference interest £1,912, while the dividend which we recommend on the Ordinary stock, at the rate of 1½ per cent. per annum, will require £3,543, leaving a balance of £964 to be carried forward to next half-year, or £14 more than we brought into the accounts on January 1st. The working expenses, comparing this half-year with the corresponding period of 1894, amount to 61·5 per cent. of the receipts against 61·69 per cent. last year, showing a small decrease; or if we take off the cost of the lifts, as we generally do, the amount is about 52 per cent., which is a fairly low rate of working, although we hope to get that very much lower some day. The locomotive expenses per train mile are 6·10d. this half-year against 6·22d., showing a satisfactory decrease. If you deduct, as we have done before, the carriage of coal, it comes out at about 4½d. The train miles run show a decrease of 3,104 in the half-year. The receipts per train mile have risen from 2s. 1½d. to 2s. 2½d. this year, in consequence of the increased fares charged, which were explained at our last meeting. The receipt per passenger has also risen from 1·61d. to 1·82d. The average number of passengers per train, on the other hand, has decreased from 48½ to 46¼, including an estimate for the season ticket holders. You will see from the statement on the first page of the report that the number of passengers has decreased this half-year, taking out the season ticket holders in both cases, from 3,383,000 in June, 1894, to 3,113,000 in the half-year to June 1895, showing a decrease of 270,000 passengers in the half-year. That has been compensated for to some extent by the increased fares and the increase in the receipts from the season ticket holders. Still, the total number of passengers shows a very distinct and decided falling off. This is no doubt partly owing to the increased fare charged and partly to the extraordinarily fine weather we had in the last three months of the half-year. As you know, fine weather does not suit this railway. You will perhaps observe that there is no mention in this report of any progress being made in the direction of putting on motor car trains. The reason of that is that although we told you last half-year that we had a motor car train, and that it was running, and was satisfactory as far as it went, our experience of it has not made us very anxious for the conversion of the rest of the stock. It is a very expensive operation, and will take a long time to do, and there are definite reasons why we think it should not be carried out at present. The most important of these is that at the last meeting you determined we should go on with the extension as far as Finsbury Circus. When that extension is completed we shall be running, and able to run, heavier trains—longer trains—conveying very many more passengers, and probably we shall endeavour to run those trains at a more rapid rate than the present. All this will require very much more powerful motors, and if we were to convert the present trains at a very large expense they would have the present motor power on them, which would not be sufficient for the heavier trains. The time, too, that would be occupied in converting the present stock would be very considerable unless we went to a very large and unwarrantable expense, and we think it better to postpone any operation in that direction until the new extension of the line is completed, when we can put on the larger and more powerful motors to the trains. By postponing this we shall save a very considerable amount of expense that would otherwise be wasted; but at the same time we have been very anxious, if we could, to provide, for the increased traffic which we hope we shall have next winter, more accommodation than we have at present. Our engineer and manager have put their heads together to see if something could be done to effect this object. Our difficulty is at the King William-street station and the small accommodation there. We have always been anxious if we could to alter that station so as to give more accommodation, but the difficulty and expense have made it almost insuperable. Our engineer, however, has at last devised a plan by which in the limited space at present at our disposal he can alter the station so as to make it similar to that at Stockwell, with a centre platform and two lines of rail on each side. By that means we shall be able to work three or four trains per hour more into that station than we can at present, which will give us about 25 per cent. additional accommodation, or very much the increased accommodation we had hoped for from the motor car trains. It will prevent our converting into motor car trains there, because the alteration will so far shorten the platform that we could not get the trains into it, but we think that without any very heavy expense we can alter that station and give an increased service of trains, increased accommodation, and carry a larger number of people. This is the most economical thing that we can do under the circumstances. We are trying in every way we can to reduce our expenditure. We now run ordinarily two of our large engines to drive the dynamos which work the line, but there are times, in the middle of the day and on Sundays, when a great deal of that power is wasted when we require rather more than one engine, but not anything like the power given by two great engines. We have now ordered a small engine and dynamo, which will reduce the cost of working to a small extent and economise in that direction. We shall be able to use one of the large engines and a small one instead of two large ones during the busy time of the day and on Sundays. We have always had a supply of water, but it has not been efficient, and we have had to buy water. We have now been able to increase the supply from our own sources, and we hope to economise a little in that direction. We are also proposing to run an additional number of two coach trains during the quieter hours of the day and on Sundays, and are proposing to order some coaches for that purpose. I believe we shall be able in all these things to show you within the next twelve months a further decided decrease in the cost of working the line. The lighting of the carriages has been a matter we have been very desirous of seeing improved. We have done something towards improving it in the past half-year; but it is not satisfactory yet, and we are going to try some further experiments with the idea of still further improving that light. As regards the question of the extension of the line, after we got the authority last February to proceed, the first question we had to settle was as to the engineering of the line, and we made arrangements with Mr. Greathead for carrying out that extension. He has had to prepare the plans, which are very elaborate and have taken a great deal of consideration, because we do not want to have any mistake with them, and our desire was to settle them with a view to the greatest efficiency. We have arranged the plans at last as to the stations, and we are now in negotiation for the sites. I told you in February that I thought it would probably take us twelve months before we should be able to acquire the sites, and it seems as if the time I then mentioned was not far from being correct. It is a slow process, however, if you are to do it economically. The Bill for the Clapham extension has received the Royal Assent. It extends the time for completing that portion of the line for another three years, and also gives us certain powers to which you gave your approval last half-year. The result altogether of the half-year's working is, as I say, not unsatisfactory. We have gone on and we are progressing, although steadily; but if the receipts of the first three months of this half-year, which showed an increase of about £700, had been continued throughout the half-year, we should have been able, I think, to have recommended a dividend at the rate of 1¾ per cent., instead of 1½ per cent. as at present, but unfortunately the decrease in our receipts in the last three months diminished our increase to the small sum I have mentioned. We hope, however, for better times in the future. I now propose the resolution.

Mr. SAMPSON HANBURY seconded the motion.

Mr. DRAKE thought the shareholders would agree, after what the Chairman had said, that the concern was managed with great care. The progress was not brilliant, but perhaps it was better for being gradual and safe. He was pleased to see that a further sum of £23,200 of terminable Mortgage Debenture Bonds had been paid off. The present was a very advantageous time for paying off debts, because well-established companies could borrow money at very cheap rates. He desired to know whether the £76,500 Preference shares was a perpetual or terminable charge. The

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Preference shares afforded the measure of the public confidence in the undertaking, and he saw that these shares were quoted at about 50 per cent. advance on their issue price.

Mr. JEFFERIES thought that on the whole they might regard the report as of a congratulatory nature. He wished to ask whether in arranging the extension to Finsbury Circus there would be a subway, or any means of getting from their station to the Moorgate-street Station.

The CHAIRMAN: I am obliged to Mr. Drake and Mr. Jefferies for their kind remarks. The Preference shares are perpetual, but some of them have been issued at a premium, and if we issue any more they will command a very large premium. We are not paying much over 3 per cent. on this capital. We pay less than 3 per cent. for what we have lately issued of our Debenture stock in exchange for the Five per Cent. Bonds that fell due. There are still £54,800 of the terminable debentures to be paid off, but we can only pay them off as they fall in each half-year. As to the question of lighting, it was not simply a question of expense. A separate system for lighting the carriages would involve a second conductor along the line, and there are objections to a second conductor in the tunnels. We are endeavouring to get over this question of the lighting in a more economical way, and I hope before very long we shall be able to do something in that direction. The light is not bad, but I am quite sure it would pay this Company to have an exceedingly good system, as it would enable people to read their papers—and travelling into town is the only opportunity which many of our passengers have for reading. Many persons who might travel by our line now prefer to go on the outside of an omnibus, where they can have a good light. I hope some day to make ours the best lighted carriages on any railway in the country. A connection with Moorgate-street station is in contemplation. The advertising is included in the rents of property, and we have a considerable sum for this.

The motion was then unanimously adopted, and the dividends recommended were afterwards approved.

On the motion of Mr. DRAKE a vote of thanks to the Chairman and Directors was cordially agreed to.

The CHAIRMAN: I beg to thank you very heartily for the kind way in which you have received us to-day. I hope that we shall meet on a more satisfactory basis, as far as the dividend is concerned, on a future occasion.

National Telephone Company (Limited).

The sixteenth ordinary general meeting of this Company was held last Friday at the Cannon-street Hotel, under the presidency of Mr. James Staats Forbes

The SECRETARY (Mr. Albert Anns) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN then said: As far as I am personally concerned, the character of our report is a little disconcerting, for I am so much in the habit of dealing with bad reports that when I get a good one I do not feel quite at home. I trust that at starting you will all agree that this report is a satisfactory one. You will see that there is a substantial increase in our income in the half-year—and I must remind you that we are on this occasion dealing with half-yearly figures, whereas for a good period of our existence we have dealt with the figures only annually. The increase in the income of the past half-year to June 30th was £33,963, as compared with the income for the corresponding period of 1894. In the working expenses there is also a considerable increase, but not very much out of proportion to the increased business. The net result, after deducting the very large amount for royalties accruing to the Post Office under agreement, amounting to £35,263, is a profit balance of £151,703, which is an advance of £11,169 over the balance shown at the corresponding period of the previous year. Our business has progressed apart altogether from the results of the particular half-year, and you are already assured of a very large amount of additional money, for the rentals carried forward for unexpired terms of running contracts amount to £390 978, or an increase of £45,619. As I have said before, a contract beginning on the 1st of January and ending on the 31st of December comes into the accounts of the year; but if it begins on the 1st of February only 11 months come in, and the other month is carried forward to the benefit of the following year. In this way we have £390,978 in our possession in respect of services to be given beyond this half-year, and it is a very large sum. It is also one of the best indications we have of the steady progress of our business in volume, and, happily, year after year we show that the volume carries an additional profit. We propose to pay the accustomed dividends secured on the First, Second, and Third Preference shares, less income tax, and 5 per cent. on the Ordinary capital, free of income tax. At our last meeting Mr. Galbraith and other gentlemen expressed a very strong feeling that it would be very acceptable to the shareholders if the dividend were paid free of income tax. Well, there is no particular reason why it should not be, and if you determine that it must be we should not object to it under the circumstances of the Company; but we find on legal advice that we can only pay the dividend on the Ordinary shares free of income tax. The Preference shares have a preference on the income of the Company, and they are not entitled to and cannot legally be credited with anything more than their bond. Having exhausted the dividend claims on us for the half-year, we have a considerable available balance; and we propose, with your permission, to do with that what we have done before—carry it to the reserve fund to the extent of £35,000, leaving £3,288 to be carried forward. Going back to the working expenses, I may say that we have debited them to the fullest possible extent, with all reasonably proper charges, and if there has been an error at all, it has been, perhaps, in the right direction. We have written off more largely than in preceding years the item of depreciation. As regards the net income, it has been arrived at, for the first time, after charging interest out of revenue upon our large reserve fund, and that is in some sense doing what certain gentlemen have often suggested, arguing in favour of a liquid asset in your reserve. The reserve fund now stands in the balance sheet as follows: Reserved from profits £237,727, and premium account £35,189, together £272,900 in round figures. If you approve of our recommendation now, that amount will be swollen by the £35,000 from revenue. I hope that this is a matter which will meet meet with your approval. We are extremely satisfied on this side of the table with the statement of accounts, considering the unsettled position in which the Company stands in relation to Parliamentary committees and so forth. Before I leave the figures I should like to refer to capital account. We expended in the six months up to the 30th of June, on construction of exchange, trunk, and private lines, £149,935, and as I have had to explain before, and may repeat now, this business cannot be extended even to one subscriber without finding so many sovereigns to carry out what is called an installation, and that expenditure has to be incurred before you can collect any revenue. The number of these new lines erected during the half-year has been 4,194. As far as a new subscriber goes, his proportion of this charge is carried to capital account. That brings out an average sum of £35. 15s. per line, so you see the risk that we run. It costs us £35. 15s. to put every subscriber on our system before we can call on him for anything for the service we render. I have been listening to many fallacies of late about telephoning. Some people have been insisting that this is a business which can be done for nothing; that it costs nothing to erect the lines, and very little to conduct the business, and that therefore our moderate charge for the enormously valuable services we render is much too high. That all rests on absolute ignorance and fallacy. There is nothing so eloquent as figures, and our experience shows from year to year how much you have to pay the piper before you can enjoy the dance. Well, that is what it cost us this half-year—on the average £35. 15s. for every subscriber; but I must subdivide that, lest any of you should go away under a misapprehension. Averages are very useful, but they are sometimes a little illusory. London is a place quite apart and special; there is only one London in any sense, and that is true more than anything else I know of with the telephone system. There is only one place like London which has to be telephoned in all the world. We have erected in London 557 subscribers' lines, and they have cost us £55,371, representing an average cost of £99. 8s. each; but that embraces a contribution to a great work which has been going on in London in the half-year in connection with the repair of a primitive error. We are asked why we did not metallic-circuit London, and we are told how short-sighted and wrong it was not to have done so and what an abominable system we have in consequence. Well, people live and learn, and this is a business in connection with which people have had to learn a great deal. On its initiation the single line was all that was sufficient, and of course it was much less costly and complex, and we adopted it; but it ceased to be good under certain circumstances, and those circumstances have arisen in London and all great centres. An enormous amount of telephone work is done in these places, where there has likewise been a growth of new disturbing causes in the way of other electric currents. That has entirely altered the condition of telephoning as compared with what it was at the period when it was first conceived and carried out. We are so persuaded of that by experience that we are spending an enormous sum of money in order to repair this mistake, and we have been metallic-circuiting London. That work has been going on quietly—almost imperceptibly—for several years, but happily it is now approaching completion. I daresay that by the end of the year the whole of London will be metallic-circuited, at enormous cost, and what is almost worse for us, at the expense of great derangement of the whole machinery of the Company from time to time, to the serious annoyance of many of our subscribers. This, however, is an incident inseparable from that great change, but when it is effected I have no doubt that two things will follow—a great diminution in all legitimate ground of complaint, and a much more efficient service; and I believe that it will also cause a vast spring in the number of telephonic subscribers. That is also going on in some other great centres—Manchester, for instance—and no doubt it will have to be carried out in all centres where telephoning is assuming large proportions. We are told that the large telephonic business in Berlin is carried on in an exemplary manner, and at a cost of scarcely anything; but neither statement is quite true. There is a very minute proportion of that business which is not performed on a single wire, and knowing Berlin very well I have often asked myself the question whether the even way in which the business is conducted there does not arise from local circumstances. Every subscriber in London thinks that he has got the fee-simple of the whole apparatus at his command—that he alone has to be served. He forgets that there are thousands of people, especially during the pressure of the busy part of the day, who have a common user of the system with himself. I am, however, told by some of our operators—ladies, too—that the language which is sometimes used, because a hot-tempered gentleman in a hurry is kept a minute or two before he is placed in communication, is of a very strong character. This arises from a misconception of the contract which the hot-tempered man has entered into, which is not for the sole possession, but for common user. In Berlin everything is regulated. The whole German people have been so drilled and regulated that they know how to wait; and notoriously—it has passed into a proverb—everything comes to the man who knows how to wait—even the telephone (laughter). The expenditure in other places in the half-year on the construction of exchange, trunk, and private lines was £94,564, which means an average expenditure per subscriber of £26. Therefore, under the most favourable circumstances, taking the various places served, it is a good round sum which has to be expended in order to enable you to start a subscriber. The average subscription now is a little over £9 for the whole of our business, so that we have to spend £26 on the chance of obtaining from a gentleman £9 a year for three years, giving him all this time the service he requires. I do not think that anyone who is cognisant of these facts—not fancies—would be wise to put his money into a competing business with us

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on the theory that every subscriber might be installed for about £10 or £15, and be worked for nothing. That is all I will say on the accounts, unless you choose to ask me any questions. I now come to paragraph 7 of the report, which is very interesting. In regard to the matter dealt with in that paragraph I will not say that we embraced the occasion, or that we were extremely sweet upon it, but we were face to face with an alternative—either to agree with the enemy in the gate, and that promptly, or fight him; and it struck us that a fight with the Government and the Post Office would not be a very wise proceeding. Therefore, like all people of experience, with their tempers well in hand, we bowed to the inevitable, and made the best terms we could, and I believe that they will prove to be extremely good terms. The relative value of them will, of course, turn on the loyalty of both parties to the contract. If the Government and the Post Office authorities are as loyal as we are—and there is not the slightest reason to doubt that they will be—then I will venture to say that for the revenue of the country, for the efficiency of the telephone service, for the public interest, and for our own interest, it will be the best combination that could have been made, because the Post Office are enabled to take risks in respect of the extension of this system which we should not have been inclined to take, but of which we shall have the benefit, while we shall be left free to develop what is our more special business—the conduct of this exchange work in the great areas. There is a great deal less risk in this work than in the expenditure necessary on great trunk lines. That is what the Government have to do, and it is very wise of them, because a Government has to consider the indirect benefits accruing to the community as well as the benefits conferred on particular people who use a particular commodity. We have to consider, on the other hand, what is best for us as people working for profit and loss, while the Government can afford to think of the advantages to the community of what they may do. The heads of this Agreement were signed more than two years ago, but they have been necessarily subjected to a great deal of discussion. No man could have been more straightforward, more considerate, or more inclined to act with entire fairness in this matter than the late Postmaster-General, Mr. Arnold Morley—and when I say Mr. Arnold Morley I mean every official of the Post Office, who are gentlemen of great knowledge and experience in dealing with these matters. They have Post Office views, and they do not go as fast ahead as we, but they are not such free agents, and they have not a terrible body of shareholders to meet to urge them on. Moreover, the Post Office cannot spend as much, perhaps, as they would like to, as they have to deal with another Department called the Treasury. We, however, can adapt this business more readily and rationally to the great wants of the public than any Government department whatever. Ours is a commercial undertaking, and theirs is only a semi-commercial undertaking tramelled with terrible official drags. I remark that of the Post Office because that Department is occasionally rudely assailed in the House of Commons and elsewhere, and they are charged with not being sufficiently prompt to meet the demands of the public or the wants of certain reforming faddists. In virtue of this Agreement we have made considerable sacrifices, for I have no doubt that if we had been allowed to go on under the old arrangement, we should have made more substantial advance in the development of the telephone system, because the expansion of the exchange business is considerable, treated merely as local business, but assisted by through communication from centre to centre there is an additional incentive for people to get on to exchanges, and we have found by experience that our business is a great deal hampered, particularly in the great industrial centres, by the paucity of trunk wires. We are no longer allowed to erect them, and our unhappy position is this—that the grumbling Briton does not discriminate. We are the people he pays his money to, and he therefore complains to us. No doubt the Post Office do not put up the trunk wires as fast as the public want them, but all that will come in time. This Agreement, I may say, was laid on the table of the House of Commons, and it was taken up and criticised by certain persons. In order to prevent anyone from saying that the Agreement was not perfectly fair and above-board, or that there was any desire to conceal it, it eventually, with the Company's consent, was referred to a Special Committee, and those who are fond of blue books will very shortly be favoured with the issue of the proceedings of that Committee. They sat a considerable time and met on several occasions, very eminent gentlemen being members of it, and the late Postmaster-General being the Chairman. We had an opportunity before that Committee of hearing a great deal, and I think that every possible thing that could be alleged against the Company was alleged, and in a considerably florid way. We were the defendants, and they took the plaintiffs' case first, and there was a constant accumulation of evidence as to what we ought to do but did not do, and as to our overbearing conduct, our extravagant charges, and our voracious appetites. However, our turn came, and then we gave the facts, the figures, and the arguments. We contrasted what we were doing with what was being done by the examples set before us. Wherever there was any parity of comparison it was made. If a small village in Holland, where some amateurs, in a sort of joint-stock mutual admiration telephonic society, found the money and worked it for nothing, and made 1 or 2 per cent., was the standard put before us, well and good; but such a comparison was not a fair one. When, however, we came to Berlin, the great cities of the Continent, and especially America, it was all one way, and we made out that when the facts were riddled we were cheaper and as efficient as any telephone service with which comparison could be fairly made; and, what is more, that the proportion of telephone subscribers in England and the user of the telephone by them bore favourable comparison with that of anywhere else. It is very important that our own proprietors, at all events, should have their minds put at ease, and I had better, therefore, tell you where this matter has got to. This is the report of the Committee, and the reference to the Committee is this: "To consider and report whether the provision now made for the telephone service in local areas is adequate; and whether it is expedient to supplement or improve this provision either by the granting of licences to Local Authorities or otherwise." This Committee sat a great many times, and heard a vast amount of evidence; and then came a disturbing cause—the Dissolution, and we poor creatures, instead of being relieved of the tension of anxiety which had hung over us, were left with this report of the Committee: "Your Committee have examined numerous witnesses upon the matter referred to them, and have completed their evidence, but have not, in view of the approaching Dissolution of Parliament, had sufficient time to consider their report. They have therefore agreed to report the evidence they have taken to the House, and to recommend that a committee on the same subject be appointed in the next Session of Parliament to consider and report upon the evidence already taken, and, if necessary, to take further evidence." I do not know what is going to happen. I am glad to say, from one point of view, that the majority of the members of that Committee—who, at all events, whatever their feelings were, concealed them—have been returned to Parliament. I am sorry to say that four or five esteemed friends of my own, who were not quite as wise in concealing their feelings as to the enormities of this Company, have not been returned to Parliament; but I do not think that their feelings towards this Company could have operated against them at the elections. However, out of the 15 members who sat on the Committee 10 or 11 have gone back to Parliament; and I hope that they will really finish this inquiry, because until they do we do not know where we are. I should like now to anticipate your perusal of the evidence which was given before the Committee by mentioning one or two facts. This is a little statement which we handed in in order to answer volumes of accusations which were made against us. It is the development of the National Company up to April, 1895. The number of towns and places supplied at that date was 537, the number of exchanges open was 593, the number of subscribers' lines was 75,216, and the number of telephones in use was 86,032. The present ratio of effective calls per annum is 139,639,032. Everyone seems to want to speak to someone else. It may be once or twice before he is put into communication. This means the operation of calling, waiting for a reply, calling again, and waiting for another reply without success; but when you have succeeded in giving Mr. A. the great advantage of talking to Mrs. B., that is an effective call, and the number of these calls per annum is 139,000,000. An effective call means at least two messages: "How do you do?" "Very well, thank you." That is a message. "Will you come to dinner?" "Cannot; already engaged." That is another message. There may be half-a-dozen of them, and there are, as a matter of fact, several of these messages; but we do not count them, but only these millions of messages on the basis I have mentioned to you. That is the measure of this wonderful service. People cannot comprehend what it means, although they are beginning to do so now. The average annual payment per line throughout the country is £9. 2s. 2d., and the average cost to subscribers per message is 0·58 of a penny. Now, if any of you have certain correspondents on the telephone what a delight it is to be able to call and talk to them for 0·58 of a penny per message! But only fancy—urgent business, matters of life and death, matters of credit, matters of great social and commercial convenience being administered safely and promptly for 0·58 of a penny per conversation! The estimated minimum average number of words per message is 100, so that for 0·58 of a penny you can have 100 words, whereas 100 words by telegraph would cost you 4s. 2d. That is one way of putting it, and it is astonishing. I watched the faces of the Committee when I read that evidence, and I saw, or I thought I saw, as regards some of the members, that it dispelled all the nonsense that had been talked about the scandalous extravagance of our charges. I will put it in another way to make it intelligible and popular. It appears that the working man is suffering terrible torture because he cannot use the telephone. My natural inquiry on hearing that was, How much does he use the telegraph? He does not use it at all. Then there is the small tradesman: he complains because he cannot compete with the great capitalists, for the reason that the Telephone Company will not let him. Well, we work it out in this way: Average annual payment, £9. 2s. 2d.; average per week, 3s. 6d.; average per day (Sunday included), 6d. Therefore the poor tradesman must be very poor indeed, and have a very small business, if he cannot afford this wonderful implement at 6d., which is about the price of sweeping out his shop. Every subscriber can have the use of the telephone by day, and in most places by night, for the price of a sixpenny telegram, and, as I have just said, whereas 100 words would cost 4s. 2d. by telegraph, the average cost per message with the minimum of 100 words by telephone is 0·58 of a penny. I hope you will not think I have wasted your time by putting you into possession of these facts. Sometimes our friends of the Press speak of us rather under a misapprehension, but I hope they will do us the justice of contributing somewhat to dispel the aspersions which they have assisted in spreading regarding our extortion. I need not trouble you, I think, with any more details about this. We hope, as we say, that this question that has been submitted to a Parliamentary Committee will be speedily determined, and then we shall know where we are, and whether we are to be competed with in every centre by the local County Council or any other modern institution which has been created for the purpose of interfering with everyone else. The business itself will not admit of competition. It is essentially a monopoly by its very nature, and is part of the Post Office business of the country; it can be done much better in the hands of one company than by means of competition, as that would mean splitting people up into two or three camps. In one or two places we serve, people have had to pay subscriptions to two companies in order to get the advantage of the telephone service. With respect to the resignation of Lord Balfour of Burleigh, he has become a Cabinet Minister, and he found it consistent with his duty to resign his position in this Company. He was a man of considerable position and of great business capacity, and he is a perfect gentleman. During the time he was with us his services were invaluable, because he was not only a first-rate man of business and a diligent attendant in connection with the detailed work of our committees, but he was an agreeable mediator. If he thought you were wron

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he had the most charming way of telling you so, and driving it home with the most forcible but pleasant arguments. He was therefore of great service to a Board like ours, where we are all strong men and fond of our own opinions. Four of the Directors retire by rotation—Mr. Eli Heyworth, Mr. Samuel Herrick Sands, Col. R. Raynsford Jackson, and myself. Col. Jackson has unfortunately been ill for a long while, and when it came to the question of his offering himself for re-election, he found it inconsistent with his duty to pretend to be able, with any satisfaction to himself, to continue further to serve you, and he therefore sent us his resignation.—The Chairman concluded by moving the adoption of the report and accounts and the payment of the dividends recommended.

Mr. ELI HEYWORTH seconded the motion.

Mr. HARRIS complained of the service given by the Company, and asserted that many of the subscribers had received very bad treatment.

Mr. LEAKE congratulated the Directors on the very satisfactory report which they had been able to submit on the present occasion. He referred to the item on the debit side of the account of "Redemption of Four and a-Half per Cent. Debenture Stock, £121,295," and said that it could not be considered an asset.

The CHAIRMAN, in reply, stated that the amount in question represented in a concrete form the advantage which the Company would gain eventually by reducing the interest on the debenture debt. He was glad that the action of the Directors, in adding to the reserve fund the interest on the fund, was approved. The main trunks which the Post Office were laying to connect the capital with other places—Edinburgh, Dublin, and elsewhere—would be connected with the Company's subscribers, who would be able from their places to despatch messages to these distant places. Mr. Harris, who was the proprietor of one share and a subscriber, had given the Company a considerable amount of trouble by the numerous complaints which he had addressed to them, many of which were unreasonable. He then put the motion, and it was carried. He afterwards stated, with regard to the two vacancies on the Board caused by the retirement of Lord Balfour of Burleigh and Col. Jackson, that the Directors had given much consideration to the question of their successors, and they had elected Sir Henry Calcraft, who was for many years Permanent Secretary of the Board of Trade, and Lord Harris, who had recently returned from Bombay, of which he had been Governor. He hoped that these appointments would be acceptable to the proprietors, whom they would have preferred consulting on the matter had there been time. It was, however, necessary for the vacancies at the Board to be filled up promptly: but he would ask them to express, informally, by a show of hands, whether they approved the selection which the Board had made. Having submitted the question to a show of hands, he thanked them, remarking that the election of the gentlemen in question appeared to be generally satisfactory to the shareholders.

The retiring Directors were then severally re-elected; and the auditors, Messrs. Welton, Jones and Co., were also reappointed.

Votes of thanks to the Chairman and Directors, and to the General Manager (Mr. W. E. L. Gaine), the Secretary (Mr. Albert Anns) and the Engineer-in-chief (Mr. D. Sinclair), brought the proceedings to a close.

Chili Telephone Company (Limited).

The annual general meeting of this Company was held on Tuesday at Winchester House, under the presidency of Mr. George Keith (Chairman).

The SECRETARY (Mr. Edmund Petley) read the notice calling the meeting.

The CHAIRMAN said: Gentlemen, I suppose you will take the report as read. You will notice mention of the death of Mr. Greenwood, one of the first Directors of the Company and its late Chairman. From the commencement of the Company until his decease he devoted a great deal of his time and experience to its interests, and his loss is much regretted by all who knew him. The report deals with the accounts so fully as to leave very little for me to say in submitting them for your approval. You will be pleased to see that the business of the Company shows a good improvement over that of the previous year, and the result is so far satisfactory as to enable the Board to recommend the payment of a dividend of 2½ per cent., free of income tax, on the shares. This result is all the more satisfactory as it is the outcome of a year which has been very adversely affected by the depression of business generally all over Chili, by exceptional expenditure, and by the extreme lowness of exchange. The bad state of business generally caused not a few subscribers to retire. During the year 704 new subscribers were brought in, and 676 gave up their telephones. This large movement entailed not only the cost of bringing in new subscribers to make up for the ceased ones, but also a considerable loss of revenue by laying idle many wires which have not yet been utilised. Yet with all this loss the gross receipts, as you will see by the report, improved about 10 per cent. The exceptional expenditure incurred by overhauling some of the trunk lines, and putting them and other parts of the property in efficient order, increased the expenses about 12 per cent., and it is very satisfactory to know from our Manager that this expenditure is not likely to occur again, at least for some considerable time. The mean average rate of exchange by which the net income in Chili was reduced into sterling, was lower than in any previous year. The exchange fell to a minimum of 10¾d. in May, 1894, and after fluctuating under the shilling for nearly three-quarters of the year, gradually rose in the last quarter to 16⅞d., in consequence of the passing of the Conversion Bill by the Chilian Legislature. Notwithstanding these adverse circumstances, the net profit for the year amounts to £6,013, as compared with £3,528 of the previous year, a gain of £2,485. During the year some important extensions have been made in the way of country and suburban lines, which have added considerably to the value of the property, and the capital expenditure has been much lessened by the subscribers of these lines having given very favourable terms to the Company for their erection in order to obtain telephone communication. The prospects of the Company for the current year have been brightened considerably by the passing of the Conversion Bill and the adoption by Chili of a gold standard. The value of the gold dollar now introduced is about 18d., and if this conversion be carried to a successful issue, as we hope it will be, there is every prospect that the exchange will vary little from the present rate of 17d., and that we shall be freed from all the difficulties arising from its recent fluctuations and depression. Lately a good deal has been said in this country about the telephone service, and not a few, principally those who know little about it, think it ought to be cheaper and better. We have some of those people out in Valparaiso, and they are attempting to carry out their ideas, but whether they will succeed or not remains to be seen. Our Manager says their chances of success are small, and their attempt will most probably end in utter failure. In any case I should think that the prospects of those who may be induced to supply the money would be anything but bright, and you may rest assured that every endeavour will be made to protect the interests of our Company. With these remarks I beg to move—

"*That the report of the Directors, with the statement of accounts to March 31, 1895, now presented to this meeting, be approved and adopted.*"

Mr. FRANK W. JONES seconded the resolution, which was carried unanimously, without discussion.

The CHAIRMAN then proposed the following resolution:—

"*That a dividend of 2s. 6d. per share, as recommended by the Directors, be and is hereby declared, and that the same be payable at the Company's bankers on and after July 31st, free of income tax.*"

The Hon. F. ERNEST ALLSOPP seconded the resolution, and it was passed.

The CHAIRMAN moved the re-election as a Director of Mr. Frank W Jones.

Mr. ALEX. HENDERSON seconded, and it was carried.

Mr. ALEX. WHITTET moved, and Dr. JOHNSON seconded, the reappointment of the retiring auditor, Mr. Thomas A. Welton, and it was agreed to.

Mr. HENDERSON, in moving a vote of thanks to the Chairman, the Board of Directors, and the staff generally, expressed his satisfaction at the declaration of the dividend, although small in amount. He noticed it was not from want of revenue that the distribution was only 2½ per cent. this year, but was owing to the low rate of exchange, which, of course, was one of those things no Directors could control. As there was every probability of the exchange keeping up to 17d. or 18d., it meant that they would receive a larger dividend next year, if the Company's earnings remained at the present rate.

Mr. WHITTET seconded the proposition, and it was unanimously passed.

The CHAIRMAN briefly acknowledged the vote of thanks, after which the meeting terminated.

Edison and Swan United Electric Light Company (Limited).

The annual meeting of this Company was held on Monday at the Cannon-street Hotel, Mr. James Staats Forbes (Chairman) presiding.

The SECRETARY (Mr. H. Charles Gover) read the notice convening the meeting.

The CHAIRMAN said: I suppose we may take the report and accounts as read, they having been circulated among you. This report and accounts contain the results of the second year of our working in the open. What I mean by that is that our patents expired at the end of the first three months of the previous year, and then we were immediately subjected to what we fully expected—namely, rather severe competition from a great many quarters, including our German friends over the water, who are pretty astute and persevering. As I had occasion to remark the proprietors at the last meeting, a public company is, no doubt, an excellent institution, and the prescription under which it is governed is excellent too, yet I am not quite sure that prudent tradesmen, in the face of very acute competitors, reveal to the outside world all that they themselves know. It is not in the interest of the shareholders or partners of this concern that the affairs of the partnership should be picked to pieces too much in detail, so that the very things our competitors wish to learn they may learn in the only way they can do so, except by induction from our accounts. That was a principle which seemed to meet with the commendation of the meeting when I enunciated it last time, and, of course, competition having become keener during the second year of our working in the open, the necessity, if it existed before, of being discreet is more urgent now than then. I think it really comes to this: you will have to extend to your Directors, or the managers of your property, whosoever they may be at any particular moment, a good deal of your confidence, and believe that their daily knowledge of the circumstances of the business, as varied from day to day by circumstances which are always varying, will enable them, with prudence and discretion, to secure your interests, without putting on them the necessity of publishing in too great detail the many items which make up the business. And you will have to be satisfied, perhaps, with yourselves, as men of common sense in business, drawing from the figures we present to you the general conclusions that under the circumstances the business is satisfactory. Of course, I need hardly tell you that having been protected for a good many years we were in a very advantageous position during that period. We were masters of the situation. We could fix our own prices and we did receive very large prices for our wares. As the time approached for our patents to expire we made arrangements, with reasonable prevision, for meeting what was probable to arise—a severe competition the moment the patents had run out, and therefore we toned down our prices by degrees, and awaited the results of the nine months' working of the previous year with a good deal of anxiety. Well, the results of the year

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during which we were for nine months subject to competition was not altogether disastrous. We laid aside a goodish bit of money, paid a reasonable dividend for the year, and entered on the second year; and I am bound to say that during the second year the accentuation of the competition and the wider area over which it has been spread, and the greater number of people who have come into the business hoping to make a fortune out of it, have made the position more difficult. We have ourselves during that time learnt a great deal to our advantage and to your advantage, and I do not think we are very much alarmed at our prospects. Of course, we shall have to face a considerable reduction in the price of the article we sell under competition, but the satisfactory feature of the past year's trading seems to be that the character of the Company and the character of the lamp has enabled us, notwithstanding the severity of the competition, not only to maintain our position, but, as regards the volume of the output, to improve it. We have sold more lamps and other things during the past year than in the preceding one, but inasmuch as for three months of the preceding year the old prices were charged, the money results of the period under review, as you would expect to find, are altered, but they still leave such a margin of profit as makes the payment of a 5 per cent. dividend for the year perfectly easy, rational, and wise. More than that, we carry forward something, and we have charged the working of the undertaking with reasonably fair sums for depreciation of the value of the plant, buildings, stock, and so forth. We have tried to keep the Company in a wholesome position. Now, with this little preliminary explanation, I will refer you to the very simple figures of the accounts. They are in exactly the same form as you have always had them before you, and they are so simple and easy to comprehend that I suppose in five minutes any of you gentlemen could make yourself master of the features of the thing. You cannot, of course, probe into the hundreds and thousands of figures which make up these in the accounts, but you will gather from these the general results which I have indicated—that our position has been maintained and, in fact, improved. Our business is now a solid one, and the Company has a very good character, so that there is every likelihood that it will be extended. People have their preferences, and it is characteristic of the English people that they are very fond of their old favourites, and, if they are wise, they stick to them. We hope they will stick to us. We happily find that our customers are doing so, and that some who were tempted by the alluring prospect of getting a lamp at half, or less than half, the old price, after having tried it, are coming back to us. As you will see by the profit and loss account, we began the year with a stock on hand valued at £87,768, and, as shown on the opposite side of the account, we ended it with the stock increased to £95,983. I will explain the reason why presently. Then wages, purchases, &c., amount to £85,112. Of course we manufacture largely ourselves. We purchase some things partly manufactured and some wholly manufactured, and that item covers the amount paid for material, wages and supervision in the workshops, and for the purchase of those articles which, either in a partly complete or wholly complete state, we find it more prudent to buy because we are able to do so cheaper than we can ourselves make them. Salaries, Directors' renumeration, rent, office expenses, &c., figure at £10,759, and depreciation on plant at £3,512. These are the items of outgoing, and you will see the depreciation on plant is a considerable item. That is a repetition of sums set aside year after year from the commencement of the business, and which in the aggregate have amounted to a very large figure, which has been written off the original cost of the plant, so that it stands in our books at a good deal less than it has cost. Then, on the other side of the account, you will see that the sum obtained by sale of lamps, fittings, royalty on holders, &c., is £114,890, and interest £2,156. Then there is a balance of £25,876 over and above the outgoings, and this enables you to be paid the proposed 5 per cent. dividend, after having paid the relatively new charge on the Company of £100,000 Four and a-Half per Cent. Debentures, which represents the purchase-money of the Swan residuum. Those who were here when the purchase was explained, will remember that we have taken over the foreign business, assets, character, &c., of the Swan Company, and the Edison and Swan Companies are consequently now being worked as one undertaking. There is a considerable advantage about that. All the separate expenditure of that Company was saved, and one of the benefits to us of the transaction was that it made us free of the difficulties which attended our export business to the Continent, because the agreement with the Swan Company was that they should only put in their British patents with the Edison here, and that we were precluded from selling lamps for the Continent of Europe, and, indeed, of exporting them without their consent. Well, that bargain we made over to the French Company, with whom we were united, and it was really the feeling of disadvantage of that bargain which made us anxious to bring back the sheep into the fold, one of the incidents being dissolution, so far as we were concerned, of the French Company. We sold out our interest to them, and got back a considerable asset in money; and we were also released for all time from the restrictions which previously existed, and obtained perfect freedom to export our lamps to the continent of Europe and every other part of the world. The balance sheet, I think, stands pretty nearly as it did at the last meeting, as far as the essential figures go. There is the share capital of different denominations, and the £100,000 of Four and a-Half per Cent. Debenture Stock, sundry credit balances, the reserve fund, and so forth. On the other side you will find the old figures—cost of establishing the business, goodwill, remaining patents, &c., £261,955, with the item "further expenditure thereon, £19,307," which I will explain, because if one did not explain it you might think there was some object in not doing so. That makes our charge, supposing we were in the position of a company liquidating, as £262,000 in round numbers to be accounted for against the share capital and the £100,000 of debentures. We have a sleeping partner in the concern, and the "B" shares represent the interest which Mr. Edison and his friends hold in this Company in virtue of their having been patentees and the original people who constituted the Company. The shares are made subject to a 7 per cent. dividend being paid on the other shares. When the happy moment arrives at which 7 per cent. is payable—and it has been paid for a good many years—and there is a surplus, these gentlemen are entitled to participate in it to the extent of one quarter. Any deficiency in paying the "A" shareholders has to be wiped out before the "B" shareholders can touch any of the profits earned. Well, that £19,000 odd I was speaking about is this: When we went into the French combination we raised a particular capital—2,000,000fr., and that was contributed on two principles. 1,000,000fr. was the assumed value of the patents put into the pot by the Edison and the Swan Companies; the other 1,000,000fr. was subscribed in cash to start the business and conduct it. We went on, as you know, for a considerable number of years under the contract, and the question that arose at the expiration of that contract by effluxion of time was whether it should be renewed or determined by mutual consent. Our French colleagues were not very sweet about going on, neither were we, principally for the reason that our experience showed us that any benefit we could get from the investment of that money in France was very dearly purchased by our being excluded, under the contract, from the rest of Europe, and also from exporting to our Colonies and the rest of the world. Therefore we thought it better to get out of it. The ideal proportion in respect of goodwill, &c., comes back. It was never represented in hard cash, and we have it for what it is worth for the whole of Europe. The cash we got back a considerable portion of—about £12,000 out of £15,000—and that is the price at which we have become free and unencumbered as regards our French partners, and there is more an imaginary than a real addition to the expenditure of our undertaking in this £19,000. That is the outcrop of the operation. Part of it, representing some £15,000, was the book value of the goodwill, and the other was the balance of the £15,000 paid in cash, which had been diminished to some extent in the course of the operation of the business. There is another item—freehold and leasehold property—which I may say a word of explanation about, and I refer to it to anticipate any question that may be asked as to the diminution in our reserves of cash. One knows perfectly well how valuations of property connected with a company of this kind works—how much the value of the plant, machinery, &c., depends on its being a going concern. If you equip a factory, put plant into it and everything else you require to start a particular business, and it fails, the probability is that that factory, with all its appurtenances, is not worth so much to a purchaser for some other purpose as it is to you, and as it cost you to make it applicable to certain purposes; and, therefore, one has to proceed in such a case as you would do in opening a shop or a set of offices—namely, that the original outlay being a necessary thing, it has to be recouped by the profits from the business. That has been done with regard to our property. The primitive figures have been much reduced out of our profits. The additional part of the item is the leasehold property. I do not know whether the proprietors ever care to see where their property is. If they do, and will walk round to Queen-street, they will see what an admirable building we have there, in a capital position for our business; and if they will be good enough to call on the secretary he will enable them to see how admirably it is laid out for the conduct of our business, including, as it does, sale rooms, store rooms, and the necessary offices and appurtenances for what is, after all, a considerable administration. It involves a large establishment to conduct a business like ours. We are obliged to watch with a good deal of vigilance and carefully check the cost, even to a very trifling sum, the goods that we manufacture. For instance, suppose we say an article cost 6¼d.: well, that farthing is a most essential element in the matter, and it is worth a good deal to prove that that farthing is a superfluity, and should not be spent. This is a business in which the figures will run into millions in the course of time. One has only to appreciate what a million of farthings amounts to to see the importance of reducing the cost of manufacturing our articles by every fraction that it is possible to do. The next item is plant and stock, which together comes to £132,260. That includes all the plant in our several factories, and the great number of depots we have got, and also the lamps and fittings we have for sale, and also a variety of things, platinum and so forth, which, at the end of every half-year, has to be accounted for. I have remarked several times that that looks a large amount in the aggregate, and would be so if we had only one depot. But we have besides the depot in the City, another at Westminster, and others in 12 of the principal cities of Great Britain, each of which has to be stocked with a great number of appliances. If you walk to our Queen-street depot after this meeting, you will see there innumerable articles which have to be kept in stock to show to people who come to select their electrical fittings. That means a large lock-up of money, and a business of this kind cannot be conducted without a considerable lock-up. As I have said before, we have not anything to fear from small companies. Any serious competitor in this business must be people armed with a great deal of capital. There must be a great deal of money expended before you are able to give your customers a wide choice, which is what they expect. People will not come to us to buy a lamp if they have to go elsewhere for the holders and fittings, and so we have to keep a great variety of lamps and everything else in stock in order to prevent customers going elsewhere. Then we have some debtors, which amount to £41,609. I suppose that so far as anyone can say a thing is absolute that that sum is absolutely good, and as you will see, it exceeds our credit balances, which are, in fact, our debts, by about £10,000. Then we have a sum of £25,000 invested in the National Telephone Company Five per Cent. Non-cumulative Third Preference shares. I believe the price in the market is quite the amount at which they stand in the balance sheet—perhaps a little more. These are the items in the balance sheet, and except for the purpose of answering any questions or elucidating further any point, I think I need say no more about them. Then, of course, we come to the dividend. The third account shows how we

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propose to appropriate the profits. Of course, we are bound to make the payments of interest on the Debenture stock as they become due on January 1st and July 1st, and that has been done. We paid an interim dividend in respect of the business of the half-year ended December 31st last at the rate of 5 per cent., and we propose to pay you now a further dividend at the rate of 5 per cent. for the past six months, making 5 per cent. for the year, and leaving £3,702 to be carried forward. To sum it all up I may say that notwithstanding severe competition and the natural desire of prudent people to substitute a cheaper article for a dearer one until they learn that cheapness is not always economy, we have been able to maintain our position. I think we have improved our character and learnt a good deal, and we know now, no doubt a great deal more accurately the wants of the public under competition than we knew before, and the volume of our business has increased, although the receipts have diminished in consequence of the price having fallen. As far as my colleagues and myself can judge—and we are bound to give you the benefit of our convictions—we believe this business is established now on a fair and solid basis, and is calculated to yield a pretty fair dividend, and will in the course of time become more lucrative than it is now. With these remarks I beg to move—

"*That the report and accounts for the year ended June 30, 1895, be received and adopted.*"

The EARL of LICHFIELD seconded the resolution.

Mr. K. W. HEDGES recommended the immediate publication of a catalogue, and of curves showing the superiority of Edison-Swan lamps over others.

The CHAIRMAN: The Directors think we may rest on the fact that most of our customers who have tried other people's lamps come back to us, but Mr. Hedge's suggestions will have our best consideration, if we can get them presented in an intelligible form. With regard to the complaint that we have no catalogue, I should explain that this is taking a new form. As soon as our patents expired and we opened shops, we found ourselves bound to go in for holders of many types, and to compete with firms who for years have had the great advantage that artistic taste in the fitting up of our houses with gas fittings gave them in adapting those things to electric lighting. To us that was a new business, and we have had to get the machinery together and form a staff. The catalogue is in the press.

The adoption of the report was then agreed to unanimously, as were the dividends announced in the report.

The Earl of Lichfield and Mr. Ernest Villiers were re-elected Directors, and Messrs. Welton, Jones and Co. as auditors.

The CHAIRMAN then referred to the next business—the proposed alteration in the Memorandum of Association, set out on page 438 of our last issue, the import of which was explained to the meeting by Mr. Crisp, the Company's solicitor, after which

Mr. G. BLACK said he did not think the proposal a fair one to the Edison fully-paid shareholders, as the payment of 2s. 6d. was not a sufficient equivalent for what they were asked to give up, and if this resolution were passed over his head he should consider if he could not take steps to prevent it from being carried out.

The CHAIRMAN said that 98 shareholders, representing 4,800 shares, had consented to this proposal in order to get a Stock Exchange quotation, and here was Mr. Black and his friend standing out, one representing 12 and the other 63 shares. It was not reasonable that the undoubted advantages to the shareholders as a body of a Stock Exchange quotation was to be upset in this manner. They had had cases of shareholders having to part with their fully-paid Swan or Edison shares at a price below that which they could get for the shares with £3. 10s. paid, because the £3. 10s. shares were quoted on the Stock Exchange.

The EARL of LICHFIELD made a special appeal to Mr. Black to consent to the proposed agreement, as it was to the interest of all the Edison fully-paid shareholders to do so.

Mr. BLACK said after what had taken place he would not press his objection further.

The motion for the alteration of the Memorandum having been put to the meeting and approved,

A vote of thanks to the Chairman and the Board brought the proceedings to a close.

Eastern Telegraph Company (Limited).

The forty-sixth half-yearly general meeting of the Eastern Telegraph Company (Limited) was held on Thursday, July 25, 1895, at Winchester House, 50, Old Broad-street, London, under the presidency of the Most Hon. the Marquis of Tweeddale, the Vice-Chairman.

The SECRETARY read the notice convening the meeting, and the minutes of the last half-yearly general meeting.

The CHAIRMAN, having signed the minutes, said: I have now to move the adoption of the report and accounts, which you have had in your hands some days, and which you will probably take as read. Before actually making the motion I feel it right to explain that we were under the necessity of holding this meeting a few days later than usual, but this will not occur again, and next year you may calculate upon the meeting being held at the usual time. I have also to mention that our Chairman is unavoidably absent to-day. This is polling day at the Wick Burghs, and I am sure you will all join in expressing the hope that he may accomplish what he is so anxious to achieve. This is our forty-sixth meeting, and Sir John Pender has presided on every occasion excepting this one. I know he regrets his absence very much, as he takes a particular pleasure in being present at the half-yearly meetings of the Company whose prosperity owes so much to his energy and ability.

I propose to follow the example which he sets on these occasions, giving you a few observations on the accounts and the report. The gross revenue for the half-year under review amounted to £420,526, being an increase of £31,212 on that of the corresponding period of 1894. On an examination of the message receipts from all sources we find a small decrease in the traffic with India, but a considerable increase in the traffic beyond India, to Australia and China. There is also a marked increase in the traffic with South Africa, no doubt owing to the activity in mining business which has prevailed there for so long. You will remember that the Chairman at the last general meeting announced that the Eastern and South African Telegraph Company (in which this Company is largely interested) was about to complete an arrangement with the Governments of Great Britain, the Cape of Good Hope, Natal, and the South African Republic, as well as with the British South Africa Company, for a continuation of a portion of the subsidies now payable for telegraphic communication with South Africa, in consideration of a reduction of the tariff over the Associated Companies' lines between Europe and South Africa. Those negotiations were brought to a satisfactory conclusion; and here I may perhaps read a telegram which I received from Sir John Pender a minute or two ago, in which he says how much he regrets not being present at the meeting to-day, and adds, "You can tell the shareholders that arrangements just completed with the Cape, Natal and the Transvaal, insure us 15 years' prosperity." The rates were reduced from 8s. 9d. to 5s. per word for public telegrams, and from 2s. 2½d. to 1s. 6d. per word for Press telegrams. The accounts which are submitted to you to-day are, of course, not affected by the reductions, but the result so far may be considered satisfactory to all the parties to the agreement as well as to the telegraphing public.

Looking at the ordinary expenses of the half-year we find that they amounted to £98,060, or an increase of £3,220. From this increase, however, must be deducted about £2,293 for proportion of stationery charged against this half-year's accounts. This has been fully explained at the last two general meetings. The present half-year's is charged with its proper proportion of the annual supply. The comparisons between one half-year with another will in future be easily made, as each period will bear its proper share of the annual cost. The actual increase in the ordinary expenses is therefore only about £927, and this notwithstanding a very large increase in the number of messages dealt with. This increase, I may mention, amounts in words to half a million, and in messages to very nearly 100,000.

Looking now to the working expenses at the stations, you will find that they amount to £81,220, being an increase, compared with those of the corresponding period of 1894, of £4,579; but, deducting the item for stationery just referred to, the increase under this head amounts to only £1,396. This is mainly due to the salaries and allowances of the increased number of staff required to deal with the additional traffic, and also to the annual promotions to the other members of the staff. For instance, the number of the staff at the stations in March, 1895, was 729, whereas in March, 1894, the number was 714, so that there is an increase this year of 15. You are, I believe, aware that we take great pains to make our employés, wherever they may happen to be stationed, as comfortable as possible. We pay them good salaries, and provide them with means of recreation both indoors and out. In return for that we look for active and zealous discharge of their duties, and we have not been disappointed (hear, hear). I question if any service can show a body of men more animated with a desire to do their duty and carry out the wishes of their employers than the men in our service.

The expenses attending repairs and renewals of cables amounted to £52,730, or an increase of £3,070. Full details of the work done by our ships during the half-year will be found on page 6, Abstract "C." You will find there that they have been very actively employed—more than in the preceding year. The ordinary expenses of the ships this half-year amounted to about the same figure as they did in the corresponding period of 1894, notwithstanding that they were, as I have just said, more actively employed during the half-year under review. The credits received from other companies for the hire of our ships show an increase of £8,000, so that the increased expenses attending repairs to cables are due to our having laid an exceptionally large quantity of new cable into the original Aden-Bombay section. During the last 18 months we have laid in about 300 miles of new cable. You will be glad to know that this section, laid so far back as 1870, is, with these repairs, now in good working order. This section, you will notice, is 25 years old.

Under the head of depreciation of spare cable we find that there is an amount of £3,222, or an increase of £844 as compared with the same item in the corresponding period of 1894. This item necessarily depends on the amount of the stock of cable in the tanks from time to time, but it is kept as low as possible compatible with the efficiency of our service. The amount carried to maintenance ships' reserve fund is £9,000, showing an increase of £4,000 compared with the corresponding period of 1894. This increase is really necessary in order to strengthen this fund in view of expenses which we see coming before us. One of our ships—I refer to the "Amber"—will require a new boiler and a general overhaul, which will be expensive. As I have already mentioned, we have made a profit from the hire of our ships during the half-year, and we think the maintenance ships' fund should have the benefit of any profit which may be made in that way. You will observe in the accounts that this profit is credited to the maintenance ships' fund.

The net result of the half-year's work is that, after providing the usual amount for interest on debentures, Debenture stock, and Preference shares, we are able to recommend the usual final dividend of 1¼ per cent. and a bonus of 1½ per cent., making, with the interim dividends already paid, a total distribution of 6½ per cent. for the year ended March 31, 1895, and to carry the sum of £100,000 to the general reserve fund, against £110,000 in 1894. We have also, in pursuance of an arrangement arrived at, and approved by the shareholders some time back, applied a further sum of £50,666 from the reserve fund in reduction of the cost of the Aden-Bombay No. 3 cable and other expenditure chargeable to capital. The total amount applied from the reserve fund now amounts to £1,451,718, and our capital account,

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with the exception of some additions to buildings, practically remains at the same figure as it has done for many years past—in other words, a little over £6,000,000.

Now, gentlemen, although our general reserve fund is a very substantial sum, and the securities are higher in value than they were when they were made, yet the sum falls very short of what we consider it should stand at, having regard to the number and age of our cables. It has been urged by speakers at some of our recent meetings that we should raise money to provide for capital expenditure, and thus have a large sum available for dividend purposes. This, however, has not been our policy, which has been to keep down the capital account, to provide adequate reserve, and at the same time to pay a good—I think I might say handsome—dividend to our shareholders. This policy has been approved at every meeting at which it has been propounded—approved of by the great body of our shareholders, and I see no reason to expect that it will be altered. I do not think I have anything to add to the remarks which I have now made. Your property is in a very prosperous condition. I observe from a return I have here that the market value of the Eastern Telegraph Company's Ordinary stock, amounting to £4,000,000, is £6,700,000; and taking the whole of our shares—Ordinary and Preference—our debentures, and Debenture stock, their nominal value is £6,099,690, whereas it stands in the market at £9,719,439, an appreciation of 59 per cent. Your Company is in a flourishing condition, the management is both efficient and economical, our traffics are improving, and our relations with the Colonies and foreign Powers are, thanks to our Chairman's tact and energy, on a most satisfactory footing. I therefore think we have a right to expect from you, if not a unanimous, I hope, certainly, a general approval of our report (hear, hear). I now beg to move the motion, but before sitting down I shall be very glad to answer any questions. The resolution is as follows:—

"That the printed report and accounts of the Directors to March 31, 1895, submitted to this meeting, be and the same are hereby received and adopted. That a dividend on the Preference shares of the Company to June 30, 1895, at the rate of 6 per cent. per annum, be paid, less income tax; and that, in accordance with the Directors' recommendation, a dividend be and is now declared of 2s. 6d. per share, with a bonus of 3s. per share, both free of income tax, on the Ordinary shares of the Company, making, with previous payments by way of dividend on account, a total payment of 6½ per cent. on those shares for the year ended March 31, 1895."

Mr. GEORGE GARDEN NICOL: I beg to second that.

The CHAIRMAN: The motion has been proposed by myself and seconded by Mr. Nicol, but before putting it I will inquire whether any gentleman desires to address the meeting.

Mr. GOODSALL: I should like to ask where the 300 miles of new cable has been laid in the 1870 Aden-Bombay cable. Will you let the Managing Director point out on the chart or map where it is?

The MANAGING DIRECTOR (Mr. J. Denison Pender): At the Bombay end.

The CHAIRMAN: The 300 miles has been laid in the section between Bombay and Aden.

Mr. BAYNES: The accounts and the report are eminently satisfactory, not only to the Board but to the shareholders also. Still, notwithstanding this fact, which we have to congratulate ourselves upon, our dividend remains very stationary, and half-year after half-year we carry very large sums to the reserve. In addition to that a considerable portion of the revenue is diverted to duplicating and triplicating the cables and to laying new cables. All these things ought to conduce to the payment of a somewhat larger dividend than the shareholders have been receiving for some length of time. In the early part of the career of this Company the prospect was held out of our receiving dividends of 10 or 15 per cent. That we none of us now expect, because circumstances have arisen which it was impossible for the Directors to foresee. Notwithstanding that, the Company has gone on prospering very much indeed, and we, as Ordinary shareholders, having borne the brunt of the battle, have a right to expect some little increase of dividend. Ours is a very strong and rich Company. I have mentioned this subject before, and on the last occasion Sir John Pender said that the time might arise, and probably would, when the dividend might be increased. The noble lord in the chair, however, does not take that view. I think we are entitled to some consideration, remembering all the circumstances, and the prosperous state of the Company.

The CHAIRMAN: In answer to Mr. Goodsall, I have to say that the 300 miles of cable referred to have been laid in different portions of the Aden-Bombay section, but the repairs have been made on the Bombay side. With respect to the remarks of Mr. Baynes, I can only repeat what was said at the last meeting—by our Chairman, I think. He said he hoped, as soon as the reserve fund was sufficiently large, to be able to give something more to the Ordinary shareholders, and that he would be only too glad to do so when he could. I am sorry to say that the reserve fund is not nearly large enough. We have an immense system—a great number of cables, some of which are very old; and although I am glad to say that age has not injured them so much as we at one time expected, yet our reserve fund is not nearly large enough at present. We are, as you know, adding a substantial sum to it every year, and I am sure that no one could be more anxious than your Chairman to pay a larger dividend than the present one. I only hope that we may live to see that. Well, gentlemen, the motion has been proposed and seconded, and those who are in favour of it will please to signify the same in the usual manner. To the contrary. Carried unanimously. That constitutes the business of the meeting.

Mr. BAYNES: I desire to move a vote of thanks to our Chairman, which I do most heartily, and also to the Board and the staff. I think that they have managed this Company exceptionally well. They have taken care of the interests of the shareholders, and I trust they will continue to do so, and I have very little doubt they will. We do not see our Chairman among us to-day; but he is on election business, and I trust he will return to town again successful as a member of Parliament. It will be very satisfactory to us if that should be so.

Mr. H. P. BURGESS: I have very much pleasure in seconding the resolution, and in endorsing every word which the last speaker has said. Although our Chairman is absent he is not forgotten, and I hope Sir John will be returned with a splendid majority. I think we are very much indebted to him for the manner in which this Company has been conducted so prosperously. I therefore beg to endorse every word that my friend has said in proposing that our best thanks be given to the noble Marquis in the Chair, the Directors, and the staff, who work so ably and so well.

The motion was carried unanimously.

The CHAIRMAN: I beg to thank you on the part of my colleagues and myself, and also on the part of Sir John Pender. I am sure that if he is not here in body he is in spirit, and will be extremely gratified when he sees the account of this meeting and the most cordial manner in which his name has been received.

The proceedings then terminated.

Anglo-American Telegraph Company (Limited).

The ordinary general half-yearly meeting of this Company was held on Friday at Winchester House, the Marquis of Tweeddale (Chairman) presiding.

The SECRETARY (Mr. T. H. Wells) read the notice calling the meeting, and the minutes of the previous half-yearly meeting.

The CHAIRMAN said: Gentlemen, I have now to ask your approval of the report, which has been in your hands for some days, and which, I presume, you will take as read. For three half years and more I have had, when addressing you, to deplore a falling off in our receipts. In July of last year the loss was £16,791, and in January last it amounted to £6,948; but on this occasion I am, happily, able to report to you an increase of £9,382. This, though not a very large addition to our gross income, is a step in the right direction, and an indication, it seems to me, of a return of confidence in business circles which will certainly lead to a greater increase in future. This hope is confirmed by the receipts of the current month, which show a larger increase than we have had during any month of this year. It is somewhat disappointing that the whole of the half-year's increase is not available for dividend. This is in consequence of the ship "Minia" not having earned as much as she did at this time last year. The decrease in the earnings of the ship amounts to £2,550, which, together with the fact that we brought forward a smaller sum into this account by £358, reduces the increase of £9,382, which would otherwise have been available for division, to £6,658. On the other hand, the expenses show one or two satisfactory features. There is a decrease of £1,342 under the head of repairs to cables, but against this has to be set an increase of £1,009, made up of several not very important items. On balance there is therefore a decrease in the expenses of £333. This decrease, however, compares with a considerable decrease at this time last year, so I think it must be regarded as satisfactory. The renewal fund is creeping up, and now amounts to £609,148; but, taking the middle price to-day of the securities in which part of the fund is invested, it will be found that they represent an increased value of no less than £79,000, thereby raising the amount at which the fund may be said to stand to £688,148. Of course, this is much too small a sum for the purpose of the reserve fund, and it will be some time longer before we shall be able to do what we used to do—namely, devote merely the interest obtained from the fund to increasing it. I next come to the important matter of the condition of our cables, and I am glad to say that all our principal cables are in first-rate working order. The new cable is as good, if not better than it was expected to be in point of power of transmission, and the 1873 and 1874 cables, although old—one being 21 and the other 22 years old—are in excellent electrical condition. The same may be said of the 1880 cable. There are two cables interrupted at the present moment: the Duxbury and the Newfoundland-Cape Breton cables, and also, of course, the Brest-St. Pierre cable. Our repairing ship is occupied now in putting the Duxbury and the Newfoundland-Cape Breton cables in good order, and this will take some time, so I am afraid we shall not be able to devote any time to repairing the Brest-St. Pierre cable just yet. The net result of the half-year's working, as you know, is that we are able to pay a dividend of 21s. per cent. in place of 19s. paid for the corresponding half-year in 1894. It is only a slight increase, but still it is in the right direction, and as we have a very large capital it is not so much as otherwise it would be. We have had a good many lean years, and I think we are entitled to look forward to something better in the future. If this hope is realised I shall be able when I meet you six months hence to present a better statement of accounts than we have to-day. I had almost forgotten to refer to the French case, which is still *sub judice*. I think you are aware that we took the opinion of eminent counsel as to the wisdom of appealing from the decision already given in the Court of Appeal. We were advised that there was a reasonable prospect of a successful issue to an appeal, and therefore we have taken the necessary steps to do so. We understand that there is little probability of the case being taken before the Long Vacation, and I do not know whether it will be taken at an early date afterwards or not. If it is we shall be able to give you an account of what has taken place at our next meeting. Gentlemen, with these remarks, which, I think, deal with almost every interesting point connected with the operations of the Company during the past half-year, I beg to move the following resolution:—

"That the report of the Directors and the accompanying statement of accounts, to the 30th of June, 1895, submitted to this meeting, be and the same are hereby received and adopted."

Mr. FRANCIS A. BEVAN (Deputy-Chairman) seconded the resolution.

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Mr. MICHAEL DAVIES said he should like some further explanation of the law proceedings which had been going on so long. Was it not the fact that the decision already given was in favour the Company?

Mr. HARDY inquired if it were necessary to keep so many cables at work as they were doing?

The CHAIRMAN, in reply, said: With regard to the last question, I may say that in order to earn our share of the pool receipts we must have three cables at work. Considering the age of the four cables, excepting the one we recently laid, it would be dangerous to rely on three of them being in working order for a great length of time, and I think it is only common prudence that we should have one more than the three that are absolutely necessary to secure our share of the pool receipts. Any falling off in our share of the pool receipts would have a serious effect on the dividends we pay, which are small enough already. With regard to the question asked by Mr. Davies, I may say that the judgment already given was in favour of our Company, but not altogether. There was some modification. The most important part of the judgment was that it limited the period during which the Company might claim damages to 3½ years, instead of the entire period since December 31st, 1886. Whether our appeal will lead to any substantial result in the shape of our getting damages is a matter for the future, and one on which it is impossible for us to express any opinion now.

The resolution was then carried unanimously.

On the motion of Mr. JOHN NEWTON a vote of thanks was accorded to the Chairman and the Board of Directors, and the meeting then terminated.

Direct United States Cable Company (Limited).

The thirty-sixth ordinary general meeting of this Company was held at Winchester House, Old Broad-street, on Tuesday. Sir John Pender, G.C.M.G., M.P., presided.

The SECRETARY (Mr. T. Finnis) having read the notice convening the meeting and the minutes of the last ordinary general meeting, the report of the Directors was taken as read.

The CHAIRMAN: Gentlemen—As usual, I will go over some heads of the report, so as to give you such information as I think it is desirable that you should have. The revenue for the half-year to June 30th, after deducting outpayments, amounted in round figures to £37,653, and the working and other expenses, including income tax, but exclusive of the cost of cable repairs, absorbed £18,909, leaving a balance of £18,744 as the net profit of the half-year, making, with £1,808 brought forward from the previous half-year, a total of £20,552, which has been appropriated as follows: Interim dividend of 2s. per share for the quarter to March 31st last, £6,071; final dividend of 2s. per share, now proposed, for quarter to June 30th, £6,071; transferred to reserve fund account, £7,000; balance proposed to be carried forward, £1,410. The revenue, as compared with that in the corresponding period of last year, shows an increase of £2,810, and it is satisfactory to note that the traffic generally is showing a tendency to further improvement after the long-continued depression. The expenses in London, as shown by Abstract "A" in the accounts, remain about the same as in the corresponding period; the items altogether absorb an additional £44. The expenses at stations, as detailed in Abstract "B," show as follows: Increases of £174 in salaries and wages, and £43 in printing and stationery. On the other hand, there are reductions of £51 in maintenance of instruments, £22 in rates and taxes, and £67 in agencies. On the whole, the stations' expenditure shows an increase of £76. In the remaining items of expenditure there is a reduction of £158 in Directors' remuneration, and an increase of £150 in use of patents, due to the automatic transmitter. In the aggregate, the expenses and other payments come within £159 of the same amount as in 1894. The cost of cable repairs has been £1,730, and this has been charged, as usual, to the reserve fund account. At the same time this account has been debited with £673. 14s. 8d. in respect of the cost of old buildings, which have been pulled down to make way for the new permanent buildings now in occupation at Ballinskelligs. On the other hand this account has been increased as follows: By interest on investments, £1,429; by profit on sale of securities, £1,139; transfer from revenue, £7,000; making a net increase of this reserve fund account for the half-year of £10,165, and bringing up the total to £298,369. 18s. 10d. The investments have been increased during the past half-year by £12,331, and considerable further appreciation has taken place in the market value of the securities as a whole, which are to-day worth about £51,000 more than the figure of cost at which they stand in the balance-sheet. Now, gentlemen, that is a very satisfactory account. There is just one dark spot on it, but I hope that with the better times which are coming round we may be able to pay you a better dividend. The United States have passed through a state of depression which, I am told, has not been exceeded since they became a united Government. Looking to a better state in the future, I hope that that dark spot in our position will be obliterated. I call it a dark spot, and I admit freely to you that the dividend we are paying does not contrast well with the old-fashioned 5 per cent. we paid you for so many years; but I repeat what I said at the last meeting—that there are more cables in the Atlantic at present than are required for the work that has to be done. Taking that into account, together with the bad times, the result to you is that you get a dividend of 2 per cent. instead of 5 per cent. I cannot say how soon we shall come back to a better state of things, but judging from the improvement that has taken place in the present month, in which we have a very satisfactory increase, and the increase upon the past half-year was £2,800, we are going the right road at present. I hope we shall continue on the right road until I am able to declare a better dividend than we have to offer you to-day. But it will be satisfactory to you to know that what I have stated shows that the concern is in a very sound condition. I must, however, also remind you that our cable is reaching a period when we have to look carefully after it. Cables, like old people, require a good deal of attention, and we are watching the cable with considerable interest; but there is one satisfactory point in connection with it—that during the times when we have made repairs we have introduced a good deal of new cable into it, and therefore our present cable is not quite so old as it looks, or as we may be told that it is. I am therefore hopeful that for many years yet to come we shall be able to see that our cable is a fairly dividend-earning system. The only other point I have to mention to you to-day—and I shall only say a few words about it—is that the suit in France still goes on, and when it will end I cannot say. At all events, it pleases the French solicitors to keep it going, and as they promise some good results if we get the thing our own way, we cannot very well object. This business, I may remind you, is carried on entirely by the Anglo-American Company. I spoke at considerable length last half-year, and really beyond what I have just now said to you I have very little to comment on; but to leave a good taste in your mouth I may say that your Company is in a very satisfactory position. After a long period of depression I think we have turned the corner, and as you are going upward now I hope that movement will be greatly beneficial to all concerned. I thank you for your attention, and I now beg to move—

"*That the report of the Directors, dated July 9, 1895, together with the statement of accounts to June 30, 1895, annexed thereto, be, and the same are hereby received and adopted, and that a final dividend be now declared of 2s. per share, free of income tax, making, with the interim dividends already paid, a total dividend of 2 per cent. for the year ended June 30, 1895.*"

Mr. E. M. UNDERDOWN, Q.C., seconded the motion.

The CHAIRMAN: Before I put the question I will, as usual, invite any one who desires to put a question to do so now, and I shall be pleased to answer him to the best of my ability.

Mr. VARLEY observed that there was no certificate as to the condition of the cable, but he presumed it was in good working order. The Board had realised some of the securities. It was patent to everyone that the price of Consols was very high indeed, and he would like them to pursue that course and realise the profit now shown. If trade improved the price of Consols would not stand at what it was now. There was a statement that they would rise to 110, but they ought to be careful of such statements.

The CHAIRMAN: This point was put to me six months ago. I said then that 105 was a high price, but at the same time I said that money in the market was not worth more than 1 per cent., and that as long as money was at 1 per cent. and people could get more from Consols, Consols might go up. I consulted more than one banker, and I used my own common sense also; and while I thought that 5 per cent. was the price to realise at, if I had done so I should have thrown away 2 per cent., because Consols are worth 107 to-day, and they are therefore approaching to the 10 per cent. spoken of. I do not mean to say that I am right, or that those bankers who advised me are right; but my common sense tells me that as long as people cannot get 1 per cent. in the market for their money, Consols will rather go up than down. When they get to 10 per cent. I think we will say we had better realise the profit on them. Meantime, I think you must leave the matter in my hands to do the best I can for the Company. I have shown you that I was right last time, and I hope that I may be right this time. As to the condition of the main cable, it is working well. We have one cable—a short one, from Rye Beach to Halifax—down, but I expect before very long that it will be again in working order. Meantime our traffic is not suffering in any way by the interruption, as we have the use of an alternative land-line. I think that is all I have to reply to, and I will now put the resolution to the meeting.

The resolution was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. JAMES PENDER M.P., Mr. Charles E. Günther was re-elected a Director, as was also Admiral of the Fleet the Hon. Sir Henry Keppel, G.C.B., D.C.L., on the motion of the CHAIRMAN, seconded by Mr. UNDERDOWN.

Messrs. Deloitte, Dever, Griffiths and Co., and Messrs. J. and J. Sawyer and Co., were afterwards re-elected auditors of the Company for the ensuing year, at a remuneration of £50 each.

The CHAIRMAN having intimated that that concluded the business of the meeting,

Mr. VARLEY proposed a vote of thanks to the Chairman and the Board.

Mr. JOHN NEWTON seconded the resolution, and congratulated the Chairman on his successful contest in the North. That was the first time that telegraph shareholders had seen Sir John Pender since his success and he was sure they all congratulated him. He also desired to congratulate Mr. James Pender on his success.

The resolution was carried unanimously.

The CHAIRMAN: It is not always wise to introduce politics on an occasion of this kind, because people have differences of opinion. I have had a hard fight for my seat, I can tell you, and I can therefore speak with a little feeling, but I think you will all agree with me in this—that a strong Government is what is required. I do not care whether it is one side or the other, for I think the common sense of the country will always keep a Government right; but if we have a strong Government—a Government that will work and bear in mind closely the best interests of the large mass whom they have to represent, that is the Government to make a prosperous country. I think that ought to satisfy both sides. My own feeling is strong that we are going to have a strong Government now, if numbers testify anything; and I do hope and believe that they will cease to tinker with the constitution of this great country, and do something to ameliorate the condition of the great mass of the people.

The proceedings then terminated.

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Electrical Power Storage Company, Limited.

The sixth ordinary general meeting of this Company was held at the Office, 4, Great Winchester-street, London, E.C., yesterday (Thursday), Mr. John Irving Courtenay in the chair.

The SECRETARY (Mr. J. W. Barnard) having read the notice convening the meeting, the report of the Directors was taken as read.

The CHAIRMAN said: I am glad to meet the shareholders again and to be able to say that the Directors recommend the same dividend as last year, viz., 5 per cent. We have also been able to increase the reserve fund by the sum of £2,684. 12s. 11d., so that this account now stands at the satisfactory figure of £12,000. A larger sum than usual has been spent at Millwall in plant and tools, viz., £1,696. 10s. 8d., which includes new boilers, engine, and building extensions. As stated in the report the Directors have reduced the selling prices of the Company's storage batteries. They fully appreciate the exertions of the manager (Mr. Frank King) and his staff, who have, by their unremitting attention to maintaining the high quality of the Company's batteries, and at the same time reducing the cost of manufacture, enabled the Directors to meet the severe competition in this most practical and telling manner. With these brief remarks I now move the adoption of the report and accounts.

Sir DANIEL COOPER, Bart., G.C.M.G.: I have much pleasure in seconding the resolution—

"*That the Director's report and statement of accounts to May 31, 1895, be and are hereby approved and adopted, and that a dividend of 5 per cent. on the paid-up capital be declared payable forthwith.*"

The resolution was carried unanimously.

It was next proposed by the CHAIRMAN, and seconded by Mr. FREDERICK GREEN—

"*That the retiring Director, Mr. James Pender, M.P., be and is hereby re-elected a Director of the Company.*"

This resolution was also carried unanimously, and the auditors, Messrs. Meston and Co., were re-elected.

A vote of thanks to the Chairman brought the proceedings to a close.

The following is the Directors' report for the period to May 31st last:—

The net profit for the year is £3,419. 16s. 9d., which, with a balance of £993. 14s. 2d. from last year's accounts, amounts to £4,413. 10s. 11d., out of which the Directors recommend the payment of a dividend of 5 per cent. on the Ordinary Share Capital, which will absorb £4,223. 13s. 1d., leaving £184. 17s. 10d. to be carried forward. Provision has been made for the effective maintenance of buildings, plant, tools, &c., at a cost of £2,373. 7s. 3d. The reserve fund for diminution in value of assets has been increased by the sum of £2,684. 12s. 11d. out of the profits of the year's working, and now amounts to £12,000. The Directors are pleased to report that the Company's batteries still maintain the leading position which they have for some years occupied. The Company's staff has devoted considerable attention to reducing the cost of manufacture, and the Directors have, in consequence, further reduced the selling prices.

Globe Telegraph and Trust Company (Limited).

The twenty-second ordinary general meeting of this Company was held on Friday, July 26, at Winchester House, Old Broad-street, E.C., under the presidency of the Marquis of Tweeddale.

The SECRETARY (Mr. Sidney Collett) read the notice convening the meeting.

The CHAIRMAN, in moving the adoption of the report, said: The receipts for the year ended July 18th inst., after paying all expenses, amounted to £179,465, as against £195,076 in the previous year, or a decrease of £5,611. This reduction is attributable to three causes—namely, the smaller dividends we have received from the Anglo-American Company for the first two quarters of the current financial year; smaller returns on our investment in the Direct United States Cable Company, and also the paying off of the Direct Spanish Company's Six per Cent. Debentures. I need hardly say that it will not be easy to replace these debentures with a stock having as high a rate of interest as 6 per cent. However, notwithstanding these losses, we are able to recommend to-day the payment of a dividend on the Ordinary shares of 4½ per cent. for the year under review, as against 4½ per cent. for the previous year. This, you will observe, gentlemen, is a lower figure, but, remembering the state of depression which has been prevailing during the last few years, the dividend we are declaring to-day is, after all, a very fair one, especially when I tell you that if you take the two classes of shares in like quantities they show a return of £5. 1s. 3d. per cent. Now, gentlemen, it has been the practice of our Chairman from year to year to give you the most ample information with respect to the Company that is possible, and I do not propose on this occasion to make any departure in this respect. I will, therefore, give you particulars of the several investments in which the returns have differed from those of last year. The Anglo-American Telegraph Company has paid us £2,547 less than we received from them last year, but the whole of this loss belongs, as I have already mentioned, to the first two quarters of the year under review. The dividends we received from that Company in respect of the third and fourth quarters, I am glad to say, show in both cases increases over the amounts received in the corresponding quarters of 1894, and a further increase is announced in that Company's report, just issued, in respect of the dividend to be paid on August 1st. These increases are due to—what we all like to see—the growth of traffic passing over those lines, resulting, no doubt, from a better state of trade generally, which is noticeable on all hands. You will observe on comparing the statements of page 6 of the report with that of last year, that we have sold £1,120 Anglo-American "B" Preferred Stock and a similar amount of Deferred "A." The reason of this was that we have recently bought, as the report shows, some more Submarine Cables Trust certificates. These certificates, as probably most of you know, contain a proportion of Eastern and Eastern Extension Companies' shares and Anglo-American Company's stock, but as it was deemed by the Directors inadvisable to increase our interest in the Anglo-American Company, it was decided to sell a proportion of the Anglo-American stock equal to the amount of that Company's stock which we may be said to have acquired in purchasing the Submarine Cables Trust certificates. You understand that we considered it, on the whole, a better investment—these Submarine Cables Trust certificates. We preferred having our share of Anglo-American stock in Submarine Cables Trust certificates rather than in its previous form. We consider that we purchased the Submarine Cables Trust certificates at a very moderate price, which I shall mention afterwards, when I come to that investment. The Cuba Submarine Telegraph Company, as you will observe, gentlemen, is a new investment; the Company has been for years a quiet and prosperous one. For several years past they have been paying very good and steady dividends, and while you know there is at present an insurrection in the island of Cuba, still for the moment this is acting as a feeder to those cables, and if their usual dividend is maintained, we shall receive over 6 per cent. on our investment in that undertaking. The Direct United States Cable Company has paid us £1,989 less than the amount we received from them last year; but I am glad to be able to tell you that there are distinct signs of increased traffic over the lines of this Company, and if this continues we, of course, shall share in the benefits of that increase. Since the last meeting a further sum of £38,592, resulting from the paying-off of the Direct Spanish Company's Six per Cent. Debentures, has been invested as follows: 520 Ordinary shares of the Direct Spanish Company, 102 certificates in the Submarine Cables Trust, 1,135 shares in the Western Union Company, 400 shares in the Cuba Submarine Telegraph Company. I need scarcely say that your Directors have had considerable difficulty in re-investing this money, which amounted in all to over £62,000, and on which we were receiving 6 per cent., because, while our first consideration must ever be to invest in such securities as will preserve our capital intact, and as far as possible avoid the risk of depreciation, still, seeing that we have to pay 6 per cent. to our Preference shareholders, which represent half of our capital, the question of the return on the money we invest has always to be very seriously considered. You will remember that at our last meeting it was mentioned that some of this money had been temporarily invested in Egyptian Government Three per Cent. Guaranteed Loan and Two and Three-quarters per Cent. Consols; the greater part of this, I am glad to say, has now been permanently placed. We sold the Egyptian stock at a much higher figure than we bought it at, and therefore a considerable profit on this temporary investment has been the result. The Consols also stand at a very much higher figure to-day than we bought them at, so that there will be a further profit on these when we find it desirable to dispose of this investment. As I have already mentioned, we have increased our holding in the Submarine Cables Trust; but there is one point under this heading which needs a little explanation. If you compare the figure given in the last column of the statement on page 6, showing the cost per £100 certificate, with that given in last year's report, you will see that it is slightly higher; but this difference is, I may say, more apparent than real, in this way—that the nominal loss on the sale of the Anglo-American stocks referred to has been added to the cost price of the Submarine Cables Trust certificates recently acquired. However, as your Directors, in purchasing these certificates, took advantage of the low prices which recently prevailed, the cost price of this stock is very much below the present market value—on the whole a very satisfactory transaction. In regard to the West African Telegraph Company, you will remember that, on the last occasion of our meeting, Sir John Pender explained to you the precautions that had been taken with a view to preventing the heavy expense connected with the frequent interruptions to this Company's cable, and he said that he hoped when he met you again he would be able to report some return on our money invested in this Company. That hope, I am glad to say, was not without good foundation, for although we have not as yet actually received any dividend on those shares, still a dividend has been declared of 2s. per share, and is payable to-day. This will give us over £300, and, though small in itself, is, we trust, only the beginning of better things in the future. The returns from the Western and Brazilian Telegraph Company are more encouraging, as we have received £300 more in dividends from them this year than they paid us last year. The returns on our other investments show but little or no change. Many of the companies in which we hold large interests continue to return us very handsome dividends, as you will see from the report in your hands. There is one thing I would like to mention before closing my remarks, and that is the increased confidence in this Company's shares shown by investors. This is illustrated in a most remarkable way by the fact that our Ordinary shares, which stood this time last year at 8¼ to 8½, are now quoted at 10$\frac{1}{16}$ to 10$\frac{5}{16}$, and the Preference shares, which in July, 1894, were 15⅜ to 15⅝, now stand at 17 to 17¼. It will further interest you when I tell you that the market value of the securities we hold has been steadily increasing for the last year or two, and to-day, while the amount of our paid-up capital is £3,602,690, the present market value of our securities is £4,395,395, showing the very handsome surplus balance of over £792,000. That is notwithstanding the fact that the depreciation in our American securities is nearly £500,000, which is included. In spite of that, however, the surplus balance is £792,000. It is just as remarkable that that amount is £429,862 better than this time last year, and I think you will agree with me that this is a very satisfactory statement to be able to make. I have only to refer, in conclusion, to Sir Henry Gooch's resignation. We need not tell you that we regretted the necessity he found himself under to sever himself from our Company, with which he had been connected, as well as his father before him; but he had very few engage-

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ments in London, and he found it very inconvenient to come up to the meetings. He has therefore resigned his post. There is another matter which, I think, will perhaps interest the shareholders—the question of the payment of our dividends half-yearly instead of quarterly. If any gentleman thinks it right to address the meeting, perhaps he will offer a few remarks on this point. The Chairman then proposed the adoption of the report and accounts.

Lord SACKVILLE A. CECIL seconded the motion.

Mr. MICHAEL DAVIS inquired what the Company gave for the "B" stock of the Anglo-American Company, and what it was sold at.

Mr. JOHN NEWTON remarked that he had been a shareholder in the Company from the commencement, and, as regarded making any change in the periods at which they declared their dividends, he thought the shareholders might take a lesson from the emphatic opinion which has just been pronounced by the country at large in demonstrating the importance of not tinkering with their Constitution. He considered that a great deal of the high price and the market stability of telegraph property was due to the payment of quarterly dividends; and it should be remembered that many claims were made upon them every quarter for taxes and other payments.

Mr. WICKHAM inquired the price paid for the Submarine Cables Trust certificates.

The CHAIRMAN, in reply, stated that it was not possible to say what they paid for their Anglo-American "B" stock separately, for it was purchased before the division of the stocks took place. The Anglo-American stock was formerly one, but the holders were given the option of dividing it into Preferred and Deferred stock. This option was not exercised by the Globe Company, and we have now sold, as I have already stated, a small proportion of Preferred and Deferred.

Mr. DAVIS said that they held about one-third of their capital—namely, £1,115,114—in the stocks of the Anglo-American Company, and he did not think that their holding ought to be so large in that concern.

The CHAIRMAN, continuing, said that they sold £750 Preferred "B" stock in the Anglo-American Company at 81½, and a similar amount of Deferred stock at 7⅞, and £370 of Preferred "B" stock at 81⅝, and £370 of Deferred "A" stock at 7⅞.

Sir John Pender, G.C.M.G., M.P., and the Hon. St. John Brodrick, M.P., were re-elected to their seats at the Board, and Messrs. Deloitte, Dever, Griffiths and Co., and Mr. William Griffith, B.A., were re-elected as auditors.

Mr. NEWTON proposed a cordial vote of thanks to the Chairman and Directors for their successful management of the Company's affairs, which was unanimously carried.

The CHAIRMAN briefly responded, and the proceedings terminated.

Thomas Parker (Limited).

The first annual meeting of the shareholders of this Company was held on Wednesday at the Works, Wednesfield-road, Wolverhampton, under the presidency of Mr. Alderman C. T. Mander.

The CHAIRMAN, in moving the adoption of the report and accounts, said the Company did not commence work until January last, and consequently the balance sheet only represented six months' trading. The Company had developed in a satisfactory manner, and during July it had increased to such an extent that additional hands had to be employed. It was gratifying to them all that the dispute with the Electric Construction Company had been settled, and as the result of long negotiations that Company had paid them £2,000, and had given them the right to use several patents which had not been included in the prospectus of Thomas Parker (Limited). He hoped, therefore, that the public would now take up the remainder of the shares, in order that the works might be extended. They had over £24,000 worth of orders on their books, they were turning out an enormous quantity of work, and there was every prospect of a continuance of good business.

Mr. T. PARKER (the Managing Director), in seconding the motion, said that the invoices for July were of the value of £5,000, and if that standard could be maintained, and he had no doubt it could, shareholders would find the business a profitable one. The present turnover would earn a profit, and a little more capital expenditure would enable the Directors to double the output; in fact, they could obtain any number of orders if they were in a position to execute them.

The resolution was adopted, and the Chairman and Mr. W. Thomas were re-elected Directors, Mr. R. Armistead being appointed a Director in place of Mr. T. Graham, who had resigned. The auditors were re-elected, and the usual vote of thanks to the Chairman terminated the proceedings.

Cuba Submarine Telegraph Company (Limited).

The report of the Directors of this Company for the half-year ended June 30th last, which will be presented at the forty-eighth general meeting, held at the offices, 58, Old Broad-street, London, E.C., on Wednesday, the 7th inst., at 12 o'clock, states that the gross receipts amount to £30,817. 1s. 5d., and the gross expenditure to £6,118. 14s. 8d., leaving a sum of £24,698. 6s. 9d., which, added to the balance brought from the last account, £3,380. 3s. 6d., leaves £28,078. 10s. 3d. to the credit of revenue account.

The insurrection in Cuba, which broke out in February last, and still continues, has caused an abnormal use of the Company's lines, with a corresponding enlargement of receipts. As, however, the business of the island will no doubt suffer from the effects of the war for some time after the restoration of order, it has been thought advisable to place the sum of £13,638. 10s. 5d. to the reserve fund. The sum of £1,500 has been set aside as a further reserve against any loss from the deposits with banks.

The dividend on the Preference shares will absorb £5,000, and leave £9,939. 19s. 10d., out of which the Directors recommend the payment of a dividend on the Ordinary shares at the rate of 8 per cent. per annum, free of income tax, the balance, £3,539. 19s. 10d. being carried forward to the current half-year.

The cables have continued in good order throughout the half-year. The new cable between Batabano and Cienfuegos was taken over from the contractors on March 4th, fulfilling in all respects the requirements of the contract. The balance of the cost has been deducted from the reserve fund.

The position of the Company's suit against the Spanish Government at Madrid remains the same as at the date of the last report.

The report refers to the death of Mr. Thomas Greenwood, and the retirement, owing to advanced age, of Mr. A. F. Low. Mr. Robert Kaye Gray and Mr. A. G. Low have been appointed to the vacancies on the Board. Mr. R. K. Gray seeks re-election at the meeting, as does Mr. John Gane, the auditor.

Liverpool Overhead Railway Company.

The report of the Directors of this Company for the half-year ended June 30th last, to be submitted to the general meeting held at the Law Association Rooms, Cook-street, Liverpool, on Tuesday, the 13th inst., at 3 o'clock, states that the gross revenue receipts for the half-year amount to £28,143. 3s. 1d., and the working expenses to £18,653. 18s. 1d. The number of passengers carried since the opening of the railway is as under:—

	Half-year ending Dec. 31, 1893.	Half-year ending June 30, 1894.	Half-year ending Dec. 31, 1894.	Half-year ending June 30, 1895.
First class	260,221	277,653	362,179	400,260
Second class	1,293,840	1,246,975	2,228,224	2,114,462
Workmen (special return tickets)	921,578	1,336,803	1,050,976	945,338
Total	2,475,639	2,861,437	3,641,379	3,460,060

The contracts for the southern extension have been let, and the works will be commenced without delay. In order to meet the necessary expenditure, the Directors have decided to offer to the shareholders at par, on application, the unissued portion of the Ordinary capital.

From the total receipts of £28,143. 3s. 1d. has to be deducted the interest on Mortgage Debentures, amounting to £2,500, leaving, with the balance brought forward (£1,087. 12s. 5d.), £8,076. 17s. 5d. available for dividend. Out of this balance the Directors recommend dividends at the following rates (less income tax), payable on and after August 17th, viz.: 5 per cent. per annum on Preference shares, taking £2,529. 0s. 9d., and 2½ per cent. per annum on Ordinary shares, taking £4,244. 17s. 9d., leaving £1,302. 18s. 11d. to be carried forward.

NEW COMPANIES, STATUTORY RETURNS, &c.

AUTOMATIC ELECTRIC SIGN COMPANY (LIMITED).—This Company was registered on July 23rd, with a capital of £5,000, in £1 shares, to enter into and carry into effect two agreements made between George F. Kenyon, Frizinghall, Bradford, electrician, and James S. Critchley, Bradford, engineer (for the Company), to acquire, develop, work, and generally deal with any inventions and rights capable of being used in connection with the supply of electricity, and to carry on the business of electricians, suppliers of electricity for the purposes of light, heat, motive power, advertisement signs and like devices, advertising agents, makers of signs and devices, iron and brass founders, mechanical engineers, tool makers, &c. The subscribers, with one share each, are: J. A. Jessop, W. Craven, G. F. Kenyon (electrical engineer), T. Newboult, E. Niven (electrical engineer), C. Wilson and H. Jackson. The first Directors are: J. A. Jessop, W. Craven, and G. F. Kenyon (managing).

I.E.S. ACCUMULATOR COMPANY (LIMITED).—This Company was registered on July 26th, with a capital of £100,000, in £1 shares, to carry on the business of manufacturers of and dealers in electric storage batteries and electrical engineers in all its branches, electricians, mechanical engineers, manufacturers, sellers and dealers of and in electricity, motive power, light, electrical apparatus and appliances; to generate, produce, store, accumulate, and distribute electricity, electromotive force, or other similar agency, for the purpose of lighting omnibuses, tramcars, cabs, and other vehicles, buildings, manufactories, mines, ships, lighthouses, railways, &c.; and to acquire the right to use, manufacture, or put up telephones, telegraphs, electric bells, phonographs, &c. The subscribers, with one share each, are: J. L. Higgs, Edward Mann, electrical engineer; Percy Greville, electrician; C. E. Masterman, J. B. Evans, electrical engineer; J. Lloyd, and W. J. Griffiths.

HUBERT GRENFELL (LIMITED).—The statutory return to June 4th has been filed. The nominal capital is £12,500, in 10,000 Ordinary and 2,500 Preference shares of £1 each, and of these 8,250 Ordinary shares have been issued as fully paid. In addition, 895 Preference shares have been paid for in full.

JOHANNESBURG LIGHTING COMPANY (LIMITED) (IN LIQUIDATION).—The annual return to June 14th has been filed. The nominal capital of £127,132 is divided into 77,132 Ordinary and 50,000 Preference shares of £1 each. 77,125 Ordinary shares have been issued as fully paid, and the full amount has been paid on the remaining Ordinary shares.

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JONES BROTHERS AND COMPANY, BIRMINGHAM (LIMITED).—The statutory return to September 19, 1894, was filed on June 1st. The capital is £2,000, in 1,000 Preference and 1,000 Ordinary shares of £1 each. 800 Ordinary and 300 Preference have been taken up, and considered as fully paid.

LLANDUDNO ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return to July 6, 1894, has only just been filed. The nominal capital is £15,000, in £10 shares. Only 14 shares have been taken up, and the full amount has been paid on these. As the Llandudno Improvement Commissioners have passed a resolution to carry out the electric lighting of the district themselves, it is proposed to call a meeting to consider the advisability of winding up the Company.

PHONOPORE COMPANY (LIMITED).—The annual return to June 27th has been filed. The nominal capital is £150,000, in 100,000 Ordinary and 50,000 Preference shares, all of £1, and of these 90,000 Ordinary and 28,343 Preference shares have been taken up. 69,025 of the former and 10,380 of the latter have been issued as fully paid. The full amount has been called on the remaining 20,975 Ordinary and 17,963 Preference shares.

RIVER PLATE ELECTRICITY COMPANY (LIMITED).—The annual return to June 13th has been filed. The nominal capital is £500,000, divided into 49,900 Ordinary shares of £10 each, and 1,000 Founders' shares of £1 each. 13,557 of the former and 892 of the latter have been taken up, and 2,400 of the Ordinary have been issued as fully paid. The full amount in each case has been called on the remaining shares.

TELEGRAPH MANUFACTURING COMPANY (LIMITED).—The annual return to June 21st has been filed. The nominal capital is £50,000 in £10 shares, and of these 3,310 have been taken up. 646 have been issued as fully paid, and the full amount has been paid on the remainder.

UNITED ELECTRIC SEWAGE AND CHEMICAL SYNDICATE (LIMITED).—This Company is extinct.

UNITED ELECTRIC TRAMWAYS (LIMITED).—The annual return to December 31, 1894, has only just been filed. The nominal capital is £30,000, in 6,000 £5 shares, of which 3,007 have been allotted. Of these, 3,000 were issued as fully paid, and the full amount has been paid on the remainder.

VAUGHAN AND BROWN (LIMITED).—The statutory return to June 22nd has been filed. The nominal capital is £40,000, in 4,000 Preference and 4,000 Ordinary shares of £5 each. 2,600 of the former and 2,620 of the latter have been taken up, and 2,000 of each class have been issued as fully paid. The full amount has been called on the remaining 600 Preference and 620 Ordinary shares.

WEST COAST OF AMERICA TELEGRAPH COMPANY (LIMITED).—The annual return to June 25th has been filed. The whole nominal capital of £300,000, in £10 shares, has been paid up.

CITY NOTES.

BRISTOL TRAMWAYS AND CARRIAGE COMPANY (LIMITED).—The report of the Directors for the half-year to June 30 states that the gross receipts amounted to £42,820. 17s. 10d., and the expenses to £33,177. 7s. 10d., leaving a balance of £9,643. 10s. The report also states that the construction of the line between the City and Kingswood, which is to be worked by electricity, and the conversion of the St. George's depôt into a generating station, are approaching completion; and it is anticipated that this portion of the line will be opened for traffic within a few weeks. This may fairly be claimed as one of the smartest bits of work in the way of rapid tramway laying ever effected in this country. The extent of the reconstruction is two miles, but, with the large portion of double line, the actual run of single line laid has been three miles, and this work has been done in six weeks, or at the rate of a mile a fortnight. The Company originally intended to adapt the old line with its T rails and chairs, but about two months ago decided to lay down a new line with girder rails and a heavier form of construction, uniform with the new section in course of construction from St. George to Kingswood. With the assistance of Mr. J. C. Robinson, C.E., upon whose report the Directors had already acted in connection with the electrical scheme, and who was in cordial co-operation with Mr. Challenger, the traffic manager, the whole of the work was completed to time. As an earnest of the Directors' appreciation of the smartness displayed, they voted £100 for distribution amongst those engaged in the work.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LIMITED).—The Directors of this Company have declared an interim dividend for the half-year ended 30th June last, at the rate of Four per Cent. per annum on the Ordinary shares, amounting to £150,000, and have carried forward £2,870 to next account. The dividend will be paid on and after August 12th.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended July 28, 1895, were £827, against £858 in the corresponding week of 1894, a decrease of £31. The total receipts for half-year amount to £3,421, against £3,458 for the corresponding period of 1894, a decrease of £37.

ELECTRICAL BANKING ENTERPRISE.—A bank for financing electrical undertakings has, it is stated, been constituted at Zurich, Switzerland. The share capital is to be £1,200,000, of which 25 per cent. is to be paid up, and the Directors are authorised to issue bonds to the amount of double the paid-up capital.

GAS LIGHT AND COKE COMPANY.—The report of the Directors of this Company, which will be presented to the meeting of shareholders to-day (Friday), refers to a large increase in the quantity of gas sold during the six months to June 30th, which is stated to be equal to 6⅝ per cent. excess over the corresponding half-year of 1894. A reference is made to a considerable increase in the number of consumers of gas supplied on the automatic meter system, but no reference is made to the competition of the electric light.

GULCHER COMPANY (in Liquidation).—As announced in our last issue, an extraordinary general meeting was held at 73, Lombard-street, London, E.C., on Monday last, to receive the liquidator's statement of accounts. Our representative was informed that the meeting was private.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY (LIMITED).—The first batch of letters of allotment for the new issue of Ordinary shares in this Company has been posted. The entire issue was, it is stated, taken up by the shareholders of the Company.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 28th inst. amounted to £1,197. The amount for the corresponding week last year was £933. Increase £264.

NATIONAL TELEPHONE COMPANY (LIMITED).—The Right Hon. Lord Harris, G.C.S.I., G.C.I.E., has been elected a Director and Vice-President of this Company, to fill the vacancy caused by the resignation of Lord Balfour of Burleigh; and Sir Henry George Calcraft, K.C.B., has been elected a Director, to fill the vacancy caused by the resignation of Colonel R. Raynsford Jackson.

OTIS STEEL COMPANY (LIMITED).—Meetings of the First Mortgage Debenture-holders, Preference shareholders, and Ordinary shareholders will be held at 2:0, 2:45, and 3:15 p.m. respectively on August 14th, at Winchester House, London, E.C., to consider a scheme of arrangement proposed to be made between the holders of such debentures and the Company.

RAND CENTRAL ELECTRIC WORKS (LIMITED).—The statutory general meeting of this Company was held on Wednesday at Winchester House, Old Broad-street, E.C. Sir Charles Rivers Wilson, who presided, said that the Board had every expectation that the hopes held out when the Company was formed would be fully realised. The contractors had arranged to complete their portion of the work within 18 months from May 3rd last, and they would hand over all the appliances not later than November 3, 1896. The London offices of this Company have been removed to 120, Bishopsgate-street Within, E.C.

REDUCTION OF CAPITAL.—Notice is given that by an order of the Chancery Division of the High Court of Justice, dated June 29, 1895, the reduction of the capital of the British Electro-Chemical Agency (Limited), from £75,000 to £50,000, was confirmed. The minute showing the several particulars required by the statutes was registered by the Registrar of Joint Stock Companies on the 23rd ult.

SANITAS COMPANY (LIMITED).—The Directors of the Sanitas Company, makers of the well-known "Sanitas" powders, fluids, soaps, &c., have declared an interim dividend at the rate of 10 per cent. per annum for the six months ended June 30th last, free of income-tax, payable September 1st next.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY (LIMITED).—Warrants for the interim dividends on the Preference and Ordinary shares of this Company for the half-year ended June 30th last have been posted.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to allow 25,000 shares (Nos. 1 to 25,000) of the Amazon Telegraph Company (Limited) to be quoted in the official list.

TORONTO RAILWAY COMPANY.—This Company, which operates by electricity the only street railways in the City of Toronto (Canada), has this week, through Messrs. Coates, Son and Co., of 99, Gresham-street, London, E.C., invited applications for £323,000 sterling Four and a-Half per Cent. First Mortgage Bonds of £100 each, on which interest is payable half-yearly. The price of issue is £108 per bond, payable £5 on application, £10 on allotment, and £93 on August 31st inst. The Company was incorporated in 1892, and has the exclusive privilege of working street railways in Toronto for a term of 30 years from September 1, 1891, and is now operating 85 miles of electric railways in that city. The bonds are stated to be secured by a mortgage trust deed, and are a first charge on the undertaking after working expenses, annual payment of the Municipal Authorities under agreement, and certain payments of debentures issued by the original Company, and which are being redeemed, have been made. The gross earnings for 1894 amounted to $958,371. The Company's paid-up share capital is $6,000,000, and the assets have been valued at $9,562,318. The list of applications closes this day (Friday) at 4 p.m.

WATERLOO AND CITY RAILWAY COMPANY.—The report of the Directors of this Company, to be submitted at the third half-yearly meeting, to be held at Waterloo Station, London, S.E., on Thursday next, at 2:30 p.m., states that the Directors submit the following statement of accounts: The expenditure for the half-year ended June 30th amounted to £48,982. 3s. 6d., and that the probable further outlay within the current half-year rendered it necessary to make a call of £2 per share upon the 54,000 shares of the Company, payable on July 1st. The severe weather during the early part of the year caused a complete stoppage of the works for several weeks, but since that time satisfactory progress has been made. The tunnels have been completed under the river, and are being extended rapidly towards the City as well as in the direction of Waterloo. Negotiations are in progress for the terminal stations, the contracts for which will shortly be let, and the works commenced before the end of the year.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended July 26th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,109.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, July 24.		Price Wednesday, July 31.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending July 31. Highest	Lowest
			TELEGRAPHS					£ s. d.		Highest	Lowest
£1,012,880	Stock	11/0	Anglo-American	47	49	46	48	4 13 9	Jan., Apr., July, Oct.	..	..
£2,993,560	Stock	22/0	Do. Preferred	88½	89½	88	89	4 15 6	" "	89¼	..
£2,993,560	Stock	5/0	Do. Deferred	8¼	8¾	8¼	8¾	..	..	..	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer) xd	102	105	103	105	3 16 2	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	13½	14	13¾	14½	4 7 9	Mar., June, Oct., Dec.	14⅛	13 11/16
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 6 11	June and December	..	..
10,000,000	$100	1¾%	Commercial Cable Capital Stock	160	165	160	165	4 4 10	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	—	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	3½	4½	3½	4½	4 8 11	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10½	9¾	10½	4 7 7	" "	9⅜	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	—
60,710	20	2/0	Direct United States Cable, 1877	9¼	9¾	9¼	9¾	4 0 5	Jan., Apr., July, Oct.	..	—
400,000	10	5/6	Eastern	16⅞	17⅛	16⅞	17⅛	3 15 8	" "	17 1/16	16 11/16
70,000	10	6%	Do. 6 per Cent. Preference	17¾	18¼	17¾	18¼	3 5 9	" "	18	17¾
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	126	129	126	129	3 2 0	May and November	126½	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	107	110	107	110	4 13 0	February & August	..	..
250,000	10	2/6	Eastern Extension	17¼	17½	17⅜	17⅝	3 19 4	Jan., Apr., July, Oct.	17½	17 5/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	127	130	127	130	3 1 7	February & August	..	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	102	106	102	106	4 14 4	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	102	106	102	106	4 14 4	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	107	110	107	110	3 11 1	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	112%	115%	3 10 2	May and November	..	..
180,227	10	2/3	Globe Telegraph and Trust	10⅛	10⅜	10¼	10½	4 1 0	Jan., Apr., July, Oct.	..	..
180,042	10	6%	Do. 6 per Cent. Preference	17	17¼	17	17¼	3 9 7	" "	—	..
150,000	10	5/0	Great Northern	21¾	22¼	21¾	22¼	3 16 3	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	..	..
17,000	25	37/6	Indo-European	49	52	49	52	4 16 2	May and November	51	50
37,548	10	2/6	London Platino-Brazilian	5	7	5	7	..	" "	51	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	107	111	107	111	5 10 1	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	107	110	107	110	3 12 9	..	—	..
11,839	8	4/0	Reuter's	3½	4½	3½	4½	..	April and October	..	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	124	129	125	130	4 15 3	" "	..	..
15,609	10	2/0	West African Telegraph xd	5½	6½	5½	6½	..	January and July	..	—
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	104	107	104	107	4 14 4	March & September	106	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	1 11/16	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	104	99	104	7 13 10	June and December	103	..
88,321	10	6d.	West India and Panama	¾	1	¾	1	..	..	⅞	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10	10½	5 14 3	May and November	..	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	5 13 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110	113	110	113	4 8 6	June and December	..	..
64,242	15	6/0	Western and Brazilian	10½	11	10½	11	4 1 11	May and November	..	..
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	—	6¾	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4¼	4¾	4¼	4¾	..	—	..	..
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	104	108	104	108	5 14 3	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	104	108	104	108	5 14 3	" "	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	..	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	..	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	—	..	—	..
224,850	10/0	1½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	—
171,504	£1	8·215d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	..	..
484,597	5	2/6	National	5⅞	6⅛	6	6¼	4 0 0	June and December	6¼	6 1/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	16	17	16	17	3 10 7	" "	17	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	" "	16	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅞	6⅛	6	6¼	4 0 0	—	6 3/16	6⅛
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	105	107	105	107	3 5 7	January and July	106½	..
58,000	5	3/0	United River Plate	2½	3	2½	3	..	" "	2 11/16	2⅝
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	92	97	92	97	5 3 1	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	14	15	14	15	1 13 4	—	14⅝	..
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid) xd	16	17	16	16½	3 12 9	—	..	..
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	131	134	131	134	3 12 9	June and December	133½	132
19,900	£5	..	Electricity Supply Co. for Spain	..				..	—	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	—	5 5/16	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900					..	—	..	..
8,322	£5	..	House-to-House Electric	..		..		..	—	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	—		..		.	..	..	.
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	..	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7⅝	7¾	7⅝	7¾	..	—	..	..
111,000	5	..	London Electric Supply	..		1 5/16	1 7/16	..	—	..	..
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	10½	11	10¾	11¼	2 13 4	..	11	—
£150,000	Stock	4½%	* Do. 4½% Debs.	116	119	116	119	3 15 9	June and December	..	..
6,452	£10	2/0	Notting Hill Electric	8¼	8¾	8¼	8¾	..	..	..	..
19,980	£5	2/0	St. James and Pall Mall xd	8	8½	8	8½	..	—	..	..
20,000	£5	7%	Do. 7 per Cent. Preference xd	9	9½	9	9½	3 13 8	—	..	..
59,900	5	2/6	Westminster Electric Supply (fully paid)	7¾	8¼	7¾	8¼	3 0 7	—	..	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	8	1/6	Brush Electrical Engineering	2⅛	2⅜	2	2¼	6 11 7	—	..	..
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	.	2⅜	2¼
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	112	115	112	115	3 19 8	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2	2½	2	2½	..	January and July	2¼	—
12,139	5	..	Edison and Swan United	2	2½	2	2½	..	..	2⅛	..
£100,000	Stock	4½%	Do. 4% Mortgage Debenture Stock	104	107	104	107	4 4 1	..	104	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		—		..	..	..	..
120,000	2		Electric Construction	¾	1	¾	1	..	..	29⅜	29
12,845	2	2/9¾	Do. 7 per Cent. Cumulative Pref.	2	2½	2	2½	..	..	—	—
91,195	2	10/0	Elmore's Patent Copper Depositing	⅞	1⅛	⅞	1⅛	..	..	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	¼	¾	¼	¾	..	..	..	..
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	19	21	19	21	4 15 3	February & August	20⅛	19⅞
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	..	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..	—	..	..
16,000	£10	..	Do. 8 per Cent. Preference	..		—		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)		⅛		⅛	..	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance xd	43	45	43	45	..	March and July	..	..
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	..	January and July	..	..
37,514	£5	..	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,870	10	16/0	W. T. Henley's Telegraph Works Ordinary xd	10½	11½	10½	11½	..	..	..	..
£30,000	10	..	Do. 7 per Cent. Preference	14	15	15	15½	4 10 4	..	15¼	14⅝
£50,000	Stock	..	Do. 4½% Mortgage Debenture Stock	104	107	104	107	..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1¼%	City and South London Railway	42	44	41	43	2 18 2	May and November	42	41¾
7,000	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	..	..	15½	—
£67,130	Stock	4%	Do. 4% Perpetual Debenture	133	135	133	135	.	May and November	..	..
37,500	£10	2%	Liverpool Overhead Railway	10⅝	10¾	10 7/16	10 9/16	1 17 11	—	..	..
6,295	10	5%	Do. 5% Preference	14¾	15¼	15	15½	3 4 6	..	..	—
125,000	Stock	4%	Do. 4% Debenture	110	112	110	112	..	January and July	—	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 899. [No. 15. Vol. XXXV.] FRIDAY, AUGUST 9, 1895. PRICE SIXPENCE.

NOTES.

Considerable interest of far-reaching importance attaches to the judgment delivered by Mr. Justice Stirling, last Saturday, in the action brought by the Board of Works for the Wandsworth District against the County of London and Brush Provincial Electric Lighting Company. The kernel of the interest lies in the judgment, as to what constitutes a "street box"; or rather, as to what power the Board of Trade possesses to sanction any particular excavation under a public thoroughfare, as constituting a street box "within the meaning of the Act." The evidence brought forward by the parties to this action will be found in our last issue; and this week, in our "Legal Intelligence," we give the particulars of Mr. Justice Stirling's decision. To our mind, one of the chief merits and beauties of this decision is to be found in the opinion which his lordship expressed "that the question of size (of admissible street boxes) was entirely within the province of the Board of Trade." A street box, on the one hand, is not necessarily to be cribbed, cabined and confined within the dimensions which it had when the Act was passed; nor, on the other hand, is it to know no confining law, and to expand itself, at the sweet will of the contractor, until it might hold a whole central station; but its existence is to depend on the veto of a governing body, whose experience in these matters is amply sufficient, as its judgment is competent, to enable it to hold a fair and even balance between the requirements of electrical practice and the safety of the public.

We reprint this week an interesting and valuable Paper on "Electric Power in Factories and Mills," which was read by Messrs. Crocker, Benedikt and Ormsbee, at the Niagara Falls meeting of the American Institute of Electrical Engineers. The authors embody in their Paper a number of tests of electric motors driving machine tools, under workshop conditions, at the Crocker-Wheeler Electric Company's works at Ampère, N.J. In the main we are in agreement with the authors in believing that in a great many mills and engineering works electric motors might advantageously replace the usual transmission gear. There are cases in practice where the long-continued operation of electric motors has proved this to be so. But we are, as yet, by no means warranted in supposing that in every case, or even in the general majority of cases, these advantages would accrue. In some of the instances cited by the authors, and in other works not mentioned by them, the original transmission plant replaced by electric motors was by no means as economically or suitably arranged as is possible. Where there are many hundreds of feet of steam pipe, and many intermediate lines of belt-driven shafting, almost any change must be for the better. It is only by a comparison of what electric motors can do in competition with the best and most modern arrangements of mill gear that a really useful index of the progressive value of the former can be obtained. We do not make these remarks from lack of faith in electric motors for mills; but because we believe that their true and lasting value can only be determined on some such grounds as these. For the present, each particular case must be worked out on its own particular merits and requirements; and it seems probable that while only a limited percentage of existing works could advantageously be transformed, it would pay to fit up on the electric system a far larger proportion of quite new works. This latter is what the Crocker-Wheeler and the Westinghouse Companies have done with so much advantage already.

There is an impression on the minds of some engineers that one of the chief advantages of the electric system is, as the authors assert, "that the consumption of energy ceases when the tool stops." This is not strictly true; or rather, it is true only in a limited sense; and if the fallacy is not guarded against, a serious error will creep into the estimates. As the authors go on to state: "This stoppage in the case of the busiest tools amounts to at least 25 per cent. of the nominal working hours throughout the year, and with large or special tools, which are not used so steadily, the stoppage is often as high as 50 to 75 per cent." This means that during from 25 to 50 or 75 per cent. of the *working* hours the generating machinery is running round without driving any tools. It will not, therefore, be strictly true that over that period there will be absolutely no energy consumed; for a considerable consumption will be required to overcome the internal and dead friction loads of the generating plant. What is true, however, is that so long as any particular electric motor is not running there will be no electrical losses in it, while the losses in the line will be more than proportionately diminished from their full value.

The distribution of hydraulic power in towns has always possessed more than a single interest for electrical engineers; and in the recent Paper read by Mr. E. B.

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Ellington before the Institution of Mechanical Engineers, an abstract of which we publish this week, a further interest is contributed. The similarities, on the one hand, and the essential elements of difference, on the other hand, between hydraulic and electric power supply, have taught electrical engineers more than one lesson in central station practice and economy, and have often furnished texts for valuable sermons from the leaders of the profession. The latest phase in the association together of the two branches of engineering is the impartial and careful inquiry, which Mr. Ellington has made, into the practicability of working electric supply systems with power metered from hydraulic mains. Digressing for a moment, we cannot refrain from commenting with amusement upon that solicitude with which the distributors of non-electrical power, whether pneumatic, gaseous or hydraulic, have sought to aid the electrical engineer in his competitive labours, by offering him their wares at his central station door. The situation is not without a humour of its own; though in all seriousness, there is often on both sides a great deal to recommend it. But the working of electric sub-stations from a hydraulic power centre, as discussed by Mr. Ellington, does not appear to offer any substantial advantages over the use of a steam-driven electric central station. Indeed, it appears that where some such combined system has already been tried, viz. at Antwerp, the results have not been satisfactory; and this, though the cost of labour and other conditions appear to be unusually favourable.

To turn to figures, some lessons may be learned from the table which accompanies Mr. Ellington's Paper, and which draws a comparison between the cost of hydraulic power generated at the London Hydraulic Power Supply Company's station, and that of the electric power generated by the Westminster Electric Supply Company. The costs are, respectively, 0·793 penny and 1·383 pence per Board of Trade unit or its equivalent. The difference is large enough to bring credit to the hydraulic, and hope to the electrical engineer; but it is not so great as to warrant the former in expecting to gain profit by supplying power to the latter. Taking the figures as they stand, and leaving the question uncomplicated by other financial considerations, this difference is 0·59 penny per unit. With this margin, the whole of the expenses of hydraulic transmission and conversion into electrical energy, as well as the profit to be made, would have to be covered. Nor is this all, for the condition of load factor under which an electric station works is inferior to that found in the hydraulic station mentioned; and the engines in the former are not, as Mr. Ellington has assumed, worked very closely to full load for the greater part of the time of running. On the contrary, Prof. A. B. W. Kennedy stated in the discussion that even "recently this factor for those engines had been 80 per cent., 70 per cent., and even 55 per cent." That being the case, the margin of 33 per cent. loss, between hydraulic generation and electric generation, which Mr. Ellington has assumed, is not in our opinion sufficient; while the narrow margin of 0·59 penny would probably fall far short of the requirements, even if no profit was to be counted upon.

In our issue this week Mr. W. G. Rhodes describes a neat method of obtaining the general equation to a magnetic field caused by two point poles in air. The equation to the magnetic potential at any point in the field is considered, from which the differential equation to the equipotential surface is obtained. As the lines of force are the orthogonal trajectories to the successive equipotentials, or in other words cut these normally, the general differential equation to these trajectories can be derived from the equation to the equipotential surface; and therefrom, by integration, the required equation to the line of force is obtained. As compared with the usual equation for equal poles, in which the sum of the cosines is equated to zero, the result in this general equation is to substitute for unity the coefficient k, equal to the ratio of the pole strengths, as the coefficient of the cosine of the angle at the stronger pole. Mr. Rhodes's method of arriving at this simple result is neat, and should be of interest to elementary students. A general Cartesian equation is, of course, readily obtainable from this result, as Mr. Rhodes has shown.

A correspondent draws attention in our columns this week to the need for increased rigorousness in the reproduction of standard screw threads and other standardised pieces of mechanism. Mr. Elphinstone's long and extensive experience in the use of such mechanism gives considerable weight to his statement that "B.A. screws bought to-day from any good makers are not necessarily of the same dimensions as those supplied on a similar order, by the same maker, a month or so ago, and the difference is often fairly large." Interchangeability, and the convenience of being sure that screws bought at one time will fit nuts bought at another time, are not to be assured even by the most careful and scientific specification of standards, unless there follows the utmost possible care to see that these standards are faithfully reproduced.

Cable Interruptions.—There is again no interruption to report in submarine telegraphic communication.

Islington.—A local journalist refers to the chimney of the new Islington electric supply station as "the big chimney which is to carry off the fumes of generation."

Iron and Steel Institute.—The autumn meeting of this Institute will be held at Birmingham on Tuesday, Wednesday, Thursday and Friday, the 20th, 21st, 22nd and 23rd of August.

The Telephone in Japan.—At the end of the commercial year 1893-94 there were at Tokio six telephonic exchanges; at Yokohama, two; at Osaka, three; at Kobe, two; there were in all 2,672 subscribers. The cost is about £7 per subscriber.

Deaths by Lightning.—At Boxford on Friday last a farm labourer was killed by lightning while taking shelter under an elm tree.——During a thunderstorm which passed over the district of Thurso on Monday last a man employed on a farm was struck by lightning and killed instantly.

Lighthouse Communication.—The temporary telegraphic communication recently established with the Fastnet Lighthouse is working very satisfactorily, and is being rapidly made permanent. This particular installation is exciting great interest, as Fastnet, which is nine miles from Crookhaven, receives unbroken the Atlantic storms.

Liverpool Electric Supply.—The Liverpool Corporation has now definitely decided upon the purchase of the Liverpool Electric Supply Company's undertaking for the sum of £425,000, subject only to the approval of Parliament. This sum includes the £25,000, which will cover whatever may

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have been expended on capital account for the benefit of the concern over and above its share capital.

Electric Tramways in Berlin.—According to the latest information from Germany the Berlin police, though consenting to the construction of two electric tram lines intended to connect the city with the Treptow Park, the place of next year's National Exhibition, object to the entire use of the trolley system, and have stipulated that at six different points, mostly squares and important crossing points, the conduit system must be used.

Aelotropic Magnetite.—At a recent meeting of the Société Française de Physique, M. Pierre Weiss gave an account of the results of his experiments on the aelotropic magnetic properties of crystallised magnetite. The magnetisation curve of magnetite crystallised in the cubic system presents the same general features as those of iron, nickel and cobalt. The permeability, however, varies with the inclination of the magnetising field to the crystallographic axes.

Oil Firing for Boilers.—The question of oil firing for boilers, says *Engineering*, is certain to become an important one in the near future. The usual practice has been to spray the oil by a steam jet, and compressed air has also been used for the same purpose. Following, however, the lead of the oil light makers, attempts are now being made to do away with any necessity of spraying the oil, by gasifying it instead. The oil on this system is passed through tubes on its way to the burner, the tubes being maintained at a high temperature by the issuing flame.

Electric Traction in Copenhagen.—A French syndicate, which is co-operating with several local gentlemen, is, says *Engineering*, about to construct two or three electric railways, connecting Copenhagen with various points in the neighbourhood with which there has hitherto been no connection by rail. The first line to be taken in hand is the one to the island of Amak, on which part of Copenhagen is located, and the capital for which is about £50,000. It will be a "ring" railway, and it is under contemplation for the Company to buy up land along the railway, and upon it build labourers' houses, &c.

The Horse Power of a Lightning Stroke.—In a recent issue of the *Archiv für Post und Telegraphie* Prof. Hoppe gives some interesting details of the energy developed by a lightning stroke. At Klausthal a lightning stroke struck the wooden post of a house and fused two nails 4mm. thick. Experiments made afterwards by Messrs. Siemens and Halske, of Berlin, showed that a current of 200 amperes and 20,000 volts was required to do this work in one second. This represents about 7,000 H.P., and taking the duration of the lightning as one-tenth of a second the total power would be ten times as much.

The Protection of Iron and Steel from Rust.—The Gesner method of protecting iron and steel from rust consists, says the *Engineer*, in forming on the surface of the metal a double carbide of hydrogen and iron. The articles to be treated are placed in a gas retort at from 600 to 700°C. for about 20 minutes, when a current of hydrogen is turned into the retort and kept on for 45 minutes. Naphtha is next introduced, the supply being kept on for 10 minutes, and a current of hydrogen for 15 minutes longer finishes the process. The coating thus produced has a bluish colour, and is stated to be so adherent to the metal that a treated bar can be bent through an angle of 45deg. without disturbing it.

Cause of Death from Electric Shock.—According to *Engineering*, Dr. A. M. Bleile, of the Ohio State University, explains the cause of death in electric shock as follows: "Death is due to the fact that the current produces a contraction of the arteries through an influence on the nervous system, and this constriction of the arteries throws in such a mechanical impediment to the flow of the blood as the heart is unable to overcome. Where such a drug as nitro-glycerine or nitrite of amyl is given to counteract this effect, much larger doses of electricity than the ordinary can be borne. Artificial respiration may be of use in cases of simple stunning, but when large quantities of current (*sic.*) pass, no rational means of resuscitation have, as yet, been suggested."

Electric Light in German Mail Cars.—The German postal railway vans are now being all fitted up with accumulators and electric lamps. The principal charging stations are at Berlin, Hamburg, Eisenach and Frankfort. In Berlin the accumulators are charged by dynamos driven by gas engines; in Frankfort, Eisenach and Hamburg they are charged from the local electric mains. In Frankfort the charging is indirect; the high-pressure alternating current is passed through a transformer, and is then employed to run an alternating-current motor which drives a dynamo, which charges the accumulators. It is said, says the *Gas World*, that there is even a saving of 50 per cent. in cost, as compared with compressed gas; and at any rate the post-office officials in the vans seem to be very pleased with the change.

Three-phase Plant for Tramway Work.—The General Electric Company of America is making the first American application of the three-phase long-distance system to street railway work at Lowell, Mass., where a plant is in course of construction for the Lowell and Suburban Street Railway Company. Its special features will render it most interesting. In the first place, the generators will deliver both alternating and continuous current, and when not in use for transmission work will be run in parallel with the railway generators now in the station. They will be wound for delivery of low voltage current at the alternating side, and this current raised to 5,000 volts will be carried to two sub-stations, one 9 miles and the other 14 miles distant from the generating station. The substations will each be provided with suitable step-down transformers of the General Electric air-blast type, as well as two rotary converters.

Phosphorescence.—In a Note in a recent number of the *Comptes Rendus*, M. Gaston Séguy gives the result of some experiments made by him with regard to phosphorescence in electric discharge tubes. As is well known, the phenomenon of phosphorescence is observed in tubes containing rarefied oxygen through which an electric discharge has been passed. In the course of numerous experiments on nitrogen and its components, M. Séguy finds that nitrogen also phosphoresces, at least in the presence of a metallic bichloride. The tube used by M. Séguy consisted of three bulbs, fused together and furnished with electrodes. These were filled with nitrogen obtained from atmospheric air by the Brin process, a vacuum being then made, and the vapour of bichloride of tin being added. If an electric discharge is passed, the tube glows brilliantly, and the glow persists after the interruption of the current. The glow is a reddish colour during the discharge, whilst that of an oxygen tube is a greyish violet. The phosphorescence is a milky white, filling the whole tube with the exception of a few centimetres near the poles. This glow attains a maximum brilliancy immediately after the interruption of the current, and gradually disappears at the end of 10sec. or 80sec.

Niagara Rhetoric.—Under the title of "The Great Convention" *Electric Power* delivers itself of the following: "In hundreds of years from now, when the work of our present generations will simply be remembered as some historical event, when all that remains of the best of us shines out like an insignificant spark, then, yes even then, will this last Convention of our American Institute of Electrical Engineers mark the closing of the first great chapter of power transmission. For the first time were these huge machines revolving, for the first time was power taken off these machines, for the first time were the engineers and their friends brought up to these vast dead masses which fairly seemed to possess life, for they were awe-inspiring, and in their proud and graceful motion these tremendous machines represented to us the outcome of the greatest engineering skill, not of our nation alone, no, of the skill of the best of almost all the civilised world. It was a happy gathering; one felt proud in his fellow-men and co-workers, jealousy did not seem to exist, but admiration and joy prevailed. As far as the power problem is concerned, we have found out the solution; the transmission will undoubtedly present new and unforeseen difficulties which tend not to destroy but to retard the final success of these enterprising companies."

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Wiring.—At a meeting of the American Institute of Electrical Engineers last April Prof. W. A. Anthony offered some remarks on the subject of wiring which may be of interest on this side of the water. When highly insulated wires, whose insulation resistance was measured in megohms per mile after immersion in water for weeks, came into use for electric lighting plants, it was natural, he said, to suppose that they could be put anywhere, and would last indefinitely. They were put in all sorts of inaccessible places; on the beams before floors were laid, in partitions before plastering, on the lath with iron staples to be covered with mortar. Then came the interior conduit, which it was assumed would serve both as a mechanical protection and an insulator, but it was found not to be entirely reliable in either capacity. It was not impervious to moisture, it was subject to damage by nails, saws and chisels. It was found necessary to prescribe that wire of the highest insulation should be used in it, and that it should not be drawn in until all danger from mechanical injury was passed. Then came the brass-armoured conduit; but that was not nail proof. Now we have the iron-armoured conduit, and it remains to be seen whether this will fulfil all requirements. There has been a uniform progress in the direction of greater safety and better facilities for repair, from the time when wires were put anywhere to be covered by floors, or mortar, or built into brick walls, to the iron-armoured conduit which is offered to-day.

Indirect Electrolysis.—In a communication to *Le Genie Civil* Mr. F. Andreoli describes a curious experiment on indirect electrolysis. Taking a cell divided into three compartments by porous diaphragms, a solution of any salt is placed in the central compartment, whilst the two electrodes are placed in the side compartments immersed in similar or different electrolytes. The decomposition of these latter is, on the current being passed, effected as if the central compartment did not exist, the solution in it being unaffected. In this form the experiment is an old one, but Mr. Andreoli finds that if a plate or series of plates is placed in the solution in the central compartment, reactions occur which can only be attributed to an indirect or secondary electrolysis. If, for example, the two outer compartments are filled with a solution of common salt, and the central one with a solution of cyanide of gold. Let the anode in the one compartment be of carbon, and the cathode in the other of iron. On passing a current under these conditions chlorine is evolved at the carbon electrode and caustic soda produced at the other, the cyanide solution being, as aforesaid, unaffected. If, however, whilst the current is passing, a series of metal plates are immersed in the cyanide solution, the gold is deposited on them, though neither chlorine nor soda appears to pass into the central compartment.

Science Scholarships at Cambridge.—Though only nine colleges offer entrance scholarships in science, an examination of the awards to the first, second and third year students shows, says *Nature*, that science, as tested by University or inter-collegiate examinations, does not go unrecognised. A large body of medical students, now approaching 500 in number, is distributed over all the colleges, and their presence has apparently brought home, even to the most conservative, the fact that intellectual ability, high-minded devotion to study, and social energy are not confined to students of classics and mathematics alone. Thus, though something remains to be done in certain quarters in the direction of placing science on an equal footing with the older subjects, it would appear that great advance has been made within the last ten years. The natural science tripos now attracts a larger number of candidates than any other, and this notwithstanding that its standard has been steadily raised. In the majority of the colleges distinguished eminence in this tripos has been admitted as a qualification for a fellowship, and in not a few instances governing bodies have felt the need of strengthening themselves on the side of science, and have departed from the Cambridge custom by selecting scientific members of other colleges for this honour. Scholarships and fellowships have of late years been substantially increased. Our contemporary then goes on to say that post-graduate studentships, which are expressly intended to foster advanced study and research, have already produced excellent results, although the University still lacks the means of providing for such encouragement in higher work in chemistry, physiology, scientific engineering, &c. It is to be hoped, says our contemporary, that the race of generous benefactors is not extinct, and that some of these important subjects may ere long receive the benefit of their munificence.

The Influence of Moving Matter on the Ether.—The problem of the motion of ether with or through ordinary matter has been again attacked by Herr L. Zehnder, who recently contributed an interesting paper on the subject to *Wiedemann's Annalen.* He endeavoured to ascertain whether the ether is pushed along by atoms, or whether it passes through their substance without resistance, or, finally, whether only a portion of the ether adheres, and this portion only is carried along. Herr Zehnder's apparatus consisted of a cast-iron cylinder in which an air-tight piston moved. A small tube led out from one end of the cylinder, doubled back upon itself, and returned to the other end. Now, if the cylinder was exhausted of air, so as to leave nothing but ether behind, and the piston was then worked, the inference would be that the ether would stream through the small tube with a velocity as much above that of the piston as the ratio of the sectional area of the one to the other. This ratio was 560 to 1; and exhaustion was carried to the 40,000th part of an atmosphere. To ascertain whether the ether moved in the sense contemplated, a beam from a brilliant sodium flame was passed through two thick parallel glass plates; the second one being silvered at the back. This plate, by its two reflecting surfaces, split the beam of light into two, each part travelling through one portion of the small tube. Then the same beams were reflected back upon the thick plate, and returned along the way they had travelled, being finally reflected into the reading telescope by the first plate. Interference fringes were thus produced in the field of view, the motion of which would have indicated a movement of the ether; but no such motion was observed when the tubes were thoroughly exhausted, so that it was concluded that the ether passes through solid bodies. A similar negative result has been obtained by Dr. Oliver Lodge and others, in the efforts they have made to discover if there is any molecular drag on the ether.

Niagara.—The following letter has been addressed to the editor of *The Times* by Mr. F. L. Stetson, the first vice-president of the Cataract Construction Company, and appeared in that paper last Saturday :—

Sir: In your issues of Saturday, yesterday, and to-day appear letters from Prof. George Forbes and Lord Kelvin concerning the adoption of the alternating current for the electric power installation at Niagara, and referring to the advice given by them to the Directors of the Cataract Construction Company, which did the work. As first vice-president of that Company, which sought and gladly received the advice of these two eminent engineers, I feel it due to both of them that the facts should be stated briefly as follows: 1. In January, 1891, Lord Kelvin was chairman, and Prof. Forbes the submitter of a project, to the International Niagara Commission. At the close of that commission every one condemned and rejected the alternating system, excepting only Prof. Forbes and Messrs. Ganz and Co., of Budapest. 2. In January, 1894, the Niagara Directors had adopted the alternating system upon the advice of Prof. Forbes, and with the concurrence of all the expert advisers, including those who had rejected the alternating system in 1891, excepting only Lord Kelvin. Lord Kelvin thereupon sent to us a cable, in which he certainly indicated a strong preference for the continuous current, but intended also (as we are now gratified to learn from him) as recognising that we "could certainly succeed with the alternate current." 3. Our decision was thus made because of the prohibitive cost of the continuous current installation, which in most particulars fully justified the strong preference for it evinced by Lord Kelvin, whose eminent and valuable advice and encouragement we gratefully acknowledge. Except for his early and original support, our plan would have died "a-borning," and we thank him for his continuing interest. 4. But the development of our plan must have been long delayed had it not been for the courage and comprehensive knowledge of Prof. Forbes, who alone stood for the absolute commercial advantage of the alternating current, and for his admirable conception of his 5,000 H.P. dynamo, so wonderfully worked out by the Westinghouse Company as to yield 5,315 H.P. in the actual test on June 28, 1895. Prof. Forbes is entitled to the credit, as he must bear the responsibility, of the results of the advice given by him as to the three points stated in his letter of July 25th; and we have followed his advice, perhaps not as far as his courage would carry him, yet beyond the former practice of the manufacturers, who now fully concur in the wisdom of his recommendations as adopted. The rotary transformers approved by Prof. Forbes and made by the General Electric Company are worthy of the highest praise for both design and execution. 5. In fine, the extraordinary and gratifying progress in the development of transforming apparatus, and a corresponding reduction of cost, have taken away many, if not all, of the reasons which Lord Kelvin gave against the adoption of Prof. Forbes's original recommendation of the alternating current, which now, as he truly says, "alone solves the problem well and economically."

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ELECTROMAGNETIC THEORY.—LXXII.*

BY OLIVER HEAVISIDE.

(*Continued from page 348.*)

§ 279. I have said rather more about Fourier's theorem than I meant at first. That is a good enough reason for adding one more § about it, in order to have done with it. The way Fourier's theorem presents itself in the theory of functions—that is, in *the* theory so-called thereof, which is manifestly confined to limited notions of a function—is worthy of notice. The complex variable has a double variability, and may be represented by the position of a point in a plane. But a circuital journey round the origin in the plane brings us back to the starting point. In this process the variable θ increases by the amount 2π. So we have necessary periodicity of functions of the position of the point, in the manner of Fourier's theorem, which is therefore essentially involved in the expansion of complex functions of position in integral powers of the variable denoting the position of a point in the plane.

Thus, there is Laurent's theorem for the expansion of a holomorphic function. Let $f(z)$ be the function, where z is the complex $re^{i\theta}$, r and θ being the polar co-ordinates. Assume that f is capable of representation in integral powers of z, positive and negative, say

$$f(z) = A_0 + A_1 z + A_2 z^2 + \ldots + A_{-1}z^{-1} + A_{-2}z^{-2} + \ldots$$
$$= \Sigma_{-\infty}^{\infty} A_n z^n. \qquad (109)$$

Then we may easily determine the coefficients. The mean value of z^m, regarded as a function of θ, round a circle centred at the origin, is zero when m is any integer, except zero. In that exceptional case the result is 1. So, multiplying equation (109) by z^{-n}, and integrating with respect to θ, round a circle centred at the origin, we get

$$\frac{1}{2\pi}\int_0^{2\pi} f(z)z^{-n}d\theta = A_n. \qquad (110)$$

That is, the value of A_n is the mean value of $f(z)z^{-n}$ with respect to θ. So, by (109) and (110), we have

$$f(z) = \frac{1}{2\pi}\int_0^{2\pi} f(z')d\theta' \, \Sigma_{-\infty}^{\infty}\left(\frac{z}{z'}\right)^n. \qquad (111)$$

This is Fourier's theorem generalised by the introduction of the powers of r. To obtain it explicitly, make $r = r^1$, so as to be concerned only with a function of θ. Then we get Fourier's theorem:—

$$f(\theta) = \frac{1}{2\pi}\int_0^{2\pi} f(\theta')d\theta' \Sigma_{-\infty}^{\infty} \epsilon^{in(\theta-\theta')}$$
$$= \frac{1}{2\pi}\int_0^{2\pi} f(\theta')d\theta' \Sigma_{-\infty}^{\infty} \cos n(\theta - \theta'). \qquad (112)$$

The substitution of the cosine for the exponential function occurs because the imaginary part of the latter contributes nothing to the result. The nth term cancels the $-n$th in this respect. But the imaginary part must not be omitted in the more general result (111).

For a rigorous demonstration of Laurent's theorem see works on the theory of functions. The line of integration may be any circle within the holomorphic region, so Laurent's theorem is the natural sequence to Fourier when the distance from the origin is not invariable, and when the function is controlled by the restricted functional notions. The variations with r and with θ are not independent. The values of the function on one circle control those on another.

It would be of some interest to know how the function theorists would treat the subject of Fourier's series in general, referred to the complex. In the above, the expansion is the rudimentary one in integral powers of the variable. In general, fractional powers are required, the n's following some special law. Say, for example, that $f(z)$ is given on the circle of z'. Then we require to have

$$f(z) = \Sigma A_n z^n, \qquad (113)$$

so as to be right for the given circle, and, in addition, to satisfy certain boundary conditions. For example, make a radial slit in the plane at $\theta = 0$, and let the function have to satisfy a given linear differential equation between it and its derivatives with respect to θ on one side of the slit, where $\theta = 0$, and another similar equation on the other side, where $\theta = 2\pi$. This case corresponds to that of a cable subject to terminal but not to extra intermediate conditions. The infinite series of n's, which may be real or imaginary, will follow a law depending upon the conditions at the slit; and the determination of the coefficients A may be effected by a definite conjugate property, not that of the vanishing of the mean value of z^n round a circle as before mentioned, but of a more general character determined by the conditions at the slit. I have looked into Forsyth's work to see if there is anything about these expansions in fractional powers of the variable, but without success. If the matter has not been investigated, there is room for much expansion of the subject of the determination of functions, especially when one thinks of the various extensions that may be given by the introduction of intermediate differential conditions. Matters of this sort do not present much difficulty in strictly physical problems, and the corresponding cases in the function theory would, perhaps, involve little more than formal changes. At the same time, I must say that a matter which may be sufficiently clear in physical mathematics may become much obscured by a deliberate removal of the physical ideas, which is, perhaps, the reason of the existence of such elaborate and disagreeable demonstrations for the sake of rigour, of supposed or real necessity. It is a serious question whether the study of the theory of functions ought to be taken up by any ordinary physical student. Of course, some useful knowledge of the complex is necessary, and no one could fail to pick up some as he goes along by ordinary algebra; but that is quite different from the theory of functions as elaborated, the general tone of which is quite unlike that of the usual physical mathematics. The frame of mind required is not one that is conducive to progress in mathematical analysis in its physical aspect. A man would never get anything done if he had to worry over all the niceties of logical mathematics under severe restrictions; say, for instance, that you are bound to go through a gate, but must on no account jump over it or get through the hedge, although that action would at once bring you to the goal.

§ 280. After this little excursion to the borders of the realms of duplicity and fearful rigour, we may return to the proper subject. We have to see how the general operational solutions must be treated in order to convert them to the appropriate Fourier series, by which (in one way) they become amenable to numerical calculation. It may be remembered that I have insisted upon the definiteness and fulness of meaning of an operational solution, and that it contains within itself not only the full statement of the problem, but also its solution. No external aid is therefore required to algebrise it fully; no assumption, for instance, of a special type of solution, and that the solution is the sum of a number of that type, with subsequent determination of the constants required to complete the matter. The work of satisfying the imposed conditions has been done already.

The conversion to algebraical or quantitative form may be easy or hard, self-evident or very obscure. But in any case it is possible, by the prior construction of the operational solution. Thus, the conversion furnishes a distinct subject of study which is of great practical value from the physical standpoint. As regards finding out how to effect the conversion, that is a matter principally of observation and experiment, and is in a great measure independent of logical demonstrations. It is the How, rather than the Why, with which we are mainly concerned in the first place; though, of course, parts of the Why cannot fail to be perceived in the course of examination of the How. A complete logical understanding of the subject implies the existence of a full theory to account for why certain ways of working are successful, and others not. It is important to note that it is just the same in mathematical research into unknown regions as in experimental physical research. Observation of facts and experiment come first, with merely tentative suggestions of theory. As the subject opens out, so does the theory improve. But

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it can only become logical when the subject is very well known indeed, and even then it is bound to be only imperfectly logical, for the reasons mentioned at the beginning of this volume. I feel inclined to be rather emphatic on the matter of the use of experiment in mathematics, even without proper understanding. For there is an idea widely prevalent (though it may not receive open expression) that in mathematics, unless you follow regular paths, you do not prove anything; and that you are bound to fully understand and rigorously prove everything as you go along. This is a most pernicious doctrine, when applied to imperfectly explored regions. Does anybody fully understand anything?

Three of the pernicious results of overmuch rigour may be mentioned here. First, its enfeebling action on the mind, sufficiently indicated by the analogy at the end of the last §. Secondly, it leads to the omission from mathematical works of the most interesting parts of the subject, because the authors cannot furnish rigorous proofs. Thirdly, it leads to an inability to recognise the good that may be in other men's work, should it be unconventional, and be devoid of rigorous pretence.

It may not be necessary to algebrise an operational solution. It may not even be desirable to do so, if the meaning is sufficiently plain in operational form, and the algebrisation produces complication. This is very often true when the operations are merely direct ones, as, for example, $(a+bp+cp^2+\ldots)e$, where e is the operand and p the time differentiator. But it is also true, up a certain point, in more advanced forms. Consider, for instance $(XY)^{\frac{1}{2}}e$, or $(X/Y)^{\frac{1}{2}}e$, or $R^m e$, where X and Y, or R, are operators of the form $a+bp$. If the operand e is a simply periodic function of the time, we do not require to algebrise these forms in order to see their meaning. We can do that by geometrical construction in the now well-known manner founded upon the property $p^2=-n^2$, or $p=ni$, representing X and Y by rotations of vectors in a plane. But if we desire close calculation of the results, it is desirable to have the full algebraic formula. Again, I see that Mr. Kennelly has lately dispensed with the use of the full development in the more complicated cases of the shin and cosh of a complex (the complex corresponding to $a+bp$), by means of a specially constructed diagram. I do not doubt that certain cases in which e is impulsive or steady can be done by diagram. It is best, however, to do the work analytically first, in general, at least as far as the operational solution itself, and then see if, in a reasonable time, a geometrical method of representing it is suitable for calculation. For geometry by itself is rather a heavy and clumsy machine. Remember its history, and how it went forward with great bounds when algebra came to its assistance. Later on, the assistant became the master.

The special ways which I have so far given of turning operational solutions of the diffusive kind to Fourier series have all been applied to elementary examples, the terminal conditions being such that the roots of the determinantal equation have been equally spaced, as π, 2π, &c., or $\frac{1}{2}\pi$, $1\frac{1}{2}\pi$, &c. Algebraic simplicity is thereby attained, and we are allowed to use well-known trigonometrical expansions. But, in general, the roots of the determinantal equation $\epsilon^{2ql}=\alpha\beta$, where α and β are functions of p depending on the terminal conditions, are not equally spaced, and they may not be all of the same kind—that is, they may be (as regards s in the circular functions) real or imaginary. The elementary expansion formulæ are useless. There are now three ways that present themselves of attacking the question.

First, to follow up Fourier's way by natural extensions of the kind to be found by experience. Assume the existence of a normal solution of the form

$$v=A\sin(ax+b)\epsilon^{Pt}.$$

Apply it to the actually stated problem. Find the connection between P and a so as to satisfy the characteristic equation of diffusion. Next find, by applying the terminal conditions to the above assumed solution, what relation exists between a and b. Then find the law followed by the a's, and find their values. We thus get an elementary type solution fully determined except as regards size, and we know that every admissible value of a gives a solution.

Next, assume that

$$V=\Sigma v_n=\Sigma A_n\sin(a_n x+b_n)\epsilon^{P_n t},$$

where the summation includes all the values of a_n, is the form of the solution of the special problem, namely, the sum of any number of the type solutions. Only the A's are arbitrary. To find them, observe that $t=0$ makes

$$V_0=\Sigma A_n\sin(a_n x+b_n).$$

The summation on the right therefore represents the initial state. Given the initial state V_0 as a function of x, we require to determine the A's in accordance therewith.

This may be done by finding the conjugate property possessed by the normal functions. When known, it allows us to operate on V_0 by quadratures in such a way as to isolate any single coefficient and determine its value. Finally, introducing the time factor, we arrive at the complete solution as regards the effects due to a given initial state, provided the effects are entirely due thereto. And the effect due to an impressed force may be done similarly by considering the final state it produces, and allowing that to discharge itself in the above manner.

The process of finding A_n is, when the terminal conditions are of the simple kind previously considered, sufficiently obvious. The integral of the product of two normal systems vanishes save when they are alike. But with terminal conditions in general, with energy involved in the terminal apparatus, it is quite another thing. The conjugate property is not the same, and although fundamentally simple in meaning, works out more difficultly. The determination of the A's may become a complicated process, requiring careful investigation of the terminal arrangements themselves. It depends upon the vanishing of the excess of the electric over the magnetic mutual energy of a pair of different normal systems (with different values of p, that is to say). In doing this, the two terminal arrangements have themselves to be included, if any part of the energy is located therein.

§ 281. As a second way, we may follow up the special ways of operationally working already given in connection with simple terminal conditions. First, find the operational solution. Next investigate the proper expansions in partial fractions of the reciprocal of the determinator $(\epsilon^{2ql}-\alpha\beta)$ which occurs in the operator, wherein p has to have all the values which make it (the determinator) vanish. The integration of the partial fractions follows. Complete the solution by carrying out what may be left in the way of direct operations. The expansions required are analogous to those of $\coth ql$ and other functions already used. But this process may be rather difficult, since the theory of partial fractions may lead one into obscure regions of the complex.

Finally, there is a third and very general way of converting operational solutions to the form of the sum of normal solutions. It does not require special investigation of the properties of the normal functions. It is very direct and uniform of application. It avoids, in general, a large amount of unnecessary work. The investigation of the conjugate property, and of the terminal apparatus in detail in order to apply it to the determination of the coefficients, is wholly avoided. It applies to all kinds of series of normal functions, as well as to Fourier series. And it applies generally in electromagnetic problems, with a finite or infinite number of variables; or, more generally, to the system of dynamical equations used by Lord Rayleigh in the first volume of his treatise on Sound, which covers the rest of the work, and upon which he bases his discussion of general properties.

The method may be briefly (though imperfectly) stated as follows: Let $e=ZC$ be the operational solution of an electromagnetic problem; say, for definiteness, that C is the current at a certain place due to an impressed force, e, at the same or some other place. Let the form of Z be such as to indicate the existence of normal solutions for C. Then, when e is steady, beginning at the moment $t=0$, the C due to e is expressed by

$$C=\frac{e}{Z_0}+e\Sigma\frac{\epsilon^{pt}}{p\frac{dZ}{dp}}\quad\ldots\ldots\quad(1)$$

to be understood thus:—

In the first place, the Z in the operational solution is an operator, a function of p the time differentiator. But in

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equation (1) Z, is entirely algebraical. Thus, Z_0 is the algebraical function obtained by putting $p=0$ in Z. It is the effective steady resistance to e when, as supposed, e is a voltage, and it is at the place of C. Otherwise it is more general. Then, in the summation, dZ/dp is the ordinary differential coefficient of Z with respect to p as a quantity. Lastly, the summation ranges over all the roots of the algebraical equation $Z=0$, which is, in this respect, the determinantal equation, though Z itself is much more. These special values of p are to be used in dZ/dp as well as explicitly.

Instead of a C due to an e, it may be V due to e, or V or C due to an initial charge at a point, and many other variations might be mentioned. But it must not be inferred that equation (1) expresses a general mathematical property independent of the form of Z. Dynamical conditions restrict the form in certain ways, for one thing. But it is not even true that the expansion theorem above holds good in strictly dynamical problems. I have already pointed out that we require barriers or boundaries to produce definite and finitely separable vibrating normal systems. Also that in the cable problem, subject to terminal conditions, the determinator $\epsilon^{2ql}-\alpha\beta$ which occurs as a denominator in the general operational solutions arises from the coexistence of successively (though apparently simultaneously) generated waves. So all sorts of problems are immediately excluded from the expansion theorem, at least in the form of equation (1). Inspection of the operational equations will show this, or else physical considerations. Again, the real Z may be the sum of two operators, to one of which the expansion theorem applies fully, whilst the other requires a different treatment. It may involve direct operations of an obvious nature.

Now it would be useless to attempt to state a formal enunciation to meet all circumstances. Even supposing that an absolutely perfect knowledge of the subject made it possible to do so, it would be very unpractical. It would be worse—far worse—than that very lengthy enunciation of a theorem in the 5th Book of Euclid, which may be read and re-read fifty times without properly grasping its meaning, which is not much, after all; only something in compound proportion that the modern schoolboy does in a minute or two. It is better to learn the nature and application of the expansion theorem by actual experience and practice. A theorem which has so wide an application is a subject for a treatise rather than a proposition.

So, to begin with, I will give a few elementary cases concerning one or two degrees of freedom, just to show how the expansion theorem goes, and how to discriminate different forms of Z. After that, we can apply it to diffusion problems in the same way. Other than diffusion problems coming under the same theorem may occur later. And when the reader knows how to work the theorem, it may be possible to see its inner meaning. At present all that need be said is that in its theory it contains the first method of evaluating the coefficients by the conjugate property, and also the second method involving partial fractions. Only it jumps over most of the difficulties connected with both.

(To be continued.)

LINES OF FORCE.

BY W. G. RHODES, M.Sc.

The equation to a line of force due to two equal magnetic poles has been obtained in the form

$$\cos\theta \pm \cos\phi = constant,$$

where the upper sign refers to unlike poles, and the lower sign to like poles; also θ is the angle which the line joining the poles makes with the line joining one of the poles to a point on a line of force, and ϕ is the corresponding angle for the other pole. The field of force due to the two poles is plotted by giving different values to the constant.

The following is a determination of the equation of a line of force due to any two poles, irrespective of magnitude and sign.

Let A (Fig. 1) be a magnetic pole of strength m_1 and B one of strength m_2. Take the middle point, O, of A B as origin, and A B and a line through O perpendicular to A B as axes of x and y respectively.

Let P be any point whose co-ordinates are (x, y),

$AP=r_1$, $BP=r_2$, $AB=2a$,

Angle $PAB=\theta$ and angle $PBA=\phi$.

Then
$$\left.\begin{aligned} r_1^2 &= (a+x)^2+y^2 \\ r_2^2 &= (a-x)^2+y^2 \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Now, if V is the potential at P due to m_1 at A and m_2 at B, we have

$$\frac{m_1}{r_1}+\frac{m_2}{r_2}=V. \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

If we displace P to a consecutive point on the equipotential surface through P, and in the plane of the paper, we have

$$\frac{m_1}{r_1^2}dr_1+\frac{m_2}{r_2^2}dr_2=0. \quad . \quad . \quad . \quad . \quad (3)$$

Also from (1) $\quad r_1\,dr_1=(a+x)\,dx+y\,dy$
and $\quad r_2\,dr_2=-(a-x)\,dx+y\,dy$.

Substituting in (3) and reducing, we get

$$y\left(\frac{m_1}{r_1^3}+\frac{m_2}{r_2^3}\right)\frac{dy}{dx}+\frac{m_1}{r_1^3}(a+x)-\frac{m_2}{r_2^3}(a-x)=0. \quad . \quad (4)$$

This is the differential equation of the traces of the equipotential surfaces on the plane of the paper.

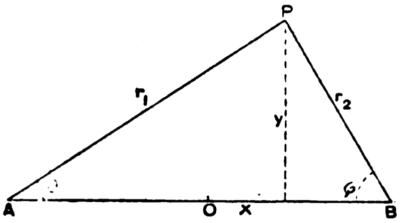

FIG. 1.

Since the lines of force cut the equipotential surface everywhere at right angles, the differential equation of the system of lines of force is

$$\left\{\frac{m_1}{r_1^3}(a+x)-\frac{m_2}{r_2^3}(a-x)\right\}\frac{dy}{dx}=\left(\frac{m_1}{r_1^3}+\frac{m_2}{r_2^3}\right)y, \quad . \quad (5)$$

writing $-\dfrac{1}{\frac{dy}{dx}}$ for $\dfrac{dy}{dx}$ in (4).

To integrate (5) put

$$a+x=y\cot\theta, \qquad a-x=y\cot\phi,$$

and
$$r_1=y\operatorname{cosec}\theta, \qquad r_2=y\operatorname{cosec}\phi,$$

so that
$$\frac{dy}{dx}=-\frac{\operatorname{cosec}^2\theta\,d\theta+\operatorname{cosec}^2\phi\,d\phi}{\operatorname{cosec}^2\theta\cot\phi\,d\theta-\operatorname{cosec}^2\phi\cot\theta\,d\phi}.$$

Substituting these values in (5) we obtain, after a little transformation,

$$m_1\sin\theta\,d\theta-m_2\sin\phi\,d\phi=0;$$

and integrating,

$$m_1\cos\theta-m_2\cos\phi=constant,$$

or
$$\cos\theta-k\cos\phi=constant, \quad . \quad . \quad (6)$$

where $k=\dfrac{m_2}{m_1}$.

The corresponding Cartesian equation is

$$\frac{a+x}{\sqrt{\{(x+a)^2+y^2\}}}-k\cdot\frac{a-x}{\sqrt{\{(a-x)^2+y^2\}}}=constant. \quad (7)$$

By giving a suitable value to the constant the equation to any line of force may be obtained.

Two cases arise according as k is negative or positive; that is, according as the two poles are unlike or like.

If k is *negative*, so that equation (6) becomes

$$\cos\theta+k\cos\phi=constant,$$

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where k is now a mere ratio, we can obtain successive points on lines of force as follows:—

Let A (Fig. 2) be the position of m_1,
B (Fig. 2) be the position of m_2,
$AB = 2a$.

Describe a circle with A as centre, and of any radius d. With B as centre describe another circle of radius kd. Draw any line C D M at right angles to A B, and cutting the circles

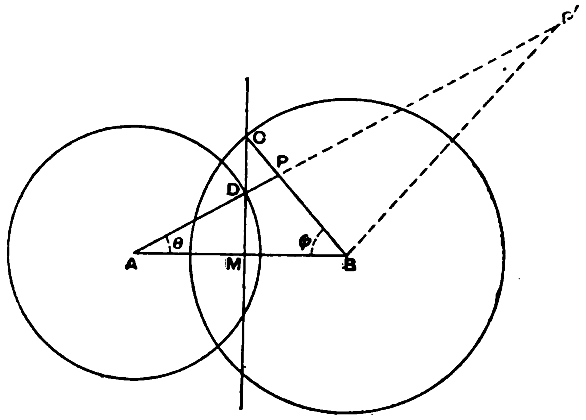

Fig. 2.

in the points C and D. Let B C and A D, or their elongations, intersect in P.

Then
$$\cos\theta + k\cos\phi = \frac{AM}{AD} + k.\frac{MB}{BC}$$
$$= \frac{AM + MB}{d}$$
$$= \frac{2a}{d} = constant.$$

Thus, as M describes the line A B, P will describe a line of force.

If k is positive, so that equation (6) becomes
$$\cos\theta - k\cos\phi = constant,$$
the following additional construction is necessary:—Produce A P (Fig. 2) to P′ and draw B P′, so that angle A B P′ $= \pi$ − angle A B P. Then
$$\cos P'AB - k\cos P'BA = \cos PAB + k\cos PBA$$
$$= \frac{2a}{d}.$$

P′, then, is a point on a line of force which it will describe as M describes the line A B. By taking different values of d the whole field of force may be plotted. The author is indebted to his colleague, Mr. G. C. Turner, for suggesting the additional geometrical construction which determines the point P′ (Fig. 2).

In the particular cases of equal like, or unlike, poles, $k = \pm 1$ and equation (6) becomes
$$\cos\theta \mp \cos\phi = constant.$$
The same geometrical construction still holds good, the radii of the two circles (Fig. 2) now being equal.

HORIZONTAL CARBON PROJECTORS.

BY E. A. N. POCHIN, B.A.

Anyone who has watched the improvements made in projectors during the last few years cannot fail to have noticed that whilst the energies of makers have been directed towards obtaining mirrors of better quality, little or nothing has been done to produce a lamp which will use these improved mirrors to the greatest advantage. The projector lamp with inclined carbons, introduced by Sautter Lemonnier, undoubtedly possesses many good points, in virtue of which it has been very largely copied by other makers. At the same time it suffers from certain defects which appear to have escaped observation, and which are due to the inclined arrangement of the carbons. The usual position, too, of the arc with regard to the mirror, renders the combination far less effective than it might be. In a 100-ampere 24in. projector of the most usual type, the arc is situated 17in. or 18in. from the mirror, and this accordingly embraces a cone of light having a solid vertical angle of about 21 per cent. of a hemisphere, whilst the light from the arc is spread over a hemisphere. Consequently, although the mirror is situated in the best illuminated region, a very large proportion of the light falls on the sides of the projector and is wasted. In order to obtain some rough idea of this waste, the question will be treated mathematically.

Let us assume that the crater is a small disc on the axis of the mirror, at right angles to this axis and luminous on the side facing the mirror. The intensity of the light in any direction will then vary as the cosine of the inclination θ to the axis. The semi-vertical angle of the cone of light falling on the mirror is about 38deg., and therefore the ratio of the light received by the mirror to the total light is represented by

$$\frac{\int_0^{38^\circ}\sin\theta\cos\theta\,d\theta}{\int_0^{90^\circ}\sin\theta\cos\theta\,d\theta} = \frac{\left[\sin^2\theta\right]_0^{38^\circ}}{\left[\sin^2\theta\right]_0^{90^\circ}} = 38 \text{ per cent. approximately.}$$

No special accuracy is claimed for this method; but the result obtained is probably not very far from the true figure. In

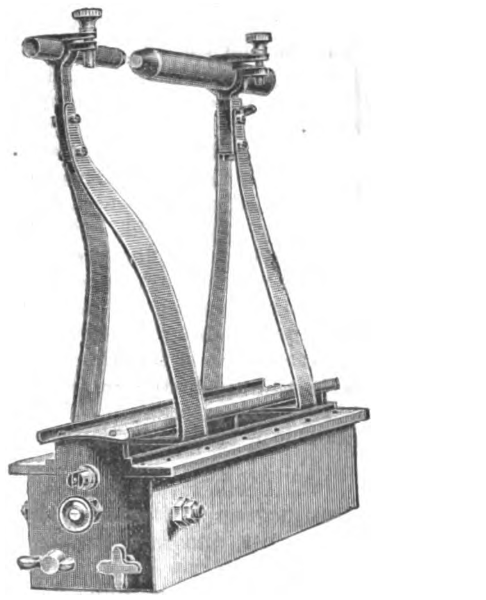

Fig. 1.—Crompton Automatic and Hand-feed Lamp.

addition to this, about 35 sq. in. of the beam is obstructed by the carbons, their supports, and the usual carbon block. Thus, out of the 38 per cent. of useful light obtained, a further 8 per cent. is lost in the manner indicated; the total efficiency of the system being only about 35 per cent.

All those who have worked with inclined lamps of large size must be familiar with the frequent unsteadiness of the arc, accompanied by a loud hissing noise. When this occurs, the arc may be seen to leave its true crater—of which the graphite core is the centre—and try to establish a new crater on some hard portion of the positive carbon, to which there is a shorter path from the negative carbon. If the carbons were placed in line, as in the case of an ordinary arc lamp, and worked at a current not exceeding 50 or 60 amperes, the crater would always remain in its normal position, and there would be no flickering or hissing. The plan of working the arc on the sides instead of at the ends of the carbons is one calculated to encourage flickering, especially with heavy currents.

Fig. 1 shows an automatic and hand-feed lamp, by Messrs. Crompton, which overcomes these objections to a very large degree; and Fig. 2 shows this lamp in combination with a special short-focus mirror. The author has had considerable facilities for making photometric tests with this type of projector, and the figures obtained bear out the statement that

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this arrangement is about two and a-half times as efficient as the usual pattern of projector of the same size. Tests made by some foreign naval and military authorities employing the Schuckert projector—which also uses horizontal carbons—corroborate these results. The increased efficiency obtained by them was given at 2·8 to 1, and it is only reasonable to suppose that the use of a shorter focus mirror should enable one to accept the above figure with some confidence.

Now, it must not be hastily assumed that a projector of the kind illustrated will give nearly three times as powerful a beam as an ordinary projector when worked at 100 amperes. It would undoubtedly do so for a short time, but as the mirror has been placed so much closer to the arc that it collects nearly three times the light, there would be a great risk of blistering the silver. The real point is, that with about 45 amperes a beam can be obtained having an intensity some 25 per cent. greater than an ordinary 100-ampere projector. The saving to be effected is in the cost of the dynamo, engine, and fuel, which are reduced by some 50 per cent. for the same candle-power. Also, where portability is an object, a similar reduction in weight is of the highest importance.

The following description of the lamp may, perhaps, be of interest to the reader. The carbons are placed horizontally, so that the crater of the positive carbon faces the mirror. The carbon supports are made of sheet phosphor-bronze placed

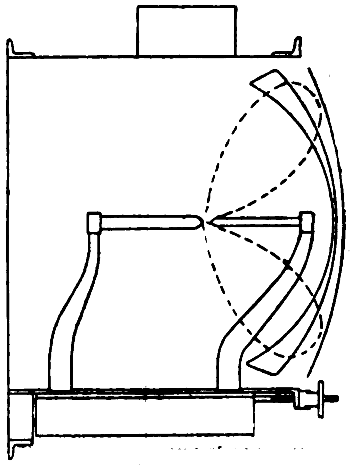

FIG. 2.—Crompton Automatic and Hand Feed Lamp, with Special Short Focus Mirror.

edgeways to the light, and only about 2 sq. in. of the beam is obstructed by them and the carbons. These supports are mounted on carriages placed below the barrel of the projector, and are capable of sliding on grooved rails, which form the upper portion of the box. The position of the carriages is controlled by means of a right and left-handed screw, provided with a milled head at one end and a ratchet wheel and sleeve coupling near its middle point. An electro-magnet in series with the main current strikes the arc by moving one-half of the screw longitudinally. The duty of maintaining the arc at a constant length is performed by an electromagnetic trembler in shunt across the arc. This trembler works the ratchet wheel, thus causing the screw to revolve and the carbons to approach one another. If it be desired to work the lamp by hand, it is only necessary to turn the star handle through half a revolution to disconnect the automatic gear both mechanically and electrically. The carbons can then be controlled by the milled head. The wing nut handle is for the purpose of adjusting the length of arc to which the automatic gear feeds the carbons. Only one focussing motion is necessary, as the arc is always on the axis.

Mechanical Propulsion on Common Roads.—M. Hospitalier has published an account of the accumulator carriages that took part in the recent race to Bordeaux and back. The figures show that these carriages have no chance whatever in competition with those driven by gazolene motors.

NOTES ON HYDRAULIC POWER SUPPLY IN TOWNS.*

BY EDWARD B. ELLINGTON.

The distribution of hydraulic power in towns has not previously been brought directly before the members of this Institution, and the fact that works of this character have just been completed in Glasgow renders the present meeting a suitable opportunity for dealing with an engineering subject of such continually increasing importance.

Existing Hydraulic Power Works.—The present position of the various undertakings which have been established for this purpose is summarised in the accompanying Table I.

General Arrangement.—Of the hydraulic power works in London full particulars have already been given to the Institution of Civil Engineers, and as all such works have much in common it is hardly necessary to add any detailed account of the most recent establishments in Glasgow and Manchester. The supplies in these towns differ from those given elsewhere in the higher pressure employed, namely, 1,120lb. per square inch. The engine house in each city is laid out to contain six sets of vertical triple-expansion engines of 200 I.H.P. each, of the kind introduced by the author in 1880, but in the earlier engines the cylinders were arranged compound with one high-pressure and two low-pressure cylinders. The scale on which the two stations have been planned is the result of the experience gained in London, which has demonstrated that for hydraulic power supply a station of about 1,200 H.P. is the most economical both in working expenses and in outlay of capital.

Delivery.—Each set of engines is designed to deliver 230 gallons per minute at a speed of 60 revolutions, or 240ft. of piston; but it is not intended that they should be run in regular work at more than 50 revolutions, or 200ft. per minute. Assuming that five engines are working at the same time, the total regular working capacity of the stations when fully equipped is 57,500 gallons per hour at 1,120lb. per square inch. The maximum recorded during regular work in an hour at the Wapping station of the London Hydraulic Power Company with five engines running has been 66,000 gallons at 800lb. per square inch, or an average for each of the five engines of 45 revolutions per minute. The reason for dividing the power at a station into so many units is, of course, that the demand for power, as for lighting, is so irregular that the maximum demand is maintained approximately for only an hour or two during any day.

Water.—Both in Manchester and in Glasgow the water supply is taken from the Corporation mains; so that no pumping is required to fill the tanks, and no filtering apparatus is needed. The whole arrangement of these stations is thereby much simplified as compared with those in London, where Thames or canal water is used; it is also unnecessary to have the same large reserve of water in the tanks. At the Wapping station in London, for instance, the tanks over the boilers have a total capacity of 237,000 gallons, and in addition there are underground reservoirs of filtered water containing 500,000 gallons. In Manchester and in Glasgow the whole storage provided is only 230,000 gallons and 200,000 gallons respectively. The pipes in the engine and boiler houses are all arranged on the duplicate or circuit system, and great attention has been given to the provision of sufficient access to all parts of the machinery.

Mains.—The supply from the stations in Manchester and Glasgow is taken to the streets through four mains, which are laid in circuit, with valves at intervals of about 440 yards. Connecting mains have a valve at each end, so that the majority of buildings supplied have two ways by which the power can be obtained. The largest mains laid in Manchester are 6in. internal diameter, and in Glasgow 7in.

Automatic Flow-Recorders.—In order to maintain a sufficient control over all these sources of waste, it is of the first importance to know the minimum flow through the mains at times when it may be supposed that no work is being done. To ascertain this, automatic recorders are fitted at all the pumping stations. The following are the maximum and minimum registrations in London for the June quarters from 1888:—

Year.	Total water pumped in June quarter. Galls.	Maximum flow per hour. Galls.	Minimum flow per hour. Galls.	Annual load factor.
1888 ...	29,238,000	39,120	1,200	0·286
1889 ...	39,873,000	49,920	1,776	0·328
1890 ...	48,172,000	61,248	1,604	0·306
1891 ...	65,386,000	79,330	3,360	0·339
1892 ...	77,103,000	91,920	3,984	0·326
1893 ...	82,586,000	101,760	4,500	0·323
1894 ...	96,876,000	114,096	4,800	0·338

* Abstract of a Paper read at the meeting of the Institution of Mechanical Engineers at Glasgow.

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Table I.—*Existing Hydraulic Power Works.*

Place.	Year of establishment.	Length of mains.	Largest diameter of mains.	Engine horse-power.	Delivery of water per week.	Number of machines worked.	Pressure per square inch in mains.
		Miles.	Inches.	I.H.P.	Gallons.	No.	Lb.
Hull	1877	2½	6	250	100,000 to 500,000	58	700
London	1884	76	7	3,400	9,500,000	2,300	750
Liverpool	1888	18	6	800	1,000,000	453	800
Melbourne	1889	18	6	800	1,500,000	413	750
Birmingham	1891	3½	6	52	78,000	...	700
Sydney	1891	12	6	688	740,000	200	750
Antwerp	1894	4½	12	1,000	3,300,000	Turbines at three stations.	750
Manchester	1894	12	6	800	1,000,000	247	1,120
Glasgow	1895	9	7	600	Nil.	Nil.	1,120

Table II.—*Comparison of Hydraulic Power Supply and Electric Supply, Compiled from the Reports of the London Hydraulic Power Supply (L.H.P.) and the Westminster Electric Supply (W.E.S.) for the Year 1894.*

1894.	Totals.		At gallons at 1,730ft. head.		At Board of Trade electric units.	
	L.H.P	W.E.S.	L.H.P.	W.E.S.	L.H.P.	W.E.S.
	£	£	Gallons.	Gallons.	Electric units.	Electric units.
Capital outlay	471,552*	411,018	...	...	...	...
Output	...	...	400,313,000	396,256,000	2,609,240	2,582,801
Quantity sold	...	...	332,390,000	333,430,000	2,166,520	2,173,298
Received for supply	49,237	50,729	...	...	...	..
Average price obtained	...	...	Per 1,000 galls., 35·55d.	Per 1,000 galls., 36·51d.	Per unit, 5·45d.	Per unit, 5·6d.
Station costs.	**Totals.**		**At 1,000 gallons at 1,730ft. head.**		**At Board of Trade electric unit.**	
	£	£	d.	d.	d.	d.
Coal	3,276	5,842	1·964	3·539	0·301	0·543
Oil, water and engine-room expenses	1,351†	1,228	0·810	0·743	0·124	0·114
Salaries and wages	3,071	6,345	1·841	3·839	0·282	0·589
Repairs and maintenance	929	1,478	0·557	0·893	0·086	0·137
Totals	7,627	14,893	5·172	9·014	0·793	1·383
Individual station	Wapping.‡	Davies-st.§	Wapping.‡	Davies-st.§	Wapping.‡	Davies-st.§
	£	£	d.	d.	d.	d.
Coal	1,242	3,263	1·684	3·906	0·258	0·600
Oil, water and engine-room expenses	385	600	0·522	0·718	0·080	0·110
Salaries and wages	1,072	2,500	1·453	2·993	0·233	0·459
Repairs and maintenance	382	931	0·518	1·114	0·079	0·171
Totals	3,081	7,294	4·177	8·731	0·640	1·340

* Including £56,000 for new site and station, started October, 1894. † Including £400 for water rights and £129 for gas lighting. ‡ Wapping station only; output 174,000,000 gallons in 1894. § Davies-street only; output 1,306,794 units in 1894, equivalent to 200,490,000 gallons.

Detection of Waste.—The whole of the 76 miles of mains in London are, as a rule, in communication with one another; but certain valves are kept closed in such a way that the several main circuits are in communication with one another at the central station only. The superintendent at the central station has it then in his power at any time to divide the supply into four distinct sections, and by observation of the pressure gauges it can readily be ascertained through which section an abnormal flow is occurring. The main in which this abnormal flow is proceeding has then to be shut down at intervals, till at last the leak is run to earth. At the pressure of 750lb. per square inch 3,000 gallons per hour would pass through an orifice of only $\frac{1}{16}$in. diameter, which shows how small in reality the leakage from the mains must be. The principal source of waste is undoubtedly on the consumers' premises.

Frost.—The severe and prolonged frost of last winter did not seriously affect the supply. About 1,150,000 gallons was pumped to waste during Sundays in order to maintain the circulation; but after allowing for this 91·65 per cent. of the total water pumped was registered. This fact alone is conclusive; but in a few places sub-mains in exposed positions were frozen, though in nearly every case they were quickly cleared. No consumer, it is believed, was seriously inconvenienced. The frost was down in the ground quite 3ft. in places, and there were five or six instances of broken mains. The damage done was greater than on any previous occasion. The surface of the roads was so hard that the water could not get through the paving, and in two or three places found its way into cellars. In two instances the water was forced between the concrete and the wood paving, floating the latter, and at last finding a vent about 100 yards away from the break. It was not found necessary to relay the pavement thus lifted, except in a few places, for it settled down all right again after the water had run off. There were other novel experiences of the severity of the weather. In the Thames Embankment subways there were several degrees of frost, and during its continuance, in order to reduce the risk, the area of supply was divided into sections, and the embankment main had thus a dead end; the temperature fell, the main contracted, a large number of the joints opened, and huge icicles formed round the flanges. As soon as this was discovered, the valve shutting off the City was opened, the water which is sent into the mains at 60deg. flowed through and thawed the pipes that had contracted, and most of the joints again became quite sound. In connection with this question of warming the water, it is interesting to note that the water pumped from the river was below freezing point. The water is heated by passing it through the surface condensers of the engines; but at the new stations, where the triple-expansion engines are used, it was found that the temperature could not be raised much above 40deg. in the filtered-water tanks, and in order to maintain the water at the higher temperature of 60deg. it was necessary to destroy the vacuum in the condenser, thereby rendering the engine less economical for the time being. Another experience my be mentioned in connection with low temperatures which shows that high apparent economy is not always real economy. At the Wapping and City-road stations the economisers are arranged much in the same way as for the Glasgow works. The temperature of the gases leaving the economisers was reduced to 238deg. or 240deg., and the temperature of the hot-well condensed water entering the economiser was 65deg. or 70deg. The consequence has been that it has been found necessary to renew the economiser tubes after three years' work, owing to the condensation on the outside of the tubes and their consequent corrosion. The cost of the renewal is larger than the saving of fuel effected. Arrangements are now being made to obtain a higher hot-well temperature.

Application of Power.—Hydraulic power has to be supplied under competition with steam, gas, and electricity, and the success which has attended its introduction shows conclusively that it is well able

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to meet this competition for lifting and for other intermittent work. None of the supply systems which have been established have aimed at meeting the demand for continuously running motors, except in Antwerp, where the supply has been laid out as a means for generating electricity for lighting. At first sight it is somewhat difficult to see how this can be an economical mode of employment. There are, however, a few places in London where the hydraulic power is used to generate electric current. The apparatus consists of a Pelton wheel, with the armatures of the dynamo mounted on the same shaft. The following are the particulars of a trial made with this apparatus at the hydraulic engineering works at Chester in October, 1894: Pelton wheel, 18in. diameter, 54 buckets; Elwell-Parker shunt-wound dynamo for charging accumulators, having a commercial efficiency of 87 per cent. as tested by the makers; speed, 1,671 revolutions per minute; bore of nozzle, 0·175in.; hydraulic pressure, 725lb. per square inch; output 37½ amperes at 120 volts; water consumption, 20 gallons per minute; power in water 10·15 H.P., in output 5·99 H.P.; efficiency, 59 per cent. This is not the highest efficiency that could be obtained, for the wheel and dynamo were not perfectly adapted to each other. External resistance had to be used for keeping down the voltage, and at this output the dynamo was somewhat overworked. In a previous trial, with 0·16in. nozzle and an output of 26 amperes at 122 volts, the efficiency was 59·86 per cent. It is unlikely, however, that even under more favourable conditions the conversion can be effected with a greater efficiency than 66 per cent.

Comparison of Hydraulic and Electric Power Supply.—It is interesting, therefore, to inquire whether there are any grounds for the assumption that hydraulic power obtained otherwise than from a natural head of water can be used economically for generating an electric current. It so happens that the materials are available for a comparison between the cost of a public supply of hydraulic power and that of electricity obtained from a central station on almost exactly the same scale. The particulars given in Table II. are taken from the records of the London Hydraulic Power Company and of the Westminster Electric Supply Corporation for the year ending December 31, 1894. In making the comparison, 1,000 gallons of water at 750lb. per square inch is taken as equivalent to 6·518 Board of Trade units of electricity. This analysis shows that the station cost of the hydraulic power is 5·172d. per thousand gallons pumped at the pressure of 750lb. per square inch; while the corresponding cost of an equivalent amount of electric energy reduced to the same hydraulic standard is 9·014d. per 1,000 gallons; or on the electrical standard of Board of Trade units, 0·793d. and 1·383d. respectively. The output during the year, the capital employed, and the average rate received for both supplies, are nearly the same. The coincidence of the figures is extraordinary, except in the cost items, in which their divergence is equally remarkable. No other conclusion can be drawn than that for some reason or other not hitherto explained hydraulic power is much less costly to produce than electricity. The Westminster electric supply is one of the largest in the country, and its cost is one of the lowest. The London hydraulic supply is the greatest anywhere, and is produced, no doubt, very cheaply. In neither, however, has the minimum cost been reached, for in both of them the station cost in the newer installations is considerably below the average for 1894. For instance, the station cost of the hydraulic power supply from the Wapping station for 1894 was only 4·177d., as against 5·172d. for the whole supply, while the station cost of the Davies-street station of the Westminster electric supply is equivalent to 8·731d. per 1,000 gallons, as against 9·014d. for the whole supply. It may be thought that the low annual load factor of, say, 0·18 for the electrical supply, as against 0·33 for the hydraulic, accounts for most of the difference; but under the able control of Prof. Kennedy the influence of a low load factor has been to a great extent neutralised by running the machinery actually in use at nearly full load. Moreover, the figures of other electric installations, such as the St. James's and Pall Mall, where the load factor is much higher than in the Westminster district, show a similar difference of cost as compared with the hydraulic supply. Now it is obvious from the figures of the London and Westminster installations that, as the output during the year was the same, while there is so great a difference in the annual load factor, the maximum horse-power employed is much greater for the electric than for the hydraulic supply; but the output per unit of capital outlay seems to be much the same. This is no doubt owing to the greater concentration of demand in the area supplied with electricity. If a large amount of power is concentrated in a single station, it is practicable to work that station much nearer to its maximum capacity than if the same power had to supplied from two or three stations. In the London hydraulic supply, while the annual load factor is 0·33, calculated on the maximum delivery at any time during the year, the load factor of the whole plant in use during the year under the most favourable conditions is only 0·20, and is often much lower; in other words, more than one-third of the whole plant is always in reserve, and in some years as much as half. The proportion of plant out of use altogether, or not running at full load at the periods of maximum demand, is no doubt much less at most electric lighting stations, and the load factors of the two systems calculated upon the total station plant probably do not differ widely. The fact that the load factor calculated on the maximum flow is lower for the electric supply than for the hydraulic does not, other things being equal, account for the larger part of the difference of cost. This is shown also by a comparison of the cost of the hydraulic supply during a week when the output is large and during another when it is small. During the week ending October 18, 1894, altogether 9,095,000 gallons were pumped at the London hydraulic power stations, and during the week ending December 27th 5,902,000 gallons only. The increased cost for fuel in the latter week was 0·317d. per 1,000 gallons, and for wages 0·77d. per 1,000 gallons, making 1·087d. per 1,000 gallons, whereas the average excess cost of the electric supply is more than 3½ times as much, and in the item of coal nearly five times as much. The immediate question, however, is the economy of using hydraulic power for generating electricity, and it will be seen from the foregoing figures that, with a loss of 33 per cent. of the hydraulic energy during conversion into electric energy, the station cost of 0·793d. per Board of Trade unit would rise to 1·189d., or 0.194d. below the cost 1·383d. of the direct current of the Westminster supply.

Table III.—*Antwerp Hydraulic Power Service.*

1895.	January to April. 4 months.	January. Maximum month.	April. Minimum month.
	Gallons.	Gallons.	Gallons.
Quantity pumped	59,080,000	20,178,000	11,772,000
Station cost per 1,000 gallons.	Pence.	Pence.	Pence.
Coal	2·618	2·483	2·614
Engine-room stores........................	0·118	0·130	0·134
Wages	0·693	0·512	0·840
Total	3·429	3·125	3·588

The cost will be further increased by the wages, superintendence, and repairs at the converting stations, so that on the whole there does not seem much probability of any economy resulting from this method of generating electricity on a large scale. It may be mentioned that the principal reason which led the late Prof. Van Rysselberghe to advise the combined method for the electric supply of Antwerp was that he considered the losses of distribution of the electric current would be much less on that method. The losses of distribution, however, are not very serious either way, and the direct or the combined method must ultimately stand or fall, the author considers, on the relative generating cost per unit. Mr. L. Moris has kindly furnished the particulars in Table III. of the working of the Antwerp hydraulic service. The very low cost per 1,000 gallons pumped is evidently due to the small amount of wages paid at the central station, and the figures include nothing for superintendence, water supply, lighting of station, removal of ashes, or repairs to machinery. At least 1½d. per thousand gallons should be added for these items in order to make the cost comparable with that of the London stations. It will be noticed that the reduced output in April increased the cost only 0·46d. per thousand gallons, or, say, 15 per cent., while the output was only 58 per cent. of that in January. It seems, however, that notwithstanding the low cost at which the hydraulic supply is obtained in Antwerp, the general results of the combined method during the first nine months of working have not been satisfactory. It is stated that the arrangements have proved more costly than the usual direct method, not only in first cost, but in working expenses. The capital outlay per electric unit would probably be greater, but there seems no sufficient reason why the working expenses should be increased. Further information is required before an explanation can be given. While the combined method does not seem to have any sufficient basis for a general system of distribution, it is evident from the foregoing figures that electricity can be economically generated by means of hydraulic power artificially obtained; and the latter can, therefore, be used with advantage as a supplement to ordinary methods of generating electrical energy. Hydraulic power is clearly much the most economical in those applications where the direct pressure can be utilised—such as for lifting and pressing. Where rotary motion is needed, the special circumstances of each case will determine what power shall be used, and all are now more nearly on a par as regards cost. For motors running regularly for several hours a day the London hydraulic power stations now supply power at a rate of 1s. 6d. per 1,000 gallons, which is equivalent to 2·76d. per Board of Trade unit of electricity, or, say, 3d. per brake horse-power per hour. It is questionable whether small powers can by any means be obtained at a lower rate when all the items of cost are taken into account.

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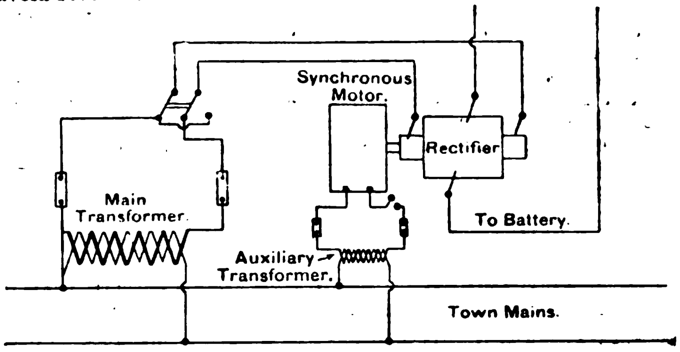
CHARGING ACCUMULATORS BY ALTERNATING CURRENTS.

An account is given in a recent number of the *Zeitschrift für Electrochemie* of a method suggested by Herr C. Pollak for charging accumulators by means of rectified alternating currents.

The requisite apparatus for converting an alternating current of high voltage into a uni-directional current of low voltage consists of a main step-down transformer and a small auxiliary transformer, which drives a synchronous motor, having a commutator on a prolongation of its spindle, to which current is led and from which it is taken, after rectification, by appropriate brushes. The whole arrangement is clearly shown in the accompanying figure. By adjusting the set of the brushes the flow of current to the accumulators can be stopped at such part of each alternation as to avoid reversal.



At the Pollak Works at Frankfort the town supply of current at a pressure of 3,000 volts is transformed down to 65 volts and rectified as described above, the resulting uni-directional current serving for general electrolytic purposes as well as for driving ordinary direct-current motors. An efficiency of 96 per cent. is claimed for the rectifier, 2 per cent. loss being encountered in driving the small synchronous motor, and 2 per cent. in contact resistance.

ELECTRIC POWER IN FACTORIES AND MILLS.*

BY F. B. CROCKER, V. M. BENEDIKT AND A. F. ORMSBEE.

Introduction.

The application of electric power distribution to the operation of factories and mills, including the driving of the various machines and other apparatus, is the latest and one of the most important problems toward which attention is now being directed, the question being one of extreme prominence both from an economical as well as from an engineering standpoint. In comparing two or more different systems of power distribution, the fundamental basis of comparison is generally that of dollars and cents. This is certainly correct, as far as it goes; but unless a very decided difference be found between the costs of running under the various systems, it may be found that other factors enter ; factors which cannot be estimated in dollars and cents—namely, questions of desirability and convenience. Without considering any tests whatever, there are several exceedingly advantageous points in the use of motors in factories which are almost self-evident, such as: 1. Clear and unobstructed passages and head room, the latter facilitating the use of travelling cranes. 2. Ease of shifting the tools from place to place, possibly necessitating the placing of a starting box and the putting up of a little extra wire, as compared with the inconvenience and trouble of setting up and adjusting a line of shafting, hangers, belts, &c. 3. The economy due to the ability to run a single tool without necessarily starting the whole factory or at least a complete section. 4. The running expense is entirely stopped when the tool is shut down. 5. The absence of the drip of oil from overhead shafting. 6. The tools may be placed at any desired points almost regardless of the distance. 7. It is not necessary to arrange the tools parallel as in the mechanical system. 8. A wider range of speed is possible. 9. Less damage caused by a fuse blowing than by a belt slipping off in case of accident or excessive load. Considerations like the above have great weight in deciding a question such as that under discussion, and there is no doubt whatever that in most cases they rise to such prominence that they warrant a complete change from the old system to the new, even though there is no gain in economy or increased output. In most cases, however, it has been conclusively shown that considerable saving and increase in production is obtained, one test showing a very considerable percentage of increase in the output.

* Paper read before the American Institute of Electrical Engineers at Niagara Falls.

The partial, if not the complete, displacement of the old method by the new is only a question of time, and it was the appreciation of this fact that induced the authors to undertake the determination of the power actually required to run the various tools and machines as used in ordinary practice.

Historical Notes.

The subject is a comparatively new one, not dating back further than about 1890; hence the history of the subject is necessarily short. About five years ago motors were in operation in the works of the Thomson-Houston Company at Lynn, the Crocker-Wheeler Company and the C. and C. Company. Shortly afterward the great German works of the Siemens and Halske Company and the Allgemeine Elektricitäts Gesellschaft began using motors to operate sections of their factories. From that time to the present the use of motors has extended rapidly, until now they have been adopted in many factories all over this country and to a less extent abroad.

Practical Tests.

In the tests which follow, the power required to drive the tools was obtained by placing an ammeter in the circuit of the motors running the various machines and groups of machines, and taking readings every few seconds, the frequency of the readings depending upon the nature of the tool and the work it was doing. The potential was practically constant at 110 volts, not varying more than 1 or 2 per cent. The first tests were made at the factory of the Crocker-Wheeler Electric Company, at Ampère, N.J., and the machines tested and the results obtained were as follows :—

1. *Large Boring Machine.*—This machine was driven by a 1½ H.P. motor, speed 1,200 revolutions per minute, mounted directly on the frame of the tool, the reduction in speed being obtained by the use of gearing. During this test, which lasted three hours, the machine was used for turning down a commutator for a 100 H.P. dynamo. The average current drawn was 8·3 amperes, representing 1·23 H.P. at 110 volts. Before the run was finished, the speed of the tool was increased by changing the combination of gears, and during this time the power required was 1·43 H.P. When the machine was started from rest, the rush of current was considerable, the average being 17·75 amperes, representing 2·6 H.P. It will be seen that this motor is well suited to the machine, the average load being very close to the rated power of the motor.

2. *Drill Press.*—A drill press was run by a 1 H.P. motor, speed 545 revolutions per minute, mounted on a shelf at top of press and belted down to countershaft at bottom and thence up again to main shaft of machine, thus securing a reduction of the speed. This machine was boring the faces of the cast-steel pole-pieces of a 10 H.P. motor, two cutting tools being used. The test lasted 4 hours and 40 minutes, and during this time the pole-pieces for three motors were bored. The first run covered 1 hour and 10 minutes, and the average current was 2·92 amperes, representing 0·43 H.P. It required 15 minutes to replace the completed pole-piece by another one. This second piece required 2 hours and 32 minutes to finish, and the average amperes was 2·82 or 0·41 H.P. This time it required 17 minutes to replace the piece, and then the machine ran only 23 minutes until closing time. The current for this short run was 2·81 amperes, representing 0·41 H.P. The total length of time the machine was running was 4 hours and 5 minutes. Therefore power was supplied to the motor 86 per cent. of the time of the test.

3. *Drill Press.*—This machine was similar to the one preceding, but the work was different—namely, drilling half-inch holes in cast-iron bearings. The average current was 2·86 amperes, which represents 0·42 H.P.

4. *Drill Press.*—This tool was the same as the other two, and the work consisted in boring the inside of cast-iron bearings. The average in this case was 1·9 amperes, or 0·28 H.P. It will be noticed that in the case of these three machines a motor of ½ H.P. would be of ample size to do the work.

5. *Punch Press.*—This was a small punch run by a 1 H.P. motor, mounted on the base of the machine and belted to its heavy fly-wheel. The speed of the motor was 700 revolutions per minute. This tool was punching slots in sheet iron discs for a 10 H.P. armature, there being 28 slots in each disc. The motor was turned off every time a disc was replaced, but it did not come to a dead stop, as the inertia of the flywheel was so great. Readings were taken every five seconds, and the time of turning on and off the current was noted. The test lasted 57 minutes, during which time the current was turned on for 35 minutes and 45 seconds, or 62·7 per cent. of the time. The average current was 4·86 amperes, equivalent to 0·71 H.P. The rush of current at starting varied from 7 to 15 amperes, depending upon the haste of the workman in turning on the starting box.

6. *Gang Drill.*—This tool was driven by a 1 H.P. motor, 1,000 revolutions per minute, mounted with vertical shaft in frame of the machine and belted directly to the three drill spindles. The material drilled was cast-iron, and the sizes of the holes were ¼in. and ⅜in. The average of the readings taken was 4·75 amperes or

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0·7 H.P. When the drills were running free the motor took 3 5 amperes. Thus the power required to overcome friction was 74 per cent. of the power used while drilling.

7. *Group of Two Machines, One Lathe and One Milling Machine.*—This group was driven by a 3 H.P. motor, belted to a short line shaft, from which belts ran to the countershafts above the two machines. The average current was 10·04 amperes, the power being 1·48 H.P. In this test special attention was paid as to which machine happened to be running free, cutting, &c., with the results given in the following table :—

Class of machines and work.	Amperes.	H.P.
Milling machine running free—lathe at rest	5·67	0·836
Lathe „ „ „ —miller „	7·36	1·085
Both running free	10·0	1·47
Milling machine cutting—lathe run free	10·33	1·52
Lathe cutting—milling tool running free............	14·42	2·12
Both tools cutting	15·4	2·28
Cutting rate increased on the lathe	17·8	2·61

8. *Group of Six Machines, consisting of 1 Milling Machine (small), 2 Lathes (10in. or 12in. swing), 1 Grindstone, 1 Drill Press, and 1 Small Punch Press.*—The last-named tool was not run at all during the test, and the grindstone ran continuously. This group was run by a 1 H.P. motor, belted to the usual ceiling line shaft. The average current required to drive these machines was 5·86 amperes, representing 0 86 H.P. Thus this motor ran at about its most economical load.

9. *Group of Seven Machines: 1 Planer (small), 1 Grindstone, 4 Lathes, 1 Hand-Turning Lathe.*—A 3 H.P. motor was used to drive this group, being belted to a line shaft, the same as the previous groups. The current was 13 36 amperes, or 1·97 H.P. When the entire group was in use 2 65 H P. were required.

10. *Group of 7 Lathes and 1 Grindstone, driven by a 3 H.P. Motor.*—The average current was 9·92 amperes, and the power required was therefore 1·46 H.P. The power used by the motor when different numbers of lathes were running is shown by the following table :—

Number of lathes running.	Amperes.	H.P.
One	7·76	1·14
Two	9·16	1·35
Three..	10·69	1·58
Four	12·23	1·8

Thus, in a group like this, it only takes 63 per cent. more power to drive four lathes than it does to run one, the reason being the fact that it probably takes about 1 H.P. to drive the countershafts.

11. *Group of Two Machines, a Large Punch Press, and a Large Planer.*—The motor for running this group was placed on the floor, and drove a short line shaft on the ceiling by the usual form of belt. The rated capacity of this motor was 7½ H P., and its speed was 1,350 revolutions per minute. The punch press did not run during the test. With the planer idle, and the motor driving the shafting and belting alone, the current was 15 5 amperes, which represent 2 3 H.P. While the planer was at work the motor required 33·1 amperes, or 4·87 H.P. As the loss from friction in the shafting is nearly constant under the variation of load, the power required to overcome this friction was 47 per cent. of the total power used. When the bed of the planer reversed from its slow cutting stroke to the comparatively rapid return stroke the current increased to 52 amperes, showing an expenditure of 7·6 H.P. for a few seconds. This tool was planing the frame of a 90-kilowatt multipolar dynamo, the material being cast iron.

12. This group was a very large one, consisting of 20 machines, 8 lathes, 4 milling machines, 3 planers and sharpers, 2 grindstones, 1 vertical shaft grinding machine, and 3 small tools. The motor in this case was rated at 10 H.P. at 750 revolutions per minute. A Thomson recording wattmeter was placed in the circuit of this motor for one afternoon. At the end of this time the wattmeter showed a total of 17,854 watt-hours used, and as the time was five hours, the average power was 3,571 watts, or 4 78 H.P. The average number of machines running was 13, most of the lathes being in use the greater part of the time. An ammeter was inserted in the circuit of the motor for a few minutes, and it was noted that the work was very steady, the current not varying more than 3 or 4 amperes at any time.

13. A group of five machines run by a 3 H.P. motor was next tested. Of these five machines, one was a lathe with 17in. swing and 8ft. bed, one was a slotter, and the other three were lathes of 12in. or 14in. swing. The average amperes were 7, and the power 1·03 H.P.

14. The last tool tested at this factory was a large new engine lathe, which had just been set up, of 50in. swing. This tool was driven by a 3 H P. motor mounted on an iron bracket built in the base of the machine. The motion of the motor shaft is transmitted to the tool by gears, thus doing away with all belts. The work done was turning a 5½in. steel shaft for a 200-kilowatt dynamo, facing the ends, &c., the cut being very light, as the work was only preliminary. The average current consumption was 11·4 amperes. Hence the average power was 1·68 H.P.

The following tests were made in the erecting shop of the De La Vergne Refrigerating Machine Company, at Port Morris, N.Y. :—

1. *Planer.*—A large planer, 120in. between posts, by 108in. high, by 22ft. bed, was driven by a C. and C. motor of 15 H.P. The voltage employed was supposed to be 220, but due to an incorrect station voltmeter the actual potential only averaged 190 volts on the morning of this test. The average current was found to be 20 08 amperes, which at 190 volts represents 5·11 H.P. At the reversal from the cutting to the back stroke the current increased to 85 amperes, equivalent to 21·65 H.P. The power required during the cutting stroke was 4·76 H.P., while on the return stroke the average was 5·73 H.P.

2. *Drill Press.*—A drill press driven by a 5 H.P. C. and C. motor was tested in the afternoon. The potential was raised before this test so that the average was 215 volts. The power required when drilling various size holes is shown in the following table :—

Size of drill.	Amperes.	H.P.
Running free.	3·0	0·865
⅞in.	4·07	1 23
$\frac{21}{32}$in.	4·37	1 26
$\frac{31}{32}$in.	4·6	1·33

3. *Corliss Cylinder Boring Machine.*—This tool was driven by a 10 H.P. C. and C. motor and was boring the brass boxes, 6¾in. diameter, of the main shaft bearing of a large ice machine. The average current was 14·47 amperes, representing 4·17 H P. at 215 volts.

In order to place the results in a more convenient form the following table of average powers was compiled :—

Tests at the Crocker-Wheeler Factory.

No. of test.	Size of motor.	Number of tools driven by motor.	Average amperes.	Average H.P.	Remarks.
	H.P.				
1	1·5	1 boring machine.	8·3	1·23	
2	1·0	1 drill press.	2·85	0·42	Less than half full load of motor.
3	1·0	1 „	2·86	0·42	
4	1·0	1 „	1·9	0·28	
5	1·0	1 punch press.	4·86	0·71	
6	1·0	1 gang drill.	4·75	0·7	Drilling ¼in. and ⅜in. holes.
7	3·0	2 machines.	10·04	1·48	
8	1·0	6 „	5·86	0·86	All small machines.
9	3·0	7 „	13·36	1·97	
10	3·0	8 „	9·92	1·46	
11	7·5	2 „	33·1	4·87	Required 2·3 H.P. to run shafting only.
12	10·0	20 „	...	4·78	Tested by wattmeter.
13	3·0	5 „	7·0	1·03	
14	3·0	1 engine lathe.	11·4	1·68	Light cut taken by tool.

Tests at the De La Vergne Works.

No. of test.	Size of motor.	Number of tools driven by motor.	Average amperes.	Average H.P.	Remarks.
	H.P.				
1	15·0	1 planer.	20·08	5·11	Planer 10in. × 9in. × 22in. Voltage 190. ⅞in. drill.
2	5·0	1 drill press.	4·07	1·23	Voltage 215.
3	10·0	1 boring tool.	14·47	4·17	Voltage 215.

The results obtained in these tests show that the power required to drive machine tools has been considerably over-estimated, for it will be noted that with a large majority of the tools tested, the motor was not more than one-half loaded, and in these cases it was seldom that the load equalled the full power of the motor, even for an instant. In the case of the large planer, although the motor was overloaded 50 per cent. upon reversal of the bed, the average load was only one-third of the rated full load. With this machine, however, when the piece of work is very short, necessitating more rapid reversals, the average load will be much nearer the most economical output of the motor.

The question of running machine tools by individual motors or grouping a number of machines together and driving them by one motor, does not seem to allow of a general solution. It would not be advisable, for example, to use the individual system where there are a number of small tools, each one of which requires only a small fraction of a horse-power. On the other hand, if we have a large tool that requires considerable power, it would seem to be far more economical to run it by a single motor, using as little belting and shafting as possible.

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Many of the manufacturers of machinery are now supplying boring mills, punching presses, drill presses and other machine tools arranged to be driven by electric motors. In most cases all that is necessary is a shelf or bracket on the tool to support the motor, and a gear wheel in place of the main pulley, unless a belt connection is preferable. A press or other tool having a large fly-wheel may be driven very conveniently by cutting teeth on the edge of the wheel which gear with a pinion on the motor shaft.

Electric Power in the New England Cotton Mills.

The introduction of the electric system of distribution of power in the cotton industries of New England is now fairly begun. Although there are no large mills driven entirely by this system, a number of them have an electric plant and certain sections of the mill are driven by motors. An electric plant was installed four or five years ago in the works of Silver Spring Bleaching and Dyeing Company, at Providence, R. I., but it was intended chiefly for lighting. But motors were placed in the carpenter and repair shops, and several other places, until at present there are about 100 H.P. of motors installed in eight units. The generating plant consists of three 100 H.P. U. S. dynamos belted together from a countershaft which is driven by a Corliss engine. Two of the machines are 110-volt dynamos, which are used for lighting and running most of the motors at present. The third machine which has just been installed is a 500-volt Westinghouse power generator of the same type as the lighting machines. There is only one machine at present connected to the 500-volt circuit, a 30 H.P. motor which drives a centrifugal pump supplying a storage reservoir with water for use in the bleacheries. The electric plant in this mill is not of much importance yet, but its chances for development are very bright, since there are a number of machines now run by individual steam engines. These could be most advantageously replaced by electric motors, as they are in some cases a great distance from the boilers, involving large losses from condensation.

A visit was made to the works of the Donnell Manufacturing Company, at Pawtucket, R.I., where a very fine electric plant has very recently been installed to drive the calico printing machines. The problem of running this class of machinery by electric motors has been a very difficult one to solve, for the motor must be capable of running at a number of different speeds and running constantly at any given speed with a variable load. In this case it has been solved by the use of a modification of the Leonard system of motor regulation. The outfit for each printing machine consists of a motor and a dynamo of the same size, the field rheostat of the dynamo being placed alongside the printing machine. The speed of the motor is thus changed by varying the voltage of the particular dynamo which supplies it with currents.

The dynamo room contains eleven dynamos of the new moderate speed, four-pole type, made by the General Electric Company. They are run by a Corliss engine through a system of belting and ceiling countershafting. Six of these are 20-kilowatt machines and four are 25 kilowatt. The eleventh dynamo is a similar 20-kilowatt machine used for exciting the fields of the other dynamos. The normal potential is 250 volts, and is lowered in any particular dynamo when slower speed of the motor connected to that circuit is desired. This plant has been completed but a short time, and it was not possible to obtain any accurate figures showing the power used by the motors under various conditions of speed and load. Formerly the machines were run by individual engines, and much difficulty was experienced in starting them, as the pressure of the printing rolls against the cloth is so great. With electric motors this difficulty is overcome, as the motors will stand a very heavy overload for a short time, and the starting torque is very great. The great advantage of the electric system as here used is not so much in the saving of power as in the convenience to the workmen, and hence the increased production. The saving of power, however, is quite considerable, as in the old system steam was piped several hundred feet to the small individual engines, which were necessarily inefficient under the best conditions, and added to this the engines were run part of the time with partly closed throttle, still further decreasing the efficiency. With the present system the attendant at the machine may quickly vary the speed any amount by turning the rheostat near the machine. Although this plant has been in operation only a short time, it is claimed by those in control that the production is materially increased. In a Paper by Mr. S. B. Paine in *Power*, June, 1895, he states that the increase in the production amounted to more than 25 per cent., and that the quantity of "seconds" (inferior product) was also considerably reduced. This is very important, as the men in charge of printing machines are skilled workmen of the higher order, and a small saving in wages for a given production is of more value than a considerable saving of power.

A visit to Baltic and Taftville was also made to see the practical working of the well-known power transmission plant between these places. At Taftville, where the Ponemah mills are located, there is not sufficient water power to drive all the machinery, so an electric plant was installed at Baltic, 4½ miles up the river, where a dam had been built, giving an available head of 34ft. The wheels are horizontal balanced turbines, two of them being rated at 800 H.P. each, while the third one is rated at 300 H.P. The wheels are belted to a long line shaft, which is in turn belted to the dynamos. The generators, of which there are two, are placed in a separate room. They are of the three-phase General Electric type and are capable of supplying 250 kilowatt at 2,400 volts. They have ten poles and run at 600 revolutions per minute, giving a frequency of 50 cycles per second. The field is excited by a 3 kilowatt bipolar dynamo belted from the generator shaft. The power is transmitted to Taftville by a very well constructed pole line. The motors are located in the basement of the Ponemah mill near the engines which they replace. They are belted to pulleys which are connected to their respective shafts by friction clutches in order to enable the motors to be started without load, as they are of the synchronous type. The motors are identical with the dynamos, except in having an induction winding of heavy bars sunk in the pole-pieces, to cause them to be self-starting. In starting the motors, the switch in the induction circuit is closed and then the line is connected to the armature, causing it to start as an induction motor, without a very great torque, however. When the motor has nearly reached full speed the field is excited and it will speed up until it falls into step, and then the induction switch is opened. This method of starting has two advantages: first, no auxiliary motor is needed; second, no device is required to tell when the motor is in synchronosm with the generator.

One of these motors drives 1,200 looms, requiring an expenditure of about 155 H.P. The other drives 500 looms and also the railway generators for the Norwich Electric Railway Company. The introduction of this plant has enabled the Company to concentrate all its power for use in one mill, tending to decrease the cost of production, diminishing transportation charges, and avoiding the use of any coal for steam power.

Conclusions.

First Cost.—Practically the only objection which can be urged against the electric system is the fact that the first cost of installation is greater than with ordinary belting and shafting, but even this is questionable, since the authors know of cases in which the estimated total cost of installing the necessary belting and shafting was actually greater than the equivalent electric motor outfit. The electric system would be cheaper, for example, in the case of very long or scattered buildings or those containing many stories or rooms, in any of which cases the belting and shafting required would be very complicated and expensive. The use of belting and shafting requires a much stronger and more expensive roof or ceiling than the electric system.

Saving of Power.—It might seem that the electric system would actually consume more power than the ordinary plan, since it involves two transformations of energy. In most cases, however, if the power has to be distributed to a number of machines, particularly if they are located at any distance from the engine, the loss of power is less with electric transmission. This is explained by the high efficiency of the dynamo and motor compared with the low efficiency of belt transmission as ordinarily practised, involving as it often does very imperfect alignment and lubrication of the shafting. Perhaps the greatest saving, however, of the electric system is due to the fact that the consumption of energy entirely ceases when the tool stops. This stoppage in the case of the busiest tools amounts to at least 25 per cent. of the nominal working hours throughout the year, and with large or special tools which are not used so steadily the stoppage is often as high as 50 to 75 per cent., since there are many whole days when they are not used at all.

Idleness due to strikes as well as to slack times must also be considered, and would usually amount to quite a large percentage in 10 years, for example. This assumes, of course, that a portion of the shop is running, which is usually the case even under such conditions. In short, with the mechanical system there is an enormous amount of shafting, idle pulleys and belting which runs for long periods of time doing little or no useful work, but consuming considerable power. Wherever electric motors can be substituted for a number of small engines scattered about, the saving in power is very great, not only because of the low efficiency of small steam engines, but also by the avoidance of condensation in long steam pipes.

Increased Output.—This is, perhaps, the most important advantage gained by the electric system, since after all the cost of power is a very small item, being, according to Mr. Richmond,* only about 1 per cent. of the wages paid in average machine-shop practice. This increased output is secured by the greater convenience and promptness in starting and stopping, as well as in regulating the speed of the machinery. The workman can, for example, temporarily increase the speed when the conditions are favourable, thereby saving considerable time.

Flexibility.—The great convenience of moving the tools and placing them in any desired position is another great advantage of the new system. The great adaptability of this system is par-

* *Engineering Magazine*, January, 1895.

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ticularly well shown in the case of a factory which was almost completely destroyed by fire; nevertheless, a few uninjured tools in a remote end of the building were operated successfully by means of electric motors within two days after the fire.

Speed Regulation.—The ordinary type of motor used in factories is the plain shunt-wound machine, fed with constant-potential current. The motor is started, and varied in speed by means of a rheostat in the armature circuit. This simple arrangement answers very well in most cases, but for variable speed between wide limits a series-wound motor controlled by a rheostat, as in electric railway practice, may be preferable. In other cases some special method of regulation, such as the Leonard system or the "boost and retard" plan, may be adopted.

In concluding, the authors wish to express their sincerest thanks to the various companies for the courtesy shown by them, and for the kind assistance which they rendered during the tests.

BIBLIOGRAPHY.

The most important Papers on this subject which have appeared up to date include:—

"Electricity in Mill Work," by C. S. Hussey, read before the N. E. Cotton Manuf. Association, April 29, 1891.

"Electric Machine Tools," by S. S. Wheeler, *Electrical Engineer*, N.Y., April 12, 1893.

"Development of Electric Machine Tools," by S. S. Wheeler. *Electrical Engineer*, N.Y., October 4, 1893.

"Power Losses in Transmission Machinery," by Wm. S. Aldrich, *American Society of Mechanical Engineers*, June, 1894.

"Electric Power in Factories," by T. Richardson, *Electrician*, London, October 19, 1894.

"Electricity in the Iron and Steel Industry," by D. Shelby Biggs, *Engineering Magazine*, December, 1894.

"Electric Power in Factories," by G. Richmond, *Engineering Magazine*, January, 1895.

"Direct Electric Driven Machines," by W. E. Hall, *Cassier's Magazine*, February, 1895.

"Electricity in Textile Manufacturing," by Dr. Louis Bell, *Cassier's Magazine*, February, 1895.

A Paper by S. B. Paine, read before the N.E. Cotton Manuf. Association, appears in *Power*, June, 1895.

AN APPARATUS FOR MEASURING DIFFERENCE OF PHASE BETWEEN ALTERNATING CURRENTS.*

BY LOUIS DERR.

Most of the methods hitherto employed for the measurement of difference of phase between alternating currents (*vide La Lumière Electrique*, March 10 and 17, 1894) assume that the currents measured are truly sinusoidal in character, or demand exceptional conditions of steadiness. The method here described is applicable to the measurement of periodic currents of any form whatever, and can be used under ordinary conditions. The apparatus is a modification of that employed by Dr. J. Puluj for a similar purpose, and described at length in the *Elektrotechnische Zeitschrift* for December 1, 1893. Dr. Puluj's apparatus consists in brief of a pair of electro-magnets, each carrying a flat steel spring at the free end of its core, a small mirror being mounted on the spring. A beam of light is reflected from one mirror upon the other, and thence to a screen. If alternating currents are sent through the magnet coils the springs will be set vibrating, and the spot of light on the screen will be lengthened into a line if the springs are parallel; and if the springs be turned so that the vibrations are perpendicular to each other, the line becomes an ellipse whose dimensions afford a measure of the difference of phase between the currents in the coils. It is evident that to maintain an ellipse sufficiently stable to permit measurements of precision requires great steadiness in the currents, a condition not always obtainable. The springs give best results when their period of free vibration is that of the current or its octave, and slight changes of the current period will throw them out of tune, instantly affecting the amplitude of vibration, as the inertia of the moving parts is very small. Belt slip at the generator, irregular load or changes of steam pressure, make precise measurements very difficult.

To obtain results without the steadiness demanded by the above method, the following modification was devised by the writer, and successfully used by Messrs. L. R. Nash and J. C. Nowell, of the class of 1894, in their thesis. The two electro-magnets were placed side by side, and the beams reflected from their mirrors received upon a prismatic mirror, and thence sent to the screen. This is shown in plan in Fig. 1. In this case the spots of light which appear on the screen when the mirrors are at rest are elongated into two vertical lines when currents are sent through the magnets, and these lines are drawn out into curves which flash across the screen when the prismatic mirror is rotated. As the motion of the springs is harmonic, these curves are sine curves, and thus bear no necessary resemblance to the original wave form.

* Abstract from *Technology Quarterly*.

The theory of measurements is as follows: If the spots of light on the screen are in the same vertical line when the prismatic mirror is at rest, the curves produced by revolving it will have the same time origin, and will be parallel if they are in the same phase. Any time lag of one behind the other will be shown by a lateral shifting of the lagging curve ahead of the other, and if a variable inductance is inserted in the circuit of B, the B curve will be seen to move farther and farther ahead of the A curve as the inductance is increased. The difference of phase is thus evident to the eye, and to obtain a direct measure of it requires only a knowledge of the angle through which one curve must be shifted to bring it into parallelism with the other. This is readily expressible in degrees by finding the angle through which B must be turned to bring E and F (Fig. 2) into the same vertical, and then finding the angle through which B must be further turned to bring G and E into the same vertical, the first adjustment giving the portion of a wave length by which the two curves are separated, and the second

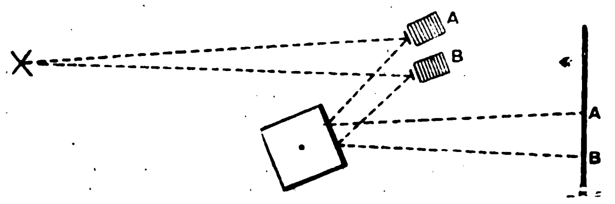

FIG. 1.

the value of the whole wave length. Calling these quantities c and d respectively, the phase difference of the curves on the screen is, in degrees, $360c/d$. One consideration is to be noted here, that as the vibrating springs execute a complete vibration for every reversal of the current, their vibration frequency is just twice that of the current, and hence the phase difference of the curves on the screen is twice that of the currents measured. The desired value is thus $180c/d$.

As c and d are too small to be directly measured with precision, a multiplying device is necessary. Mirror B is turned by a gear wheel meshing with a small pinion which carries a long pointer moving over a divided scale. With this device a wave length on the screen is covered by a displacement of 13cm. of the end of the pointer.

The procedure is as follows: With the prismatic mirror at rest, send the currents to be studied through A and B respectively. Turn B until the lines on the screen are in the same vertical, and take the pointer reading m. Start the revolving mirror, and when the curves are sufficiently elongated to permit convenient comparison turn the pointer until the curves are parallel, and take the reading n of the pointer. Turn the pointer still further until the B curve

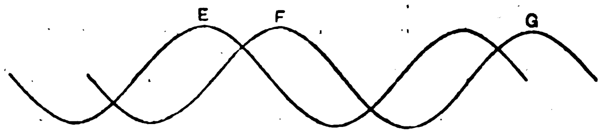

FIG. 2.

has moved through an entire wave length and is again parallel to the A curve and record the new reading p of the pointer. Then the phase difference in degrees between the currents is

$$180 \frac{m-n}{n-p}.$$

The results of these measurements plainly depend on the accuracy of bringing the curves into parallelism. This adjustment can be satisfactorily made by moving A vertically until the curves are brought close together. The apparatus was applied to the measurement of the lag between the branches of a three-phase circuit. Perfect symmetry in the dynamo windings would give 120deg. in each branch, and in any case the sum of the three lags should be 360deg. The values actually obtained are 119·22, 120·44, and 119·44. The sum of these is 359 00, the average deviation (0·92) in this case being not far from the real error.

Among the advantages of the method described above are: (*a*) Since the wave form does not enter the calculation, any source of periodic current may be employed, whether sinusoidal or not; (*b*) slight changes in the electromotive force do not impair the measurements, for their effect is only to vary the amplitude of the curves, a quantity of small consequence; (*c*) constancy in the speed of the revolving mirror is unnecessary, since irregularity affects both curves alike and does not alter their parallelism; (*d*) the approximate value of the lag can be seen at once, as well as the quadrant in which it lies; (*e*) the curves need not fall successively in the same positions on the screen, as no measurements are made there, hence the speed of the revolving mirror need bear no definite ratio to that of the springs; (*f*) the apparatus is simple and easily constructed.

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SPECIAL NOTICE.

With this week's number of "THE ELECTRICIAN" is issued (gratis) Supplement Sheet Tables showing Total Capital Outlay and Receipts and Expenditure for the year 1894 of the principal Statutory Electric Supply Undertakings in the Provinces. Complaints of non-receipt should be promptly addressed to the Publisher.

THE PROVINCIAL ELECTRIC SUPPLY BUSINESS.

We publish this week an analysis of the accounts of some nineteen provincial electric supply undertakings in a form similar to that of the analysis of the London companies' accounts published in our issue of June 28th, in accordance with our annual custom since 1892. When we first contemplated this task we had not a few misgivings. At the end of 1894 there were some seventy electric lighting concerns operating in the provinces, and the study of the detailed analysis of seventy capital and revenue accounts set out with all the minuteness required by the Board of Trade seemed likely to send most of our readers away to the seaside with a severe statistical surfeit. To avoid such an undesirable consummation we decided to pass a self-denying ordinance, and to admit no company or municipality to the ordeal—and honour—of financial dissection at our hands unless it had been engaged in the electric supply business for at least a clear twelvemonth, and had an output of the same order of magnitude as that of the least of London's electrical undertakings, that is to say, an output of 100,000 Board of Trade units. In this way about one-half of the Provincial undertakings at work at the end of 1894 were disqualified; and the final outcome of our statistical labours is a detailed analysis of the accounts of eight corporations and eleven companies. Reluctant, no doubt, to raise the envy of its less fortunate neighbours by an irritating display of unequalled figures, the Corporation of Dublin could not bring itself to transmit us a copy of its accounts. Again, owing to their accounts being made up to the end of March or May, several other Corporations, such as Glasgow and Halifax, are still, or were until the last day or so, without a complete financial *exposé* of the past year's working of their electric lighting departments. A few companies also showed a similar dislike to gratuitous advertisement. On the other hand, we have to thank those engineers and officials who were good enough to assist us in our self-imposed task.

Notwithstanding the rapid strides made by the electric light in the provinces within the last two years, the aggregate

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	Per yea	Rent, &c., Tra	Details of generating expenses.		Per cen	Cos Board	Oil	Per cen	Cost of per	Salar	P gener	Sala per	Repa	gener	Cost ma Boar
	%	d.		£	%	d.	£	%	d.	£	%	d.	£	%	d.
BIRMINGHAM	40·8	2·00		1,616	54·8	0·97	289	9·81	0·17	581	19·7	0·35	459	15·6	0·27
BOURNEMOUTH	7·43	0·44		1,785	47·3	1·99	387	10·2	0·43	867	22·9	0·97	735	19·4	0·82
EASTBOURNE	19·7	1·07		849	48·1	1·38	102	5·78	0·16	649	36·7	1·05	163	9·24	0·26
HASTINGS	36·2	2·62		1,219	49·6	1·46	129	5·29	0·15	629	25·6	0·75	477	19·4	0·57
HOVE	14·4	0·76		606	41·0	1·20	113	7·65	0·22	525	35·5	1·04	232	15·7	0·46
LEEDS	4·11	0·12		708	26·9	0·58	214	8·13	0·17	1,442	54·7	1·18	266	10·1	0·21
LIVERPOOL	36·4	1·29		2,870	41·9	0·67	387	5·65	0·09	1,091	15·9	0·25	2,493	36·4	0·58
NEWCASTLE-ON-TYNE[12]	8·97	0·26		953	33·9	0·57	260	9·26	0·15	1,132	40·3	0·67	462	16·4	0·27
NEWCASTLE-ON-TYNE[13]	25·3	0·79		1,284	44·8	0·75	355	12·3	0·28	953	33·1	0·56	286	9·93	0·17
OXFORD	15·7	0·65		428	33·1	0·65	29	2·24	0·04	451	34·9	0·68	381	29·5	0·58
PRESTON	11·8	0·48		752	40·5	0·81	154	8·29	0·16	800	43·1	0·86	149	8·02	0·16

[1] This includes £1,603

[3] This includes £400 se

[5] This sum includes £3 ...ny.

[13] These figures relate to the undertaking of the Newcastle and District Electric Lighting Company.

[14] This includes £720 for depreciation.

[15] See footnote [14].

[16] This includes 26,113 units sold for public lamps.

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electric supply business of the metropolis, calculated on the basis of lamp connections, still exceeds that of all the provincial undertakings, municipal and joint stock, by some 50 per cent. But the metropolitan undertakings not only possess a more imposing total of lamp-connections, they individually do a bigger business. The average annual output of the ten companies and one vestry, which at the end of last year divided the electrical spoils of London between them, was something like one million and a quarter Board of Trade units, whilst the average for the nineteen provincial concerns included in our analysis this week is only slightly over 300,000 units; a figure which, owing to our exclusion of all outputs of less than 100,000 units, by no means represents the truly small average size of the seventy provincial stations at work at the end of 1894. Such being the case, it might have been anticipated that the capital expenditure per unit sold, and the average cost of the unit, would be considerably less inside London than outside. But this is not so. Even if we exclude the London Electric Supply Corporation, the average capital expenditure of the London undertakings per unit sold amounted last year to 5s. 1d., whilst the corresponding figure for the municipal and joint stock enterprises in the provinces is respectively 4s. 6d. and 5s.; if we include the white elephant which resides at Deptford, London must plead guilty to a capital expenditure of considerably over 6s. per unit sold. In regard to the average total cost of the Board of Trade unit, London fares somewhat better, the figure, excluding the London Electric Supply Corporation, being 3·95d., and including that concern 4·19d. Turning to the eight municipalities which figure in our table, it will be seen that the average cost of the Board of Trade unit is 3½d., and in the case of the eleven companies 4½d. Coal no doubt costs more in London than in the northern counties. On the other hand, it must be remembered that the output of the average metropolitan company is immensely larger than the output of the average provincial undertaking, and also that an appreciable percentage of the provincial undertakings are even further off from the coal fields than the metropolis. A clue to the cause of this disparity may, perhaps, be afforded by taking into consideration the sums set aside for depreciation and renewal. In London these sums are, indeed, none too magnificent; in the provinces they are conspicuous by their absence or extreme smallness, municipalities erring almost as much in this matter as companies, the sinking funds of the municipal concerns being taken as equivalent to the depreciation funds of the companies. To what an extent this consideration affects the total cost of the Board of Trade unit is well exemplified in the case of the Liverpool Electric Supply Company and the Newcastle and District Electric Lighting Company. Making no allowance for the sums set aside for depreciation in either case, the total costs come out at 3·56d. and 3·13d. respectively. But if we take into account the £3,838 set aside by the Liverpool Company, and the £720 set aside by the Newcastle and District Company, these figures are respectively reduced to 2·75d. and 2·71d.; nearly reversing the order of merit of the two Companies, and actually doing so if we further take into consideration the fact that while at Liverpool more than 12 per cent. of the gross receipts, at Newcastle less than 9 per cent. of the same was put aside. These are two exceptionally good instances of provincial electric lighting finance; were they not so exceptional, it would not be permissible to attribute as we do some of the unfavourable disparity referred to to the more prudent finance of the London companies, who have not hesitated to burden the Board of Trade unit with the cost of the depreciation of plant inevitably entailed by its production.

REVIEWS.

Hydraulic Motors: Turbines and Pressure Engines. By G. R. Bodmer. Second Edition. (London: Whittaker and Co., and Geo. Bell and Sons. 1895.)

This is the second, revised and enlarged, edition of a well-known and deservedly successful work on hydraulic engines. Mr. Bodmer has given to the public a sound and readable treatise on a subject in which the student had previously been obliged to seek instruction in the German of Redtenbacher, Zeuner, and Weisbach. He follows the method of treatment adopted by these authorities, but by simplifying much of the mathematical discussion of hydraulic theory he has appealed to a larger body of readers, without very seriously impairing the practical value of his work. So far as it goes, Mr. Bodmer's treatise will be as useful as the larger and more comprehensive works on the subject. We say, "so far as it goes," because we believe that this treatise does not go far enough, even for the practical engineering student. There is abundance of information about the turbine itself, but we look in vain for instruction in the important matters of turbine setting and the construction of hydraulic works for bringing the water to and conveying it away from the engine. The reader is given minute detailed directions as to how to design a turbine vane, or how to compute the guide and vane passages; but he is left in total ignorance as to what he is to do with his turbine when he has made it. He is enabled by a mass of elaborate mathematics to predetermine the high theoretical efficiency which a given arrangement and shape of guides and vanes will conceivably possess; but he is not shown how that if his outlying works are not constructed properly this theoretical efficiency will for all time be an imaginary one, and the available head on the mill site will be frittered almost all away before ever the water gets to the beautiful engine. Engineers are far more frequently concerned with the erection of turbines than with their actual internal construction; and a work which treats the turbine as if it were a self-contained affair, a thing complete in itself when you buy it "out of the shop window," cannot appeal to such an extensive class of practical engineers as it would if approached the subject in all its bearings. It may serve as a useful guide to the hydraulic engine builder, but as an engineering treatise the book must be considered incomplete. To be quite fair to the author, and to prevent misunderstanding, we should add that he does give mathematical data in regard to the flow of water through pipes and outside passages; but these are a quite inadequate guide to the proper design of the external works.

But when we turn to the chapters on the various types of turbines, we find a great deal of useful practical information. In the chapter on "Turbines in General" the scheme of classification is drawn up, the author adopting the division under "reaction" and "impulse" turbines. A turbine is distinguished from a water-wheel by the consideration that "motion of the water *relatively to the buckets is essential* to its action," which is the most scientific and best definition we have met with. The conditions involving losses of energy in, and the details of design of, the two classes of turbines are next considered; the mathematical portions of these parts of the book being elucidated by means of numerical problems. The author does not make it as clear as perhaps might be desirable, that in the class of engine which he has called the reaction turbine, the energy of the water is imparted partly by impulse and only partly by reaction; and, although he has stated that in the inward-flow reaction turbine a portion of the head at the vane entrance exists as pressure due to the motion of the engine, he has omitted to show the relation between this pressure-head and the impulse-head, upon which the best efficiency of such an engine very necessarily depends. The design and action of suction tubes, and their utility in combination with reaction turbines, are matters of importance which receive due consideration. The chapter on "Descriptions of and Experiments with Turbines" is a long one, occupying some 126 pages; but it deals with important questions in a useful manner. In this chapter will be

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found, in tabular form, the details of construction of turbines and particulars of tests of their performance and efficiency. This is by far the most valuable chapter in the book, and it should be welcomed by many an engineer as a carefully compiled collection of useful practical data. The chapter includes an interesting description of the Holyoke testing station, also a short description of the Niagara Falls installation.

The next chapter is on "American Turbines," a rather misleading name for turbines of the mixed-flow type. It is quite true that America is the home of these turbines; but it is also the birthplace of quite distinct types, such as the Pelton wheel. The author summarises the chief points in favour of and against the use of mixed-flow turbines, which, whatever may be said about them, are coming largely into use, and are better adapted to certain falls and classes of work than engines of purer type. Perhaps the worst thing that can be said about these turbines is the practical matter of the tendency of their manufacturers to use cast-metal vanes in stock sizes, instead of setting out the vanes anew for each different speed and fall. Of course, stock sizes are much cheaper than special designs; but the efficiency is liable to suffer badly if the engine selected does not happen to be quite suited to the work and the mill site.

A short concluding chapter deals with "Hydraulic Pressure Engines," or reciprocating water motors. This is not a subject of especial interest to electrical engineers; so we need not do more than repeat the author's observation that this part of his work "is intended merely as a sketch of this branch of hydraulic engineering."

We should add that this work forms one of Messrs. Whittaker's well-known "Specialists' Series," and is got up in the excellent style common to that library of technical books.

Meteorology. By Thomas Russell. (London: Macmillan and Co.)

Mr. Russell's work may be recommended to those who require a book of reference; it is well paragraphed and well indexed, and brimful of those little statistical facts so dear to the transatlantic heart. On the other hand, this volume is not likely to prove particularly attractive to scientific dilettante seeking the latest thing in meteorology and requiring it to be dressed up in a thoroughly digestible form.

NOTES ON SOME EXPERIMENTS WITH ELECTRO-MAGNETIC MECHANISM.

BY P. V. McMAHON.

(Continued from page 351.)

Circular Taper Cores.

The next group of experiments were made with taper cores bent into an arc, the controlling force being a flat spiral spring instead of weights, as in the former experiments with the straight cores. This arrangement had the advantage of the cores being supported by the pivots, and not by an expenditure of energy; also the controlling force increased in proportion to the distance travelled by the core. It can be seen from inspection of the curves, especially in the case of the 5in. and 14in. cores with different springs, that the curve may be made almost any shape by a proper choice of core and spring.

In the first set two cores of Lowmoor iron 8in. long, ⅛in. diameter at the top and ½in. diameter at base, were bent into an arc of 3in. radius; the bottom part of the core was turned down to form a stud, and screwed to take a brass nut, so that the cores could be secured to cross-pieces of different shapes, sizes, and material. This cross-piece had a hole $\frac{3}{16}$in. diameter in the centre, through which passed a $\frac{3}{16}$in. iron spindle about 4in. long; on this spindle the controlling spring and pointer were fixed, and the whole supported in pivoted bearings. Fig. 10 shows arrangement. The spring was secured to a brass sleeve, which could be fixed in any position by a set screw on the spindle; in this manner an initial tension could be given the spring (at the start). The spring first used was 0·315in. wide by 0·02in. thick, 2½in. diameter over outside convolution, and ¼in. diameter in inside (or hole). It had 14 complete convolutions, and was clamped by a small clip attached to the side bearing. In this manner any number of convolutions (or length of spring) could be used. It is also well to notice that the spring was rigidly secured at both ends, and the turning moment was proportional to the amount of winding up. In fact, to prove this the spring itself was calibrated, by putting a small wooden drum on the spindle and attaching a scale pan by a piece of thread to the drum, weights were placed in the scale pan and the angle turned through by pointer observed; the results when plotted gave a straight line, every 10deg. corresponding to 0·21 inch-ounces torque.

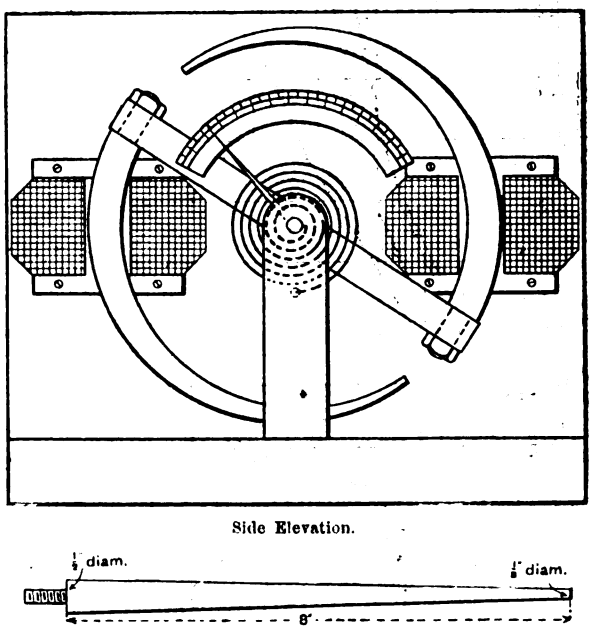

Fig. 10.

The four curves plotted on Fig. 12 show the effect of cross-pieces of different cross-section and material. In all the following experiments with the two 8in. taper cores, the controlling spring was turned through 170deg.; thus at 0deg. on the scale the coil had to exert a sufficient pull to overcome a resistance equivalent to 3·57 inch-ounces torque, and the point of the core was about 0·4in. from the top of the coil. In addition to the scale of degrees on the curve, the equivalent travel in inches of the core is given, and on the right-hand side the torque exerted by the spring against the pull of the coil is given in inch-ounces.

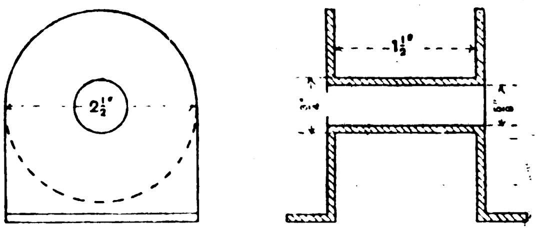

Fig. 11.—The coils first used were each wound with 1,350 turns of No. 26 B.W.G. double cotton-covered copper wire, and had a resistance of 20 ohms at 22°C.

In the bottom left-hand corner is shown the position of the coil, so that the actual position of the core in the coil can be seen by observing the position of core point, which is given by reading the scale of inches. These remarks apply to all curves where one coil was used, except in the case of curve *b* (Fig. 14), which is that obtained by using a zig-zag cross piece; here the point of the core was one inch outside the coil when the pointer was at zero. This divergence is due to the shape of the cross-piece not allowing the core to come far enough back.

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Referring to Fig. 12, the curve *a* had brass cross-piece $\frac{1}{2}$ sq. in., *b* had iron cross-piece $\frac{3}{8}$ sq. in., *c* had iron cross-piece $\frac{5}{8}$ sq. in., and *d* had iron cross piece $\frac{1}{2}$ sq. in. In this set, for a variation of excitation of 1,250 ampere-turns, the travel of *a*, or brass cross-piece, was 3·95in., and the curve obtained is nearer a straight line than that obtained with any of the other cross pieces. In *b* (the $\frac{3}{8}$ sq. in. iron cross-piece) the travel for 1,250 ampere-turns variation of excitation was 4·55in.

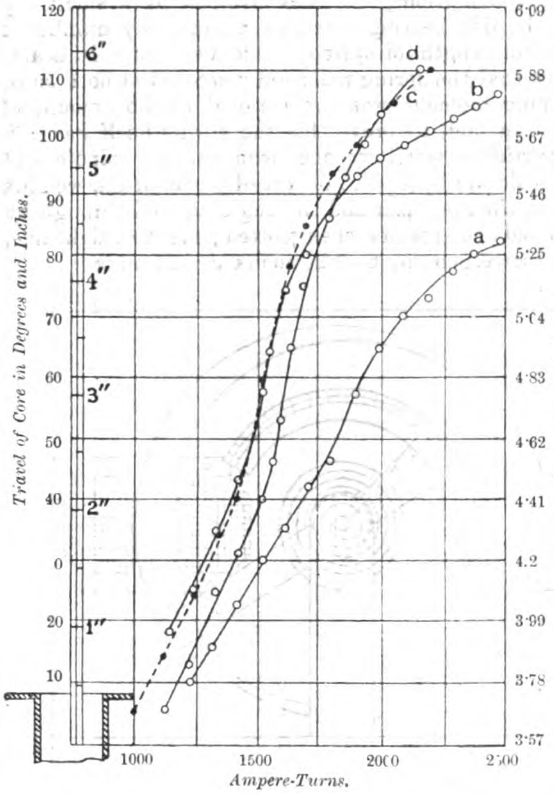

FIG. 12.

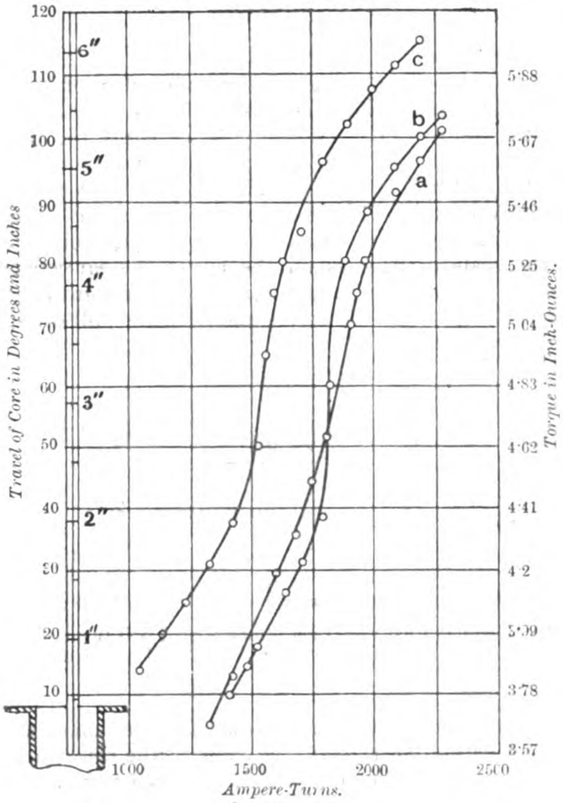

FIG. 13.

With the $\frac{5}{8}$ sq. in. iron cross-piece between the cores (curve *c*) the travel for the same variation of excitation was 5·7in., and with the $\frac{1}{2}$ sq. in. iron cross-piece between the cores (curve *d*) for a variation of 1,250 ampere-turns the travel was 5·7in.

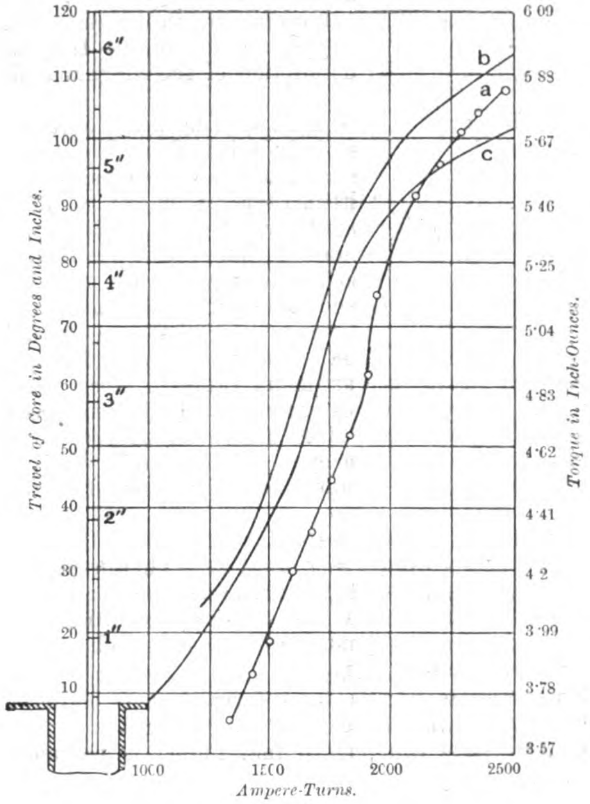

FIG. 14.

Turning our attention to the shape of the curves, it is obvious that curve *a* is nearest to a straight line, although the travel is much less than with the iron cross-piece; in fact, it is perfectly straight until the cross-piece is in a line parallel with the axis of the coils, then it bends off somewhat similar to the curves obtained in the earlier experiments with the straight cores and weights.

Now when the iron cross-piece is used, it entirely changes the shape of the curve; we get a greater travel and a more irregular curve. Altering the cross-sectional area of the cross-piece does not seem to affect the arrangement very much, although it would seem as if the $\frac{3}{8}$ sq. in. iron cross-piece became saturated after travelling 5in., and the curve becomes a straight line. With the $\frac{1}{2}$ and $\frac{5}{8}$ sq. in. cross-pieces the curves are almost parallel to one another, and have the same travel.

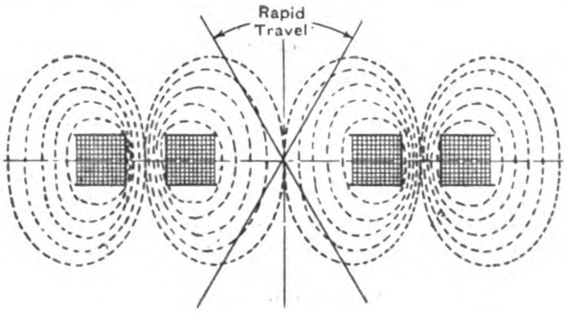

FIG. 15.

The most striking point observable with the use of the iron cross-pieces, no matter what shape or section, is the rapidity with which the cores move when the cross-piece is approaching and leaving the middle position between the coils, making the curve rise very quickly for about 2in. A feasible explanation of this rather peculiar behaviour would seem as follows:—

Mapping out the line of force due to each coil, as shown in sketch (Fig. 15) the magnetic field between the coils is weak, and that on each side near the coils strong. **When the iron cross-piece is nearing mid-position it passes rapidly through**

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the weak field into the stronger on the other side, so that the rapid travel is not due to the cores, but the iron cross-piece.

To try to overcome this effect due to the weak field between the coils, discs of charcoal iron were placed on the end of the cores and on the spindle between the coils. The results are shown in Fig. 13, curves b and c, and curve a is that obtained with the ½ sq. in. iron cross-piece, as in Fig. 12, curve d. In the experiment b a charcoal iron disc 1½in. diameter, No. 20 B.W.G., was placed on the end of each core, as shown in Fig. 16; this, as might be expected, made matters worse.

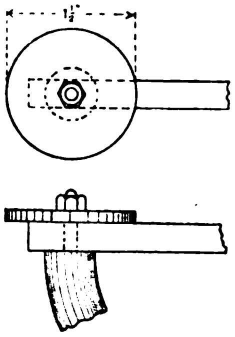


Fig. 16.—Disc on End of Core.

Inspection of the curves makes it clear that b travels more rapidly in the middle than a, and slower at the beginning and end. The travel of the core for a variation of 900 ampere-turns was 5in., that of a being 4·9in. for the same variation of excitation. The use of the disc on the end of the core gives about the worst result, bearing in mind that one of the objects in view is to obtain a straight line.

Next, two iron discs, No. 20 B.W.G., 3in. diameter, were placed on the spindle close to the cross-piece as sketched

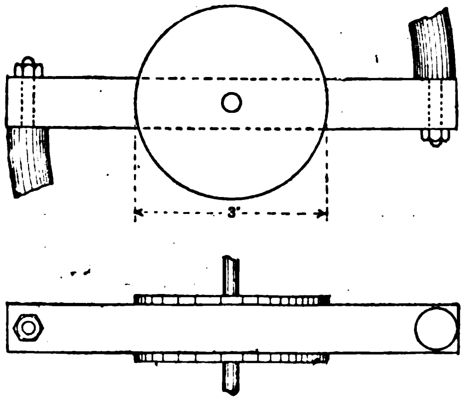


Fig. 17.—Discs between Coils on Spindle.

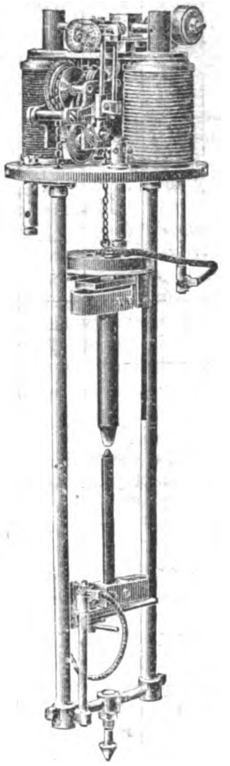
(Fig. 17), the object being to make the magnetic field between the coils more uniform. Curve c shows the result.

The travel for 900 ampere-turns variation was 4·9in., being the same as without the discs. The only effect produced by these discs is to cause the curve to rise more slowly at first, and decrease bending over towards the end of the travel.

(*To be continued.*)

THE BRUSH-VIENNA ARC LAMP.

This lamp is designed either for continuous or alternating currents, and is intended to burn 10 hours normally, but can when the carbons are so proportioned burn from 16 to 20 hours. The lamp consists of a circular plate below which are fixed the guide rods for the carbon-holders and above the regulating mechanism. This latter consists of a series coil and a shunt coil, into which are suspended iron cores fixed to a balance beam. This again is connected by means of a rod to a train of wheels which actuate the two carbons. A second rod is connected to a brake block which acts on the friction wheel of the clockwork. The action of the lamp is as follows: On closing the circuit, the shunt coil sucks in its iron core, raises the further arm of the balance beam and lifts the brake block off the wheel allowing the carbons to approach each other. As soon as the carbons touch, the series coil sucks in its iron core and raises the other arm of the beam, clamps the brake wheel, and by means of the first-mentioned rod lifts the entire clockwork, drawing the carbons apart, and striking the arc. After a certain time the balance gets into a horizontal position. The brake block scarcely touches the wheel, and the feed goes on automatically. The normal length of the arc is, in the case of continuous currents, 2·5mm. to 3mm.; for alternating currents it is only 1mm. to 1·5mm. With a longer arc alternate-current lamps burn with a violet light. The regulation of the lamp is affected by a counterweight. To obtain with a given current a higher electromotive force across the arc—*i.e.*, a longer arc—the weight should be moved along its rod away from the lamp. If further regulation is necessary lead washers can be used. The same procedure holds good if with a constant electromotive force a smaller current is desired. On the other hand, to obtain a shorter arc and a larger current the weight should be moved in the opposite direction, removing, in addition, if necessary, several lead washers. On a 100-volt circuit the direct-current lamps can be run two in series, and the alternating-current lamps three in series.



The mechanism of the lamp will be made somewhat clearer by aid of the accompanying illustration, from which it will be seen that the brake piece which is attached to the right hand rod slides up and down the left-hand rod, which is the one which, actuated by the series coil, lifts the train of wheels when it is required to strike the arc.

NOTES ON THE EFFICIENCY OF ELECTROLYTIC APPARATUS.

In the May number of the *Journal* of the Society of Chemical Industry will be found some "Notes on the Efficiency of Electrolytic Apparatus," by Dr. Hurter, which were read before the Liverpool section of the Society, and which the position of the author, and the circumstance that they furnish the results of experiments made in the laboratory of the United Alkali Company, render of exceptional value. The author points out that "the commercial value of any electrolytic process depends, firstly, upon the cost at which the electrical energy can be produced, and secondly, upon the efficiency of the apparatus which serves to transform the electric energy into potential chemical energy, *i.e.*, the electrolytic cell. The commercial value of an electrolytic process depends further on the first cost of the apparatus, the cost of maintaining it, the length of its life, and finally, upon the amount of manual labour involved in the several transformations of energy, which together constitute the process." There is, therefore, great difficulty in judging between processes. As regards the first cost of an electrolytic cell, this can be fairly well ascertained, but the

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cost of maintenance and length of life are generally problematical items.

Dealing with the different methods of expressing the result obtained by electrolytic processes of manufacture, the author prefers to state the produce per kilowatt-hour, or *vice versâ*, the number of kilowatt-hours used per kilogramme of the article to be manufactured. The energy consumed in a cell depends, as is well known, on its construction and the polarisation or back electromotive force. In estimating the value of any process, therefore, it is necessary to know the current required, the electromotive force of polarisation and the resistance of the cell, and as there are no reliable data at present from which these factors may be calculated, it is impossible to predict with precision the working of a given process in a given cell.

The author has made what he calls "current efficiency" the subject of special investigations, the result of which will be published later. If the products of electrolysis could be instantaneously removed, the exact electro-chemical equivalent would always be obtained. This has not hitherto been accomplished, though the Castner cell, in which the caustic soda separated forms an amalgam with the moving mercury electrode, is the nearest approach to it. The theoretical importance of the migration of the ions, which was investigated by Hittorf in the years 1853 to 1859, has only recently been recognised, while its technical importance is only just dawning on us; and yet these phenomena are one of the causes of low "current efficiency." In his experiments Hittorf frequently separated his electrodes by four or five diaphragms, so that only the instantaneous removal of the products of the electrolysis can prevent the migration and consequent loss of efficiency. Another important factor is the back electromotive force of polarisation, which, it is now admitted, cannot be accurately calculated from thermo-chemical data. Grave errors are generally avoided, by considering not what takes place in the cell, but what would have to be done with the products of the electrolysis, in order to reform the raw material employed. As these calculations never produce absolutely certain results, it is better to measure the electromotive force of polarisation directly, and for this purpose the author prefers the following method:—

Through a long trough a current is passed between two electrodes. Between these electrodes another very small auxiliary electrode (the position is immaterial) is inserted, which is connected with the anode through a voltmeter of 1,000 ohms resistance, the instrument is observed, and then connected with the cathode in the same way, taking another reading. The potential difference between the terminals of the cell is also measured. Let V_t be the volts between the terminals of the cell, V_a the difference of potential between the auxiliary electrode and the anode, V_k the potential difference between the auxiliary electrode and the cathode; then the electromotive force of polarisation for the electrodes and electrolytes under observation is found to be

$$e = V_p = V_t - (V_a + V_k).$$

A few examples of such measurements are given.

On a large scale the following methods are available: (1) The normal current is passed through the cell under examination, and after the cell has arrived at its normal condition, the current is interrupted, and immediately afterwards the electromotive force is measured with a voltmeter. By this method the value of e usually found is too small. (2) Currents of very different magnitude are passed successively through the cell, and the potential difference at the terminals of the cell is determined, when we get the expression, $e = (V_1 A_2 - V_2 A_1)/(A_2 - A_1)$. If possible, it is best to make three observations, one with a current smaller than the normal, and one with a greater. The electromotive force e is not found as absolutely constant, but increases with the current. The latter method has the advantage of allowing the last of the factors which are required, namely, the resistance, to be calculated. Although the specific resistances of some of the parts of the cell are known, still so much depends on the form and construction that it is not possible to predetermine the resistance of a cell as a whole with any degree of accuracy, and this is more especially the case where diaphragms are employed. The resistance of a cell is chiefly due to the resistance of the electrolyte and to the diaphragm, the resistance of the metallic parts being almost negligible. The resistances of liquids decrease with rise of temperature, and for their determination Kohlrausch's method is the best. The resistance of the diaphragm follows no special law.

As in many processes carbon is the only material available for the construction of the anodes, the author carried out a number of experiments on plates and rods supplied by different makers with a view to determining their resistance and durability. The detail of the experiments and the results are given in tabular form, for which we must refer our readers to the original Paper; but we may state that the carbons of highest conductivity prove more liable to disintegration, but when they have undergone a special heating by a powerful current, or in an electrical furnace, they resist disintegration better, and their conductivity is improved. With regard to diaphragms, their resistance constitutes a considerable, if not the greatest part of the total resistance of a cell; but the less the resistance of the material the less efficacious is it in preventing the ready diffusion of the liquids. Tabulated results are given of experiments tried with diaphragms formed of various woods when used in sheets of $\frac{1}{4}$in. or $\frac{1}{16}$in. in thickness, but the resistance was found in every case to be very high; for instance, a sheet of only 0·006in. would have to be used to keep down the resistance to that of a Portland cement diaphragm of 0·375in. thickness.

CORRESPONDENCE.

STANDARD SCREW THREADS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The great principle of the division of labour has asserted itself through almost every branch of manufacture, commencing with those where the demand for production of large quantities at cheap rates has rendered the system of producing interchangeable component parts of any apparatus of extreme importance. The American clock and watch trades afford a good example of this. The manufacture of pieces of apparatus which necessarily have to be made in small numbers, or even singly, now requires that the parts going to form such apparatus shall be interchangeable and made on accurate systems.

Among the most important of the component parts of instruments and apparatus of a similar character, are the screws which are used to hold the various parts together, and it is in this direction that attention is necessary.

The British Association in 1884 did good work in laying down systems of diameters and pitches well suited for screws of small diameters, and these are now known as B.A. threads. However, much is left still to be done.

B.A. screws bought to-day from any good makers are not necessarily of the same dimensions as those supplied on a similar order, by the same maker, a month or so ago, and the difference is often fairly large.

The fault does not, in most cases, lie with the screw makers, inasmuch as hardly any two customers who are particular as to accuracy will be satisfied with the same size of screws, even though they are nominally of B.A. threads.

The fault lies in the want of accurate recognised standards for comparison, and in the total want of uniformity in the screw plates nominally termed standards, and sold as such.

To establish a system of reliable standards in accordance with the dimensions laid down by the original Committee would be a work of the greatest importance to both makers and users of B.A. screws, and would undoubtedly tend to assist the production of work having a greater degree of accuracy, and I feel sure that any movement in the direction of removing some of the present difficulties in the matter of small screws would receive the ready support of all interested in high-class work.—Yours, &c., G. K. B. Elphinstone.

London, August 7, 1895.

LEGAL INTELLIGENCE.

Wandsworth District Board of Works v. County of London and Brush Provincial Electric Lighting Co., (Limited).

Mr. Justice STIRLING, in the Chancery Division on Saturday last delivered a reserved judgment in this case, which it will be remembered was a motion by the plaintiffs, asking that the defendants, their servants, &c., might be restrained by injunction from excavating, or constructing or placing in or under any highway within the plaintiff's district any transforming or converting stations or other chambers or receptacles for the purpose of containing transformers.

The arguments on the motion were reported in the last issue of *The Electrician*.

His LORDSHIP, in giving judgment, said that the question was really one of construction of the Order which was granted by the Board of Trade and confirmed by Parliament, and which had all the efficacy of an Act of Parliament. After referring to the scheme of the order, the learned judge said it was obvious that great powers were vested in the Board of Trade. First of all, the system of electric lighting was to be that whic

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had met with the approval of the Board of Trade, and it was only to be used subject to such regulations as might be imposed by that body; and, secondly, where the operations of the undertakers involved the placing of works under, along, or across any street, the undertakers were to furnish details of what was proposed to be done to three bodies, viz., the Postmaster-General, the Local Authority, and the County Council—and it was left to those bodies to approve or disapprove the plans; in the event of their being disapproved the undertakers might appeal to the Board of Trade, who had the function of adjudicating between the undertakers on the one hand and the three public bodies on the other. All that had been done in the present case. The Board of Trade has fixed upon the system to be adopted. They had defined it in the following manner:—"A high-pressure alternating-current supply at constant pressure to transformers, which will be placed either in converting stations or, when the houses or buildings to be supplied are widely separated, on the consumer's premises. From the converting stations a low-pressure supply at constant pressure will be given to consumers by means of distributing mains. The converting stations will be street boxes of sufficient size and suitable construction to contain several transformers, room being also provided to enable a man to enter the box and conveniently examine the transformers and controlling apparatus." According to the plans of the defendant Company the street boxes which were intended to be used, and which had been sanctioned by the Board of Trade, were receptacles made of iron, of which the dimensions were 10ft. in depth, 7ft. 6in. in length, and 5ft. 6in. in width, and they were to be used for the purpose of containing the transformers which were to change the electricity from high to low pressure. The objection raised by the Wandsworth Board of Works was that the Board of Trade, in sanctioning these receptacles, had authorised something which, according to the terms of the Order, the defendants were not entitled to use. That turned upon the construction of Clause 12. The notice of motion raised two points—first, that the receptacles were not "boxes" under the section; and secondly, that the use of them for the purpose of containing the transformers was not properly sanctioned. His Lordship dealt with those questions separately. First, were the receptacles "boxes" within the meaning of the Act? The "boxes" in common use at the time of the passing of the Order were of much smaller dimensions than those now proposed to be used. But there was nothing in the Act as to size, and it seemed to his Lordship that the question of size was entirely within the province of the Board of Trade. Then it was said that the receptacles were really chambers, and were so designated in the first plans put forward by the Company, but the question was whether they might be described as "boxes." His Lordship thought they might fairly be so described, and the Board of Trade had not gone beyond their powers in sanctioning them. Secondly, might they be used for the purpose of containing the transformers? The uses to be made of "boxes" were defined in the latter part of Clause 12, viz. (*inter alia*), for "regulating, measuring, directing, or controlling the supply of energy." It was not disputed that if the boxes might be used for transformers, the instruments themselves were such as might be properly used. But it was said that none of the words in the Order described the function to which the transformers were appropriated. On the other hand, it was said by the Company that the transformers were apparatus for regulating or controlling the energy. Their effect was to diminish the pressure on a certain ratio depending upon certain conditions, and his Lordship came to the conclusion that the operation clearly came within the words "regulating and controlling," and the Board of Trade had not gone beyond their powers in sanctioning the use of these instruments in the "boxes." The motion was accordingly refused, and, by consent, the hearing was treated as the trial of the action, and the action was dismissed, with costs

Shelfer v. The City of London Electric Lighting Company (Limited), and Meux's Brewery Company (Limited) v. The City of London Electric Lighting Company (Limited).

The cases of Shelfer *v.* the City of London Electric Lighting Company (Limited) and Meux's Brewery Company (Limited) *v.* the City of London Electric Lighting Company (Limited) on Wednesday last again came before the Court of Appeal, composed of Lords Justices Lindley, Lopes and Rigby, on the application of the defendants that the restraint imposed by the Order of the Court dated December 18th last might be suspended until the second motion day of next sittings.

It will be remembered that the injunction was to restrain the defendants from erecting their machinery in such a manner as to cause excessive vibration, to the injury of the plaintiffs' property, the Waterman's Arms public-house, Bankside, Southwark; and when the case was before the Court last week their Lordships extended the stay until Wednesday last.

When the case was called on Lord Justice LINDLEY asked Mr. Fletcher Moulton, the defendants' counsel, what had been done in the meantime.

Mr. FLETCHER MOULTON said that he had affidavits to show that the defendants had done all they could. They had removed three of the four engines, and asked for time to remove the other. As usual, there was the usual conflicting evidence as to the extent to which vibration still existed. That being so, he hoped that their Lordships would in mercy to the parties appoint an independent expert who would either report to their Lordships or direct what was to be done. He did not think it was possible for their Lordships satisfactorily to ascertain what the facts were on affidavits when the affidavits were so completely contradictory as they were in the present case.

Mr. WARMINGTON, Q.C., who appeared for the plaintiffs (the respondents on the motion) said that whatever the defendants were doing on their premises the plaintiffs were still suffering, and he (the learned Counsel) had an affidavit to that effect.

Mr. FLETCHER MOULTON said that it was not in his favour to ask for an independent expert, but it would enable the defendants to go to the realities of the case.

Mr. WARMINGTON said he agreed that something was done on July 28th, two days before the extension of time expired. What he was anxious about was that the defendants should be put upon terms. He thought that if their Lordships gave them (the defendants) till the Court met again after the Long Vacation it would be sufficient. The defendants had seen the affidavits filed by the plaintiffs, and knew that what they had done had not removed the vibration.

Mr. FLETCHER MOULTON said that the defendants asked for a suspension until the second motion day of the Michaelmas Sittings.

Mr. WARMINGTON said that he did not object to that, and

Their LORDSHIPS accordingly made an Order on the motion in those terms.

Mr. FLETCHER MOULTON asked if the plaintiffs would agree to the defendants having liberty to inspect their premises at reasonable times.

Mr. WARMINGTON: Oh, yes.

Bryson v. Crieff Police Commissioners.

This was an appeal case in which the pursuer, W. A. Bryson, consulting electrical engineer of Glasgow, appealed against the verdict of Sheriff-Substitute Grahame, who, it will be remembered, found that he had failed to prove employment by the defenders, either as individuals or jointly or severally, to perform the services which he alleged he had performed, or to incur the travelling expenses and incidental outlays charged in the account sued for in connection with the introduction of the electric light into Edinburgh. Sheriff Jameson, who heard the appeal, has issued an interlocutor, recalling his Substitute's finding as to expenses, but otherwise adhering to the interlocutor. The Sheriff finds the pursuer liable to the Commissioners in expenses, also to the defender Adie in expenses, and *quoad ultra* finds no expenses due.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.—Tenders are invited by the Vestry of Hammersmith, London, W., for complete schemes for public and private lighting, and for the supply of motor power in the compulsory area of the Vestry's Provisional Order. Further information is given in our advertisement columns, and full particulars can be obtained of Mr. H. Mair, Surveyor to the Vestry. Tenders have to be sent in by 6:30 p.m. of Wednesday, Sept. 4th.

——— It will be seen from our advertisement columns that the Vestry of St. Mary, Islington, invite tenders for the wiring of the Vestry Hall and municipal offices. Specifications, plans and particulars can be obtained from the electrical engineer to the Vestry (Mr. Albert Gay), 50, Eden-grove, Holloway, N., on and after 13th instant. Tenders, addressed to the electrical engineer, must be in by 12 noon on Tuesday, 27th instant.

——— The Commissioners for the Control of Lunatic Asylums, Dublin, invite tenders for wiring the Killarney District Lunatic Asylum for the electric light. Plans and specification may be seen at the Asylum or at the Office of the Engineer, Mr. W. Leake, 30, Victoria-buildings, Manchester, and tenders, addressed to the Secretary, Board of Control, Custom House, Dublin, must be in by 10 a.m. on the 30th instant. Further information is given in our advertisement columns.

——— The Electric Lighting Committee of the Wakefield Corporation invite tenders for the supply and erection of (*a*) boiler and fittings, mechanical stokers and engine, economiser, feed pump, injector, &c.; (*b*) steam alternators, condensers, oil filter, fittings, &c., steam, exhaust, feed, blow-off and sundry pipes, valves and water tank, &c.; (*c*) main switchboard and instruments; (*d*) cables, junction boxes, culverts, and trenching, &c.; (*e*) transformers and switchboard, &c.; (*f*) arc lamps and posts; (*g*) meters, and (*h*) overhead crane. Tenders, addressed to the Town Clerk, must be in by 2 p.m. on August 24th.

——— The Blackpool Corporation are willing to receive tenders for the right of user for a period of seven years of the electric tramways in Lytham-road, and which extend northwards from the southern boundary of the borough for about two miles. An approved overhead wire and trolley system is to be used for a portion of the route, and for the remainder the conduit or central channel system now laid down by the Corporation under the roadway. All particulars can be obtained of the Town Clerk, to whom tenders have to be sent in by August 17th before 12 noon.

——— The Vienna (Austria) Municipal Authorities invite tenders for a railway system worked by electric power in the municipal district of Vienna. Further particulars are given in our last issue, and tenders have to be sent in to the Wiener Stadt Bauamt, Rathaus, Vienna, not later than November 4, 1895.

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Tenders Invited.—The Dutch Minister of the Colonies invites tenders for the supply of a quantity of iron telegraph poles. Tenders to be sent to the Technical Bureau, Ministry of the Colonies, The Hague, by the 21st instant.

——— The Corporation of Portsmouth require tenders for laying about seven miles of stoneware ducts for electric light cables. Tenders, addressed to the Chairman of the Electric Lighting Committee, must be delivered by the 14th instant.

——— The Urban District Council of Portland invite tenders for the lighting of the district of Portland from September 1st to April 30, 1896 by electricity, gas or oil. Tenders must be sent in to the Office of the Council, New-road, Portland, by 13th inst.

——— The Allgemeine Elektricitäts Gesellschaft of Berlin invite tenders for the supply of high-pressure steam boilers for large central electric generating stations. Further particulars of the Company, 22, Schiffbauerdamm, Berlin, N.W.

Tenders Accepted.—The Building Committee of the Cardiff Free Library have accepted the tender of Mr. Thomas Brawn, of Birmingham, for wiring and fitting up the central library for the electric light. The amount of the tender is £253. 11s. 1d.

——— The Salford School Board have received the following tenders for wiring the new offices of the Board for the electric light, and for the fixing of electric bells and speaking tubes :—

Wiring.

	£	s.	d.		£	s.	d.
B. Verity and Sons (*accepted*)	£205	0	0	Drake and Gorham	£262	0	0
Brush Electrical Engineering Company	430	0	0	Maunsell Mercier and Company	260	0	0
Bennett and Druce	311	0	0	S. H. Heywood and Co.	247	10	0
Russell and Lennard	297	10	0	E. J. Dugdill and Co.	246	0	0
S. J. Waring and Sons	295	0	0	Northern Counties Electrical Engineering Co.	244	12	6
Lowcock, Hill and Co.	290	15	7	J. A. Edmondson	244	6	7
F. H. Royce and Co.	285	0	0	Paterson and Cooper	230	0	0
Corlett Electrical Engineering Company	282	0	0	Donnison, Parmiter & Barber	217	3	0
Liverp'l Gas Fittings Co.	270	10	0	Lund Bros. and Co.	197	0	0

Electric Bells.

	£	s.	d.		£	s.	d.
B. Verity and Sons (*accepted*)	£10	0	0	Drake and Gorham	£14	10	0
F. H. Royce and Co.	45	0	0	S. H. Heywood and Co.	14	6	0
Corlett Electrical Engineering Company	25	0	0	Maunsell Mercier & Co.	14	0	0
Bennett and Druce	24	0	0	Paterson and Cooper	13	7	6
Lowcock, Hill & Co.	23	11	5	Northern Counties Electrical Engineering Co.	12	18	0
Donnison, Parmiter and Barber	18	0	0	S. J. Waring and Sons	12	10	0
Lund Bros. and Co.	18	0	0	E. J. Dugdill and Co.	12	0	0
Brush Electrical Engineering Company	16	0	0	Russell and Lennard	10	17	0
				J. A. Edmondson	9	16	0
				Liverpool Gas Fittings Company	9	10	0

Messrs. Verity and Sons' tender for the fixing of speaking tubes, for the sum of £6, has also been accepted.

——— The Vestry of St. George's, Hanover Square, London, W., have accepted the tender of Messrs. Strode and Co., for wiring and fitting up the Vestry Hall and offices for the electric light, for the sum of £278. 5s.

——— The General Purposes Committee of the St. James's Vestry, London, S.W., have received the following tenders for wiring the Town Hall for the electric light :—

	£	s.	d.
Freeman and Co. (*accepted*)	£39	0	0
C. J. Smith	38	15	0
B. Verity & Sons	45	7	7

——— With reference to a Trade Note which appeared in our issue of July 26th announcing that a tender of Messrs. Thorpe and Waring had been accepted by the Metropolitan Asylums Board for the supply and running of mains and wiring of buildings at the North-Western Fever Hospital, Haverstock Hill, London, N.W. This information was obtained through the usual source, but, so far as it refers to Messrs. Thorpe and Waring's tender being accepted, is erroneous. The complete list of tenders, together with Prof. Ayrton's report to the Metropolitan Asylums Board on the subject, will be found on pages 500 and 501, and it will be seen that the Board have finally decided to accept the tender of Messrs. Fowler, Lancaster and Co., of Graham-street, Birmingham, for the sum of £859. 15s. This is £300 in excess of the lowest tender, but has been accepted as offering the best system for the work under the contract.

Tenders Received.—The Electric Lighting Committee of the Belfast Town Council have decided to recommend the acceptance of the following tenders for stores for the Corporation electricity works: Messrs. Shaw and Co., cast-iron pipes; Messrs. Doulton and Co., insulators; British Insulated Wire Company, copper strip; the Callender Company, cables; and Messrs. Coates and Son, road work.

——— The Electric Lighting Committee of the St. Helens Corporation recommend for acceptance the following tenders for the supply of electric lighting plant:—Yates and Thom, boiler-house plant; Johnson and Phillips, engine-house plant; S. Z. de Ferranti, switchboards; British Insulated Wire Company, underground work: John Fowler and Co. (Leeds), transformers; Chamberlain and Hookham, meters; Carrick and Ritchie, travelling crane.

Appointment.—Messrs. Burnett and Hooper have been appointed by the St. Pancras Vestry electricians at the King's Road station.

Appointments Vacant.—The Governors of the Woolwich Polytechnic are willing to receive applications for the posts of lecturer in physics (salary £110 for a session of about eight months) and lecturer in mechanics (salary £70 for a session of about eight months). Some further particulars are given in our advertisement columns, and applications must be sent in by the 23rd inst.

——— The Governing Body of the Northampton Institute, Clerkenwell, E.C., are prepared to receive applications for the appointment of a principal. The salary attached to the office has been fixed at £600 per annum. Applications must be sent in by September 4th to Mr. J. J. Lambert, 8, Dowgate-hill, Cannon-street, London, E.C.

——— The Stockton School Board require a head master for their Higher Grade and Organised Science School. Salary £300 per annum. Applications by Tuesday, 20th instant, to the Clerk to the Board 19, Dovecot-street, Stockton-on-Tees.

Dissolutions of Partnership.—Messrs. H. G. Ellis and G. E. East (the younger), who have hitherto carried on business as electrical engineers under the style of the London Battery Company at 16, St. Ann's-street, Westminster, London, S.W., have dissolved partnership.

——— The partnership business of art metal workers hitherto carried on by Messrs. J. S. Gardner and Caroline Gardner, under the style of Starkie, Gardner and Co., at 29, Albert Embankment, Lambeth, London, S.E., has been dissolved.

——— Messrs. R. C. Kerr and J. Vallentine, electro-platers, trading as the Empire Plating Works, at 18, Kirby-street, Hatton Garden, London, E.C., have dissolved partnership.

——— Messrs. E. Hancock and F. Hulbert, carrying on business as carbon plate makers under the style of Hancock and Hulbert, at Richmond-place, New-road, London, S.W., have dissolved partnership.

Personal.—Mr. John F. C. Snell has been appointed resident engineer at the new electric lighting and refuse destructor station (King's-road) of the St. Pancras Vestry. Mr. Snell has been engaged supervising the erection of this station for the last seven months, and was formerly chief assistant engineer at the Stanhope-street station. He was also chief assistant to Major-Gen. C. E. Webber and on Messrs. Crompton's staff.

Bankruptcy.—The first meeting of the creditors of Ronald A. Scott, electrical engineer, was held on Wednesday last. The debtor's statement shows liabilities amounting to £10,787. 2s., £3,832. 2s. being due to unsecured creditors and £4,180 to secured creditors, whose securities are estimated to produce £10,000. To partly secured creditors £2,775 is owing, securities in this case being estimated to produce £450, leaving a balance of £2,325 to rank against the estate for dividend, the total liabilities of the estate being £6,157. 2s., with an estimated deficiency of £337. 2s. The debtor states that he has now no business. He commenced business in 1889 as an electrical engineer at Acton with a capital of about £900, and continued in business till June, 1894, when he turned his business into a limited liability company under the style of Ronald A. Scott, Limited, with a nominal capital of £10,000 in shares of £1 each, of which the debtor was to receive 5,000 which were duly allotted, the debtor acting as manager. In December, 1894, a Receiver was appointed, who carried on the business until May last, when it was practically closed. There are 120 unsecured creditors, chiefly for goods supplied. The debtor attributes his present position to bad trade and competition, and to losses in bringing out advertising patents. (The debtor is the gentleman who "illuminated" the Nelson statue at Trafalgar-square.) A fairly representative group of creditors were present at the meeting, but as the proofs were not lodged in time for a vote to be taken, no resolutions were passed, the Official Receiver remarking that it seemed something like the case of Dr. Jekyll and Mr. Hyde, the Company having been formed as "Ronald Scott (Limited)" to take up the liabilities of "Mr. Scott," "Mr. Scott" remaining in the business as manager. There were no shareholders beyond the debtor and the seven subscribers to the Memorandum; there were no directors, no secretary, "no nothink." The debtor said he did not think the original Agreement with the vendors had been registered at Somerset House; he had raised £5,000 in debentures on the Company, but they were now in the hands of creditors. Some amusement was caused by certain details given by the Official Receiver, and at the list of articles assigned by the debtor when he turned himself into a limited liability company. Very little consolation was derived from the meeting by the creditors present, who will have another opportunity of discussing matters with Mr. Scott six weeks hence.

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LIQUIDATIONS.—At a meeting on June 26th last it was resolved to wind up the Universal Electric Lighting Company (Limited) voluntarily. This resolution was confirmed on July 12th, and the Secretary (Mr. J. G. B. Elliot, 18, Eldon-street, London, E.C.), to whom claims must be sent by September 7th, was appointed liquidator.

——— At a meeting of the proprietors of the International Electric Storage (Limited), on June 26th, it was resolved to wind up the Company voluntarily. This resolution was confirmed on July 12th, and the Secretary (Mr. J. G. B. Elliot) was appointed liquidator. Claims have to be sent in by the 7th prox. From a notice in another column it will be seen that the I.E.S. Accumulator Company has been formed to manufacture the I.E.S. batteries.

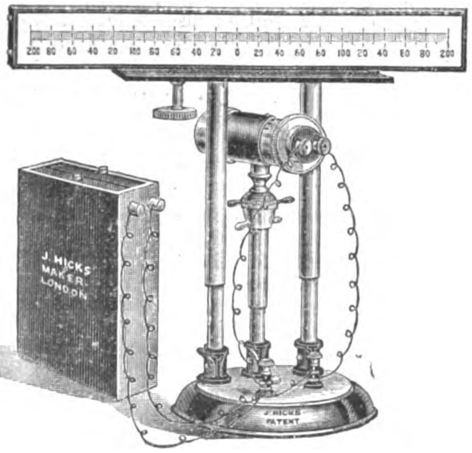
——— It was resolved on July 1st that the Keighley Electrical Engineering Company (Limited) be wound up. This resolution was confirmed on July 22nd, when Mr. E. Clough, Cemetery-lane, Keighley, was appointed liquidator, and was authorised to transfer the assets and liabilities to another company proposed to be formed and registered.

——— A meeting will be held at 59 and 60, Wind-street, Swansea, on the 10th prox., at 11 a.m., to receive an account of the winding up of the Lundy Cable Company (Limited).

——— A petition has been presented by Mr. J. L. Fuller, electrical engineer, trading as Fuller and Co., 28, Bush-lane, Cannon-street, London, E.C., to the County Court of Worcestershire, for the compulsory winding up of the New British Electrical Installation Contractors (Limited), and will be heard at the Shire Hall, Worcester, on the 21st inst., at 10 a.m. Messrs. Scott, Spalding and Bell, 15, Queen-street, London, E.C., are the petitioner's solicitors.

NEW BRANCH.—It is stated that the St. Petersburg branch of Messrs. Siemens and Halske are about to establish branch works in Odessa.

GALVANOMETER SCALE AND LAMP.—Mr. J. J. Hicks, of Hatton Garden, London, E.C., is the sole manufacturer of Burstall's galvanometer scale and lamp (Hicks's patent), of which we give an illustration below. The scale and lamp has been designed so as to be portable, rapidly adjusted, and to work in the open daylight. The focussing tube is carried on a ball joint, and by means of a sliding tube can be set at any required height; when the spot of light has been thrown on to the mirror, both these motions can be



locked, so that focussing can be done without fear of the spot being shifted off the mirror. The scale is divided in millimetres on ground glass, and is capable of adjustment both vertically and horizontally, the latter adjustment being by means of a rack and pinion. The source of light is a small glow lamp, worked by two storage batteries. A fine line is etched on the object glass, and this line is focussed on the scale. By means of hinged joints the lamp and scale can be folded into a very small compass, by no means a small consideration for portable work.

ADMIRALTY CONTRACTS.—The United Abestos Company (Limited), of Dock House, Billiter-street, London, E.C., have been awarded the contract for the supply of asbestos packing and other goods to the Admiralty for the ensuing year (1895-6).

D.P. BATTERIES.—The makers of these batteries announce that several novel developments have recently been made, with the result, it is claimed, that a plate has now been produced which will resist very considerable ill-treatment. For country house work, where skilled attendance is not always available, the improvements recently effected will be appreciated.

ELECTRIC LAUNCH.—An electric launch has been shipped from Messrs. T. and G. Tagg and Son's Boat-building Works, East Molesey, Surrey, to the Imperial Palace, St. Petersburg, to the order of the Czar.

WESTINGHOUSE ELECTRIC COMPANY (OF AMERICA).—It is stated that this Company has entered into a working arrangement with Messrs. Burnham, Williams and Co., proprietors of the Baldwin Locomotive Works at Philadelphia, who possess one of the largest and best-equipped railway locomotive works in America.

J. G. STATTER AND CO.—Mr. J. G. Statter notifies us that he has purchased the designs and goodwill of Messrs. J. G. Statter and Co. (Limited) (in liquidation), and that the firm will be carried on under the style of J. G. Statter and Co.

WRONGFUL DISMISSAL.—The Blackman Ventilating Company (Limited) were sued in the Lord Mayor's Court, London, by Mr. Watel, an electrical engineer, for wrongful dismissal. The plaintiff is the patentee of a electric fan, and granted a license of his patent to the defendants in 1890, part of the consideration being that he should be retained as engineer. The evidence having satisfied the judge and a jury that the plaintiff's claim was a reasonable one, a verdict was returned for the plaintiff for £50.

OUTING.—The works staff of the D.P. Battery Company travelled on Saturday last to Hastings, where a dinner was provided at the "Royal Albion" Hotel, under the chairmanship of Mr. J. Jones, works manager.

ABERYSTWYTH.—The pier was lighted electrically for the first time on Saturday last.

ACTON.—Electric lighting matters seem to have arrived at a decidedly uncertain stage in this district. It will be remembered that some time ago the District Council agreed to transfer its Provisional Order to Messrs. New and Mayne. In April last it was, however, agreed to ascertain the views of the parochial electors before finally transferring the Order, since when nothing has been done. Recently the Capital and Counties Electricity Supply Company gave notice of its intention to apply for a Provisional Order to supply electric current, and the Council decided to oppose this application. At the last meeting of the Council a letter was read from a prominent local ratepayer asking when electric current would be available, and the Works Committee recommended that he be informed that "there was no immediate prospect of the electric light being brought into the district."

ASYLUM LIGHTING.—The Metropolitan Asylums Board on Saturday last adopted the report of the North-Western Hospital Committee, recommending the acceptance of the tender of Messrs. Fowler, Lancaster and Co., for running mains and wiring the five new wards and other buildings being erected at the North-Western Hospital, for the sum of £859. 15s. The plans and specifications were prepared by Prof. Ayrton, to whom the 17 tenders received were referred for report. Prof. Ayrton reports that when it was decided to electrically light the new buildings he applied to the Westminster Insurance Office for permission to use a conduit system, but as that office had to obtain the consent of other insurance companies interested in the risk, it was some time before the necessary permission was given, and it was then coupled with a preference for a non-metallic tube. Under these circumstances, and especially as the details of several of the conduit systems are covered by patents, and therefore can only be used with the permission of the holders of the patent, Prof. Ayrton considered it undesirable to specify the material of the conduit with particular minuteness. To enable any firm to tender prepared to employ a conduit system, as distinguished from the old-fashioned wooden casing, he specified that "Samples of the conduit which the contractor proposes to use must be sent with the tender." The list of tenders on the opposite page gives a description of the material proposed to be used. Prof. Ayrton, after a careful survey of the 17 tenders received, and of the samples, reports that the Board will, in his opinion, receive the best value from the tender of Messrs. Fowler, Lancaster and Co., for £859, 15s., as—

(i.) Zinc tubes, such as those proposed, are much stronger than those made of bituminised paper, and will stand the action of damp and of cements better than paper.

(ii.) Zinc is stronger than earthenware unless the latter be very thick; further, zinc tubes can be obtained in greater lengths, and also can be joined together more easily, than earthenware tubes. Therefore zinc is to be preferred to earthenware for mechanical reasons, and, when insulated wire of the class stated in the specification is employed, no electrical advantage is practically gained by using a tube composed of non-conducting material.

(iii.) As Messrs. Fowler-Lancaster are prepared to use steel tube where, in my opinion, there is a special risk of mechanical injury, their system is nearly as good as one in which iron pipes are used throughout.

(iv.) The tender is nearly £200 less than the lowest of those in which iron pipes are quoted for, and only £300 more than the lowest tender of all. And as this latter is for a simple paper tube system I do not recommend its adoption.

(v.) As the zinc tubes are made out of *rolled sheet*, and as the steel tubes they use are *smooth inside*, there is far less risk of damage to the insulation of the conductors in drawing in than if rough gas barrel were employed, as is contemplated in some of the higher tenders.

The Board having received a tender, which is only fifth from the lowest, for a combination system of special zinc tube and

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List of Tenders Sent in for Metropolitan Asylums Board's Contract.

Name of Firm.	Amount of tender.	Bituminised paper.		Earthenware.	Iron.	Steel.	Zinc.
Thorpe and Waring	£554 0 0	Plain.	.....	...	......	......	......
Electrical and General Engineering Company	649 0 0	...	Covered with brass where risk of mechanical injury.	...	......	......	......
Thos. Mathews	650 0 0	Plain.	......	...	......	......	......
Waring and Sons	688 15 0	...	......	Thick.	.. ...	......	......
Fowler, Lancaster and Co., Birmingham (*accepted*)	859 15 0	...	......	...	......	Bored steel tubes where risk of mechanical injury.	Rolled sheet zinc bent into tube, and soldered.
Benham and Sons	870 0 0	...	.. ...	White.	......	... ..	......
Paterson and Cooper	895 0 0	Plain.	......	...	......	......	......
Julius Sax and Co.	944 8 9	...	......	Doulton's.	......	......	......
J. C. Howell	981 16 4	Plain.	......	...	......	......	......
Lon. & Lanc. Elec. & Gen. Eng. Co.	1,050 0 0	...	......	...	Complete iron system.	.. ...	......
Miller and Woods	1,070 0 0	..	......	...	Iron.	......	......
Sharp and Kent	1,098 0 0	...	.. ...	...	Ordinary gas barrel.	... ..	......
Tayler Smith Electrical Co.	1,124 0 0	Plain.	......	...	......	......	......
Roger Dawson	1,140 0 0	...	Covered with brass where risk of mechanical injury.	...	......	......	......
Hayward Tyler and Co.	1,340 0 0	...	......	...	Complete iron system.	......	......
V. G. Middleton	1,440 0 0	...	......	...	Iron.	......	......
Vaughan and Brown	1,557 0 0	...	......	...	Ordinary gas barrel.	......	......

smooth steel pipe, Prof. Ayrton considers that this furnishes a conclusive proof of the advantage derived from the material of the conduit having been left open in the specification.

BANGOR.—Mr. F. H. Medhurst has presented his amended report and estimates on the question of the introduction of the electric light into Bangor, and the Electric Lighting Committee now report that they have considered the same, and recommend that the Council apply for a Provisional Order, and that the Committee be empowered to take the necessary steps to carry out the scheme. Dr. Grey Edwards said they should be guided by what occurred in Liverpool, where the Corporation allowed a company to take up the electric lighting, and Liverpool had now to pay for its remissness something like £400,000! After a long discussion, an amend- was moved by Alderman T. Lewis that the matter be referred back for further consideration, and the original motion having been withdrawn, the amendment and the proposals of the Committee were accordingly referred back.

BROADSTAIRS (KENT).—The Brush Provincial Company recently gave the Broadstairs and St. Peter's Urban District Council notice of their intention to apply for a Provisional Electric Lighting Order for this district, and the Works Committee, to whom the matter was referred, recommended that the application be opposed. At the last meeting of the Council Mr. Councillor Horrell, in moving the adoption of the Committee's report, said it did not necessarily follow that the Council intended to oppose the introduction of electric light at all times into the district, but he thought it should go forth that the Council opposed this application in order to retain the electric lighting powers in their own hands, and to be able to use them when the proper time came. The motion was carried.

BLACKBURN.—The Town Council at their last meeting considered the recommendations of the Gas Committee as to the proposed extensions of the electric lighting scheme, and, as these recommendations were unfavourable to the proposal, and as the Committee itself is favourable, after a short debate, the matter was referred back for reconsideration.

CHELTENHAM.—The electric light is making very satisfactory progress in Cheltenham. The report of the Lighting Committee recently presented to the Town Council states that they have now 57 applications for current on their books. They had an equivalen of 2,160 8-c.p. lamps actually connected, while other applications brought up the total to well over 3,000 lamps. In face of this rapid increase, and without taking into account the question of street lighting, they were in danger of being overtaken by the demand, and the Committee would, at its next meeting, make some recommendation for an increase of the plant at the generating station. As their authorised capital had been expended, the Committee recommends that application be made to the Local Government Board for sanction to borrow a further sum of £10,000 for these extensions. The report was adopted. The thanks of the Committee have been voted to Mr. Preece for his gratuitous services in connection with the introduction of the electric light.

CHURCH LIGHTING.—Trinity Church, Leeds, is being fitted for the electric light by S. Dixon and Son. About 100 lights will be used.——It is stated that the Sacred College at Rome have under consideration the question of introducing the electric light into Roman Catholic churches, the use of wax candles being retained for the celebration of sacred ceremonial rites.

DARFIELD (YORKS).—The lighting question was discussed at the last meeting of the Parish Council. A discussion took place on the report presented by the General Purposes Committee on the gas supply, and a motion that the Committee reconsider the whole question, including an inquiry as to the cost of lighting the streets by electricity, was defeated by five to three.

DERBY.—The Electric Lighting Committee report that in consequence of the still rapid increase in the demand for electricity, they have had under consideration the desirability of enlarging the present station, and it has been decided to recommend the Council to grant a sum of £3,490 to enable them to build an annexe to the present station and to provide a 250 H.P. engine and alternator with exciter, including steam pipes and all connections and additions to the switchboard. The Committee recommend the Council to make application to the Local Government Board for sanction to borrow this sum. The Committee also report that the borough accountant has prepared a capital and revenue account of the electric light undertaking.

DOVER.—The lighting of Snargate street by means of arched lamps was decided upon by the Town Council some time back, but, notwithstanding, has not yet been carried out. The gas interest is strong at Dover, and a motion by Mr. Councillor Thorpe at the last meeting stops further proceedings for the present.

EDINBURGH.—The demand for electric current seems to increase at a rapid rate in Edinburgh. Recently the mains were extended to Hope Park-terrace in the South Side district, and already a number of the leading merchants are having their establishments wired and fitted up for the electric light. One of the first to use the light was Mr. James Lyle, whose premises at the University corner have been fitted up by Messrs. Milne and Sons.

FIRE.—A fire broke out on the 1st inst. on the premises of Messrs. Mackey, Mackey and Co., of 175A, Grange-road, Bermondsey, S.E. Although some slight damage and inconvenience were caused by the outbreak, we are informed that business will not in any way be interfered with.

FOLKESTONE.—The Mayor and Town Council recently held a conference with the Directors of the Dover Electricity Company in order to discuss the proposal to light Folkestone from the Dover works. The proposal is to run a cable along the South-Eastern Railway from Dover to Folkestone, by which means it is claimed current could be supplied at a minimum cost. The matter is to be brought before the Town Council, when a committee will be appointed to confer with the Dover Company.

FOREIGN POSTCARDS.—Timely warning is given by a British Consul of annoyance likely to be caused by the practice, which is growing, of sending private postcards, with an adhesive penny stamp attached, to the Continent and other parts abroad. These private cards are treated as letters, and a surcharge is made of 3d. upon each communication.

GLASGOW.—At the last meeting of the Town Council the report of the Gas and Electric Lighting Committee (referred to in our last two issues) was formally adopted. Mr. Mitchell, who moved the adoption of the report, said he regretted that there was not a profit on the electrical department, but no doubt the result would be altered in the near future, and he anticipated that the plant at Waterloo-street and John-street would be fully occupied during the coming winter.

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HAMPSTEAD (LONDON, N.W.).—The Vestry at their last meeting discussed the report of the Electric Lighting Committee recommending certain extensions of the electric lighting plant, and, after some discussion, the report was referred back for further consideration. The chairman, in referring to the intolerable heat of the Board-room, suggested that the Works Committee should be asked to fix an electrically-driven fan in the room, and this suggestion was adopted. The Board of Trade forwarded a copy of a memorandum of Major Cardew with reference to the application of the Vestry for the Board's consent to the placing of four 25-kilowatt transformers in certain sub-stations, and stating that under the circumstances the Board was unable to consent to this. It was decided, on the recommendation of the Lighting Committee, that the salary of the chief assistant engineer (Mr. E. Sayer) be raised from £104 to £200 per annum as from May 1st.

HOSPITAL LIGHTING.—At the quarterly court of the Governors of the Hospital for Consumption (Brompton, London, S.W.) last week the Committee of Management reported that they had decided, after much deliberation, to light the whole of the hospital by electricity, as it was felt it would be to the great advantage of the patients, and the expense would be amply justified. The Committee's report was unanimously adopted.

KILLARNEY.—The Killarney Electric Light Company have written to the local Board of Guardians pointing out that the Board of Control had decided to light the district asylum electrically, and suggesting that the Vice-Guardians should also adopt this method of lighting the workhouse. Particulars of the tenders for lighting the asylum will be found in another column.

KINGSTON-ON THAMES.—The electrical engineer has been instructed to submit an estimate of the cost of wiring the sewage works for the electric light, and for the supply of current thereto. The Town Clerk recently wrote to the Surbiton District Council inquiring whether Surbiton and Hampton Wick would be likely to require current from the Kingston electricity station, and at the last meeting of the Council a reply from the Surbiton Council was received, stating that they proposed to establish electric works of their own. The Town Clerk has also written a similar letter to the Malden District Council. The engineer's report states that the receipts from the sale of current and for meter rents for the half-year ended June 30th were £731. 4s. 1d., compared with £336. 10s. for the corresponding period of last year. The Lighting Committee have resolved to introduce the Brighton method of charging for electric current.

LEYTON (LONDON, E.).—At the last meeting of the District Council the Electric Lighting Committee reported that they had considered Prof. Henry Robinson's recently-presented report on the lighting of the district by electricity. Prof. Robinson estimates the initial cost of the installation (including land, buildings, plant, &c.) at £16,200, the annual up-keep at £2,072, and the revenue at £2,280. The central generating station will be as nearly as possible in the centre of the district, probably in the neighbourhood of the Grove Farm, and the land and building is estimated to cost about £5,600. The scheme provides for the laying of five miles of mains altogether. It is intended to put down plant capable of supplying 150 arcs and about 5,000 16 c.p. incandescents, but it is not intended to expend the whole of the capital at the outset, as the installation will be carried out by degrees. The charge for current to private consumers will be 6d. per unit, and it is estimated that the lighting of the public buildings will be effected for £200 a year less than the present cost of gas. The Committee also reported that they had, in conjunction with Prof. Robinson, inspected the process of gas manufacture in connection with the gas engines used for driving the dynamos at the Midland Railway Company's station and goods yard at Leicester, and, having carefully considered the practical working of the scheme, they had no hesitation in recommending the Council to authorise the prompt erection of the proposed works. As the Council have decided to adopt the electric light for their new Public Offices and Technical Institute, the Committee further recommend that Prof. Robinson be instructed to prepare the necessary plans, specifications and estimates, and that application be made to the Local Government Board for sanction to borrow £16,200. It was originally proposed to borrow only £14,200, but as it is intended to extend the mains along the Leytonstone-road, and as the land for the proposed central station will cost an additional £350 beyond the sum first proposed, it was decided to increase the amount to the larger figure. It was further recommended that the Committee be authorised to negotiate and enter into a provisional contract (if necessary) for the purchase of the land required. Councillor Bare, who moved the adoption of the report, said the Committee had unanimously come to the conclusion that the Council could not do better than adopt an electrical system of public lighting, and were satisfied that the system proposed to be adopted was the best and most economical. After considerable discussion the report was adopted with only four dissentients. The Hall Building and the Electric Lighting Committees jointly recommended that Prof. H. Robinson be instructed to prepare plans, specifications and estimates for wiring and fitting up the public buildings, and that tenders for the same be invited from 12 electrical firms to be selected by Prof. Robinson. This recommendation was also carried.

LIMERICK.—At a special meeting last week, the Town Council discussed the electric lighting question. A Provisional Order was obtained in 1892, and towards the end of 1894 the Board of Trade gave notice of its intention to revoke the Order unless evidence was forthcoming that the Council intended to comply with its provisions. Under these circumstances the Council invited Prof. Kennedy to prepare an electric lighting scheme for the town. This scheme has been duly formulated in a report recently presented to the Council. Prof. Kennedy estimates the initial cost of an electric light installation at £18,000. Mr. Bourke moved that the necessary steps be taken to put the provisions of the Electric Lighting Order in force, and that the Local Government Board be asked to hold an inquiry into their application to borrow £18,000 for that purpose. After a long and somewhat incoherent discussion, the original resolution was finally adopted.

LIVERPOOL.—The report prepared by the Chairman of the Lighting Committee with regard to the purchase of the Liverpool Electric Supply Company's undertaking was presented to the meeting of the Corporation on Wednesday, and deals exhaustively with the history of the introduction of the electric light into Liverpool. It is pointed out that the earliest date fixed for the purchase of the Company's undertaking by the Local Authority is the year 1898, subsequently extended to 1890 on certain conditions. The Corporation having decided that, if satisfactory arrangements could be made, an earlier purchase should be effected, negotiations were in the current year entered into with the Company, and experts were called in to advise the Corporation in these negotiations. Expert opinion was to the effect that the Corporation would be well advised in making the purchase, and an agreement was in May last prepared, in the terms of which the Company undertake to sell and the Corporation to purchase the entire undertaking for the sum of £400,000. The agreement is a lengthy one, and stipulates amongst other conditions that the purchase-money shall be paid over by September 2nd, or at latest on January 1st next; that the Corporation shall be liable to, and shall pay and discharge all debts and liabilities of the Company existing on the date of the completion of the purchase, and, in return, shall be entitled to all debts and moneys owing to the Company, the latter reserving all pecuniary rights until the completion of the purchase. The engineer of the Company (Mr. A. Bromley Holmes) and all other officers and servants (excluding the Directors and solicitors) shall, unless any servant should desire otherwise, be taken over by the Corporation on the same terms as to position and emoluments as if he were continuing in the employ of the Company. The agreement is, of course, made subject to the approval of Parliament and to confirmation by the shareholders, and to such alteration as either House of Parliament may think fit to make therein, a proviso being made that should these alterations be by either party considered against their interests, it is in their option to withdraw from the agreement. An arbitration clause completes the document. The agreement refers not only to the Company's undertaking in the City but to the Toxteth Park scheme also. The following table shows the development of the Company's undertaking during the last five years :—

Year.	No. of lamps on December 31st.	Sales of electricity.	Profit before deducting depreciation.
1890	11,752	£13,343	£7,792
1891	14,966	£20,123	£11,760
1892	20,254	£25,515	£16,751
1893	25,784	£27,258	£17,507
1894	31,792	£31,352	£20,908

In presenting this report Mr. Alderman F. Smith, Chairman of the Electric Lighting Committee, said the price of £425,000 might appear extremely high, but, all circumstances being taken into account, the purchase was most desirable. The lighting of a city like Liverpool was a very important matter, and it was essential that it should be intelligently carried on from the point of view solely of the public interest. The future of the undertaking in the hands of the Corporation depended entirely upon the manner in which it was handled for the public benefit. Sir A. B. Forwood, M.P., contended that the arrangement was an improvident one, but admitted that there would probably be a large extension of the use of electric current in the future. He, however, approved of the work being in the hands of a private company. He also thought they might have made a better bargain. Mr. Ald. Bowring took strong exception to Sir A. B. Forwood's remarks, and pointed to the bargain made with the gas company which proved the most unfortunate the city had ever made. If they had had the foresight to acquire the gas undertaking it would have been an excellent proceeding for the community. Other speakers followed, cordially approving the action of the Committee, whose report was adopted.

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LONGTON (STAFFS.).—At the last meeting of the Town Council the draft of an agreement between the North Staffordshire Tramways Company and the Corporation, with reference to the alteration of the date when the Corporation could compulsorily purchase the tram lines from 8 years to 22 years, and to the sanctioning of the installation of electricity by overhead wires, was read, and, after a brief discussion, approved.

MANCHESTER.—The City Council have decided to purchase additional land in Dickinson-street for the purpose of enlarging their electric supply station. It is intended to duplicate the plant at the generating station, and as this would take up all their present space, they were compelled to buy more land for storage purposes and possible future extension.

NORTHWICH.—The Lighting Committee of the District Council have considered the recent proposals of Mr. W. M. Beckett, of Manchester, for supplying electric current to this district, and they recommend the Council to inform Mr. Beckett that they were not at present disposed to take up the electric lighting question, but if a syndicate were formed to obtain a Provisional Order the Council would consider and discuss the terms of any proposal that might be made.

OSWESTRY.—The Oswestry Electric Light and Power Company will be in a position to supply electric current in the course of a few weeks. Satisfactory progress is, it is stated, being made with the erection of the plant at the Company's central station at Coney Green, and several large establishments in the town are being wired and fitted up for the electric light.

PERTH.—The Caledonian Electric Supply Company have notified the Town Council of their intention to apply for a Provisional Order. The Town Clerk pointed out that the notice was too late, and that the Council had hitherto opposed all proposals for the introduction of the electric light into the town, but he suggested that the Company should be allowed an opportunity of laying its terms before them, and this course was agreed to.

PRIVATE HOUSE LIGHTING.—Messrs. Drake and Gorham have received instructions from Major Kearsley, of Stapeley House, to fit the electric light throughout the house and stables. The plant includes a Marshall engine and a D.P. accumulator set of latest type.——Melmerby Hall, Ripon, the residence of Mr. J. T. Pearson, is being fitted for the electric light by Messrs. S. Dixon and Son, of Boar-lane, Leeds, the plant consisting of a 7-H.P. Crossley oil engine and a set of E.P.S. accumulators. 150 lights are used.

RUGELEY.—The District Council recently discussed the lighting question at some length. The Lighting Committee reported that they had received the usual tender for lighting the street lamps from September to April, but they recommended that the gas company be asked to make a reduction in the present price of gas. Mr. Buttery thought they should get the town lighted electrically. The Lighting Committee are to further consider and report on the whole question.

ST. HELENS.—The Town Council propose to ask the Local Government Board to sanction the loan of £10,000 for electric light works.

ST. PANCRAS.—At the last meeting of the Vestry, the Finance Committee reported that they had been unable to obtain the loan of £75,000 for electric lighting and dust destructor purposes from the National Bank, but the London County Council had agreed to lend them £56,100 at 2¾ per cent. interest, the loan to be for varying periods. The Works Committee reported that they had been in communication with the Electricity Committee on the subject of sanctioning the laying of mains by the London Hydraulic Power Company for the service of business premises in Charlotte-street, to extend along Tottenham Court-road, Windmill-street, and across Charlotte-street; but the latter Committee, viewing the Hydraulic Power Company as possible competitors with their electricity works for the supply of motor power, recommended that leave be not given. Mr. Purchese (Chairman of the Works Committee) stated that he was in favour of the application, which he thought a reasonable one. The refusal was only carried by a majority of one in a small committee, and he understood that the Hydraulic Company would give an undertaking not to use their power to produce electric current. As Chairman of the Works Committee he had to move the resolution confirming the Committee's decision, although, personally, he thought so reasonable an application should be granted. Mr. Wetenhall moved an amendment that the application be acceded to. A discussion ensued, in the course of which Mr. Sweet (Chairman of the Electricity Committee) said that from the moment the Vestry had decided to adopt electricity it was well understood they should never allow any rival competitors for supplying motive power into St. Pancras, and he hoped that if the Vestry consented to the application, they would insist simply on a service pipe to certain premises, and would not allow the laying of a main. On the amendment being put to the vote, it was found that there were 32 for and 32 against. The Chairman, on being appealed to, gave his casting vote against the amendment, and the recommendation of the Works Committee, refusing the application, was therefore confirmed.—A proposal to wire the Vestry Hall and offices for the electric light has been postponed.

SUNDERLAND.—The Town Council have decided to increase the salary of their electrical engineer (Mr. C. S. Vesey Brown) by £60 per annum.

THEATRE LIGHTING.—The Grand Theatre, Leeds, is being installed for the electric light by Messrs. S. Dixon and Son, of Boar-lane. The fittings are stated to be very elaborate and specially designed.

WESTERN AUSTRALIA.—The telegraph service belonging to the Victorian Government Postal Department has been for some time past in a state of great muddle, owing possibly to a too rapid extension. Mr. H. W. Jenvey, electrician to the Victorian General Post Office, has recently been on an official visit to report on the telegraph and telephone services of Western Australia, and has notified Mr. Sholl, the Postmaster-General, that direct telegraphic communication between Derby, in Western Australia, with Cape York, the northernmost point of Australia, has been effected, the total distance being 7,207 miles. The experiment proved an unqualified success, and the two offices exchanged messages for an hour. This, Mr. Jenvey asserts, is unequalled in the history of telegraphy, the best previous record being that London has spoken on the wires with Kurrachee, in North-Western India, a distance of about 6,000 miles. Automatic repeaters were used at Roebourne, Hamelin Pool, Perth, Albany, Israelite, Eucla, Lincoln, Adelaide, Melbourne, Sydney, Brisbane, Rockhampton, Townsville, Bowen and Cardwell. The following are the distances:—Derby to Perth, 1,609 miles; Perth to Adelaide, 2,062 miles; Adelaide to Melbourne, 500 miles; Melbourne to Sydney, 570 miles; Sydney to Brisbane, 640 miles; and Brisbane to Cape York, 1,826 miles—total, 7,207 miles. The signals are stated to have worked, on the whole, satisfactorily.

WREXHAM.—The Board of Trade have written to the District Council asking for their observations upon a request from the Wrexham and District Electric Supply Company for a further extension of six months in which to comply with the conditions of their Provisional Order. The Council have decided not to oppose the application, on the understanding that this would be the last extension applied for.

COMPANIES' MEETINGS AND REPORTS.

Cuba Submarine Telegraph Company (Limited).

The forty-eighth ordinary general meeting of this Company was held at the offices, 58, Old Broad-street, on Wednesday, August 7, 1895, under the presidency of Mr. Charles W. Parish.

The SECRETARY (Mr. James Scott) having read the notice calling the meeting,

The CHAIRMAN said: I daresay, gentlemen, that you will, as usual, take the report as read. You have it in your hands. ("Agreed.") Before reverting to the accounts before us, I would like to refer to the great loss we have sustained in the death of our valued Chairman, Mr. Greenwood. Those of you who were present at our general meeting last February may have noticed that he seemed far from well. I think his strong devotion to his work and duties had somewhat overtaxed his strength, and he fell a victim, like many others, to influenza. I am sure that no Company ever had a keener man of business upon its Board, and we shall long miss his valuable advice. You will also notice that our colleague, Mr. Low, has retired from active service. He has been a most useful member of this Board, and had been connected with it since the foundation of our Company, nearly a quarter of a century ago. He wisely thought that he had some right now restfully to enjoy the good dividends it has earned. We have been fortunate in appointing Mr. Robert Kaye Gray and Mr. Alexander Graham Low to fill these vacancies. The former gentleman has great experience, and is well known in connection with cables, while Mr. Alexander Graham Low is as keen as his father was, and will doubtless make as good a Director. Now, gentlemen, if you will kindly take the accounts in your hands, and refer to page 5, you will notice that our traffic receipts mount up to the splendid total of £29,164, which compares with £23,188 for the first half of last year, and shows no less than £5,976 increase; but I would have you clearly to understand that this increase is quite abnormal, and almost entirely results from the unfortunate revolution which is now going on in Cuba. Many of the land lines at the eastern end of the island have been destroyed by one party or the other, and consequently senders of messages have been glad to avail themselves of the excellent and reliable service which our cables provide. As regards expenses there has been some increase to meet the present circumstances, the expenses for the half-year under review being, as you will notice, £6,118, as against £5,113 for the same period last year, or an increase of £1,005, but of this £188 was due to an income tax adjustment, leaving the actual working increase at £817, and when I explain to you that more than three-quarters of this amount is due to expenses at stations, and includes a hut for the cable ends at Santiago, and a house for the cable tank at Cienfuegos, I think you may be well satisfied with the accounts. We have thought it advisable to add £1,500, as you will notice, to the reserve against loss on deposits with

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banks. Business has not improved as quickly as was expected in either South America or Australia, and it is our duty to be on the safe side. This £1,500, together with the proposed dividends, will absorb £10,900, while £3,539. 19s. 10d. remains as a balance to carry forward to the next account, and we are able to place £13,638. 10s. 5d. to the reserve fund. We are especially glad to be able to strengthen our reserve in this manner, for I must prepare you that a reduction in our rates appears very imminent. We have warned you of this from time to time, as you are aware, and we have staved it off as long as possible, but we do see it is now approaching, and it is most necessary that our financial position should be as strong as possible. I would only add that our cables have worked well, and are in excellent order. I will now, with your permission, propose—

"*That the report and accounts for the half-year ended June 30th last, now submitted, be received and adopted.*"

Mr. GEORGE KEITH: I beg to second that.

Mr. COCHRAN: I think you have somewhat anticipated an inquiry I was going to make, but I do not think you have quite covered the ground. I was not present in February last, when our meeting was presided over by our late Chairman, whose sudden death I, with all the members of the Board and the proprietors, deeply regret; but I find that Mr. Greenwood, in referring to the extra expenses incurred at that period on maintenance of land lines, spoke of an extra outlay of £600, which he led the meeting to believe, I think, as far as I can judge from the report, was the extent of the expense incurred. I find under that item that we have in the last two years increased, as you say, by something like £600. Now, that is £1,200 expended in two half-years. I think it surely wants some further explanation than that you have given why so very large a sum should be expended. Looking back for many years, I find that from £230 to £250 has been the average half-yearly expenditure under this head. You have named the very large increase in our working expenses. I believe that as far back as the year 1890, in reply to a question which I put to the Chairman, the latter then assured us that our expenses, as far as he could see, were not likely to increase. They were then £4,921, whereas they now mount up—for the past half-year—to £6,118. When you reply to these inquiries you will, perhaps, let the proprietors know whether the additional charge this half-year exhausts, as far as the Directors are able to judge, the special expenditure under the head of maintenance of land lines.

The CHAIRMAN: With respect to Mr. Cochran's remarks, I should like to say that a large proportion of the expenses he has spoken of is in connection with maintenance of land lines, and it would be impossible for me to give you any assurance as to how much that expenditure may be in the future. It is our first duty to maintain your property up to the highest pitch. In the previous half-year there was a considerable outlay under that head, which arose because certain land lines had to be replaced, while in the half-year under review certain alterations had to be made. We took advantage of Mr. Keith's presence there to move the shore-ends of one cable, and we brought the ends from one hut to another. It was an advantageous alteration, but it entailed considerable cost. The house for the cable tank was also an important matter. I can only assure you that we are watching these figures most carefully, and you may take it for granted, I think, that we shall not waste any money, and we will not spend more than is necessary. With your permission I will now put the resolution. Having submitted it in the usual way, he declared it carried unanimously. I have now to propose—

"*That the following dividends for the half-year be now declared on the shares of the Company, viz., at the rate of 10 per cent. per annum, subject to income tax, on the Preference shares; and 8 per cent. per annum, free of income tax, on the Ordinary shares, payable on and after to-morrow.*"

The motion was seconded by Mr. KEITH, and carried.

Mr. R. K. Gray was re-elected a director of the Company and Mr. John Gane as auditor, and a cordial vote of thanks to the Chairman and Directors terminated the proceedings.

Waterloo and City Railway Company.

The third half-yearly general meeting of the shareholders in this Company was held yesterday at Waterloo Station, under the presidency of Mr. Wyndham S. Portal.

The SECRETARY (Mr. Fred. J. Macaulay) having read the notice convening the meeting,

The CHAIRMAN said: I presume you will take the report as read. Since we met six months ago we have all been actively engaged in continuing the work of this railway. The result has been, of course, a very considerable increase in the capital expenditure—much in excess of the previous half-years. The outlay for works and for properties amounts to £47,256—that is, up to June 30th last, as compared with £2,626 up to December, 1894. In February last I had the satisfaction of informing the shareholders the progress that was being made, and that there was every prospect of still increased advancement, as it went on without any interruption of any kind. Since then, as we all know—although we are dealing with things underground—the frost, to which every railway chairman has referred at the present half-yearly meetings, occurred, and we were not exempt therefrom. The very severe weather prevailed for about three months of this half-year, and caused a total stoppage of your works for several weeks. We were also interrupted by the requirements of the Metropolitan District Railway Company, under whose line we have to pass, and that further delayed the work on the City side of the river. We have here the plan, which is before your Board every time they meet, and we thought it would be interesting to the shareholders to see it. The marks on it show the progress that has been made in each tunnel every time we meet. One represents the up tunnel and the other the down tunnel, and you see that they are going on very nearly *pari passu*. It is an extremely interesting diagram to study. All the difficulties arising in connection with crossing under the Metropolitan District Railway have been overcome, and the present rate of progress is, we are told by the engineers and contractors, satisfactory in every shape and form. The engineers' report states that good progress has been made with the tunnels, which have been driven entirely underneath the bed of the Thames and for a length of 300 yards on the Surrey side and 120 yards on the Middlesex side of the river, and that, up to June 30th last, 1,200 yards of single tunnel had been constructed. We have further detailed information from the engineers as to the progress made during the past six months, which may be interesting to the shareholders. I am quite sure you would like to hear it read. It is dated the 22nd July, and is signed by Mr. W. R. Galbraith and Mr. J. H. Greathead:—

"At the date of our half-yearly report, on January 4th, the position of matters was that the stage had been completed in the river, two shafts had been sunk, the four shields for driving the two tunnels in each direction had been fixed, and the up or westernmost tunnel had been actually commenced and driven 100 yards, but the down tunnel had not been begun. During the past six months all the shields have been brought into use, and good progress has been made in both tunnels. Commencing in the river and driving in each direction, the tunnels have passed entirely beneath the bed of the Thames, and towards the City have been carried under the Thames Embankment wall, the Metropolitan District Railway, and the complication of sewers and subways which are concentrated at that point. Towards Waterloo the tunnels have also made good progress, and have passed underneath the whole of the buildings situated between the south side of the Thames and Stamford-street, and are now being driven under the roadway of the street. The total length of single tunnel driven during the six months is about 1,200 yards, the total contract length apart from station work being 4,400 yards. Satisfactory as the above is, better progress would have been made had it not been that questions arose with the Metropolitan District Railway Company, causing a delay of more than two months; but these differences have been satisfactorily adjusted. Tunnels have, however, now successfully cleared the Metropolitan District Railway, the air locks have been removed, and the tunnels are being driven forward in the ordinary way. Towards Waterloo one of the tunnels has always been wholly in the clay, but the down or westernmost tunnel touched the gravel near Hatfield-street; but all appliances for the application of compressed air being ready, it was at once brought into use, and found to be perfectly effective, as the water was held back, and none of it came into the tunnel. The works generally are in a very satisfactory state, and there is nothing apparently to prevent the tunnels being driven at full speed towards the Mansion House, the borings having disclosed an ample cover of solid London clay in that direction. Towards Waterloo both tunnels have cleared the buildings between Stamford-street and the river, and will be driven wholly under the street without interference with private property until they reach a point a little eastward of the Waterloo Bridge-road. The operations towards Waterloo will presently not be so easy as those towards the City, as we shall in the course of the next two months undoubtedly not only touch, but have to drive through, water-bearing strata; but ample machinery has been provided for an abundant supply of compressed air, which will be employed as soon as it is necessary. As regards the construction of the line under private property, we are glad to say that we have been unable to detect any damage whatever to the buildings underneath which we have passed. As electrical traction will be used on this railway for the haulage of the trains, it may be interesting to note that the contractors have now two electric locomotives at work, one in each tunnel, and that they convey the waggons from near the working faces to the shafts with expedition, and have given every satisfaction."

I should state that the negotiations with the District Railway Company did not retard our operations more than one week, and every assistance and fairness was shown to us in the matter by that Company. It is only right and just that we should state this. They were, of course, obliged to protect their own interests and take precautions which were only fair and reasonable as regards their own line; but they gave us all the help they fairly could. With respect to the terminals, negotiations are going on with the South-Western Railway Company as regards the Waterloo terminus; and the arrangements for the City terminus are still under discussion with the Central London Railway Company. There seems every appearance of our being able to come to a satisfactory conclusion of this matter, and that the contractors will be able to proceed with the work satisfactorily. I may just touch on the accounts, and state that the balance to the credit of capital account of £80,085 includes the sum of £32,500, received previously to the closing of our books on June 30th, on account of calls payable on July 1st. Without this the balance at credit would have been £47,585. I may mention that, with respect to the call lately made, the whole amount has recently been received, and will appear in the current half-year's accounts. The capital expenditure to June, 1895, is given in detail in table No. 5. The item of £2,589 for land and compensation represents the payments made for easements under properties and certain houses acquired by the Company. The next item, of £44,666, is for construction of way and stations, including engineering (£1,900). The item to credit—£466. 19s. 11d.—under the head of "Interest and commission," represents what we have received in dividends for our parliamentary deposit and interest on money with our bank. The statement I have made to you is to our mind in every way satisfactory and healthy looking. I may say that the number of our shareholders has increased to 541, against 494 the last time we met, and on the whole they rank rather highly, for they hold on the average nearly £1,000 each. It only remains to me now to congratulate you on the present prospects of the railway, and I am sure I may be allowed to congratulate the engineers, Messrs. Galbraith and Greathead, as well as the contractors, Messrs. Mowlem, Burt and Co., on the comparatively few difficulties they have had and the great hopes they

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entertain that there will be nothing amounting to any real difficulty in the completion of this line. I now beg to move—

"*That the report of the Directors and statement of accounts to June 30, 1895, be and the same are hereby received and adopted.*"

The DEPUTY-CHAIRMAN (Lieut.-Col. the Hon. H. W. Campbell) seconded the motion.

The CHAIRMAN, in answer to a question from Mr. Beavis, said: We shall not be able to accommodate the shareholders in the way proposed, for one simple reason: that we do not want the money. A large sum might come in and we should not want it; and we shall therefore adhere to an interval of not less than two months between each call.

Mr. BEAVIS inquired the meaning of the entry in the No. 2 account, "Amount uncalled, less paid in advance."

The CHAIRMAN: That was paid in anticipation of calls, but no interest is paid on the amount.

The motion was then unanimously adopted, and the proceedings terminated.

Crompton and Co. (Limited).

The following is the full text of the report of the Directors of this Company, which was abstracted in our last issue. The general meeting takes place at the Cannon-street Hotel to-day (Friday) at 3 o'clock:—

The Company's business has again increased, but as will be seen from the statement of accounts to March 31st last accompanying the report the net profits show a considerable falling off in consequence of the further reductions in prices forced upon the Company. It is satisfactory to state that the Company's order book is well filled, and the works are kept extremely busy, more so probably than at any previous time. The Directors consider that a much healthier tone prevails in the business of electrical manufacturing, and they hope that there will be now a steady advance to better prices and better profits. The new debentures offered for subscription in January last were subscribed for to the amount of £82,850, which has provided additional working capital, and enabled the Company to materially reduce bankers' loans.

With regard to the Company's cooking and heating department the Directors have, since March 31st, granted a licence for the manufacture and sale of these appliances in France, the Company receiving £1,000 for the privilege and a substantial royalty on all sales; negotiations are also in progress for granting licences for other foreign countries.

The net profits for the year amount to £6,953. 10s. 11d., and after providing for debenture interest and other payments there remains a net revenue balance of £2,343. 15s. 9d., from which the Directors propose to set aside £1,000 for contingencies and doubtful debts, and to carry the balance £1,343. 15s. 9d. forward. They further propose to transfer the sum of £1,000 from the reserve fund in reduction of the preliminary expenses account.

The seven years fixed by the purchase agreement of July 16, 1888, during which the Company secured the right to the services of Mr. R. E. Crompton and Mr. J. F. Albright as Managing Directors, having expired, the Board have made arrangements for a continuance of their services.

Mr. H. H. J. W. Drummond has resigned his seat on the Board of Directors; Mr. Bernard Gibson seeks re-election as a Director, as do Messrs. J. H. Duncan and Co. as auditors.

NEW COMPANIES, STATUTORY RETURNS, &c.

PHŒBUS ELECTRIC BATTERY SYNDICATE (LIMITED).—This Company was registered on July 30th, with a capital of £3,000, in £1 shares, to carry into effect an agreement for the acquisition of certain inventions in relation to primary electric batteries, to construct, lay down, establish and carry out all necessary works, lines, batteries, accumulators, lamps and cables, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity for the purposes of light, heat and motive power, electrical apparatus manufacturers, manufacturing chemists, and the general business of an electric light company in all its branches. The subscribers, with one share each, are: A. Gianella, V. Guidotti, R. Maldifassi, E. Pellas, C. N. Ganzentes, M. Cizzio, and Ernest Lovett.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED). — The annual return to May 26th has just been filed. The nominal capital of £1,300,000, in £10 shares, has been subscribed for and allotted, and the full amount has been called and paid.

CALLENDER'S BITUMEN TELEGRAPH AND WATERPROOF COMPANY (LIMITED).—The annual return to June 25th has been filed. Of a nominal capital of £80,000, in £10 shares, 6,500 have been taken up. Of these, 3,000 have been issued as fully paid, and the full amount has been paid on the remaining 3,500 shares.

CITY NOTES.

BULUWAYO WATERWORKS COMPANY (LIMITED).—At the statutory general meeting of the shareholders of this Company last week the Chairman (Mr. Jarvis) said that it might be regarded as rather a novel departure to begin lighting so young a town as Buluwayo with electricity, but, on consideration, he could only come to the conclusion that the cheapest means of lighting is by electricity if you have water-power. The Company had received a cablegram from Sir John Willoughby to the effect that he had made all necessary arrangements for the electric light plant. Under the terms of their concession the electric lighting works would have to be commenced by November 10th and completed by February 10th.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended August 4th were £804, against £849 in the corresponding week of 1894, a decrease of £45. The total receipts for the half-year amount to £4,224, against £4,306 in the corresponding period of 1894, a decrease of £82.

DIRECT SPANISH TELEGRAPH COMPANY.—The estimated traffic receipts of this Company for the month of July are £1,889, against £1,400 in the corresponding period of last year, an increase of £489.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of July amounted to £61,413, against £56,753 in the corresponding period last year, being an increase of £4,660.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of July amounted to £47,555, and to £42,873 in the corresponding period of last year, an increase of £4,682.

EDINBURGH STREET TRAMWAYS COMPANY (LIMITED).—At the ordinary general meeting of the shareholders of this Company, on Monday, Sheriff Vary Campbell, who presided, referred to the question of a change from animal to mechanical traction, and said Edinburgh seemed to indicate a preference for cables, but the Directors were by no means satisfied that cabling was the best system. On the contrary, they thought some form of electric traction would be much better. They were, however, dependent upon the choice made by Edinburgh, and if the Edinburgh Corporation chose the cable system the Edinburgh Company must follow it.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED).—An extraordinary general meeting of this Company will be held at the Offices, Ediswan Buildings, Queen Street, London, E.C., on Friday, the 16th inst., at One o'clock, when the resolution, passed at the meeting held on the 29th ult., will be submitted for confirmation as a special resolution.

GAS LIGHT AND COKE COMPANY.—At the ordinary general meeting of this Company on Friday last, the Chairman (Col. W. T. Makins), in moving the adoption of the report, said that the quantity of gas sold during the past six months was 9,841,000,000ft. against 9,227,000,000ft. for the corresponding period of 1894, an increase of 614,000,000ft. Commenting on the question of the incandescent gas light, the Chairman said "it was largely taking the place of the electric light," and the shareholders would consequently be the gainers, although by this system rather less gas was consumed than by the ordinary burner. He hoped the County Council would give this system a consideration, as he contended they would get a more brilliant light from it than by electricity, and it might be rather cheaper. A feature of the half-year was the abolition of meter rentals, which benefited the consumers to the extent of £29,000. He thought they had been fully justified in that policy, but he thought it was undesirable to make any further reduction in the price of gas at present. The Chairman made no mention as to what reduction would have been made in the price of gas, nor as to how long consumers might have waited for the abolition of meter rents, if it had not been for the actual and potential competition of the electric light.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this Company for July amounted to £25,600, and from 1st January to 31st July to £174,800, against, in the corresponding months of 1893 and 1894, £156,800 and £155,400 respectively.

HOUSE-TO-HOUSE ELECTRIC LIGHTING SUPPLY COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend on the Preference shares for the half-year ended June 30th last at the rate of 7 per cent. per annum. The dividend is payable on the 26th inst. The transfer books of the Company will be closed from the 16th to the 26th inst. inclusive. This Company notify that Mr. W. C. Weir, late secretary, has ceased to occupy that position. Mr. Thos. J. Owens is at present performing the duties of the office.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 4th inst. amounted to £1,355. The amount for the corresponding week last year was £1,000. Increase, £355.—A special service of fast trains was run during the busiest part of Monday (Bank Holiday) at intervals of 2½ to 3 minutes, and 52,447 passengers were carried, which is the largest number ever carried on the railway in one day. During the day a train mileage of 2,628 miles was run.

SMELTING COMPANY OF AUSTRALIA (LIMITED).—During the week this Company invited applications for 250,000 £1 shares, payable 2s. 6d. on application, 2s. 6d. on allotment, and the balance as may be determined. The Company has been formed for the purpose of erecting metallurgical works for the treatment of sulphide and other ores at Lake Illawarra, near Sydney, New South Wales, and to acquire from the Camden Syndicate (Limited) certain properties and rights, and also the benefit of an agreement to grant the sole licence to use in the Colony of New South Wales the electrolytic process of Messrs. Siemens Brothers and Co. (Limited) for the production of metallic zinc, patents for which are to be obtained by Messrs. Siemens Brothers. The lists opened yesterday (Thursday), and will close at noon to-day (Friday) for both town and country.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Tuesday next, the 13th instant, a special settling day in 10,277 Ordinary shares (Nos. 1 to 10,277) of the Chelsea Electricity Supply Company (Limited), and have ordered the same to be quoted in the Official List.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended August 2nd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,930.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the half-month ended July 31st are £1,830, as compared with £1,762 in the corresponding period of 1894, an increase of £68.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, July 31.		Price Wednesday, August 7.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending August 7. Highest	Lowest
			TELEGRAPHS					£ s. d.			
£1,012,880	Stock	11 0	Anglo-American	46	48	47	49	4 13 9	Jan., Apr., July, Oct	..	..
£2,993,560	Stock	22 0	Do. Preferred	88	89	88½	89½	4 15 0	" "	89	88½
£2,993,560	Stock	5/0	Do. Deferred	8¼	8¾	8½	9	..	" "	8¾	8 9/16
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer) xd	103	105	102	105	3 16 2	January and July	102½	..
130,000	£10	3/0	Brazilian Submarine	13¾	14¼	13¾	14¼	4 7 9	Mar., June, Oct., Dec.	14⅛	13¾
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 7 6	June and December	..	..
10,000,000	$100	1¾%	Commercial Cable Capital Stock	160	165	160	165	4 4 10	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	—	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	3½	4½	4	5	4 0 0	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10½	9¾	10½	4 7 7	" "	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	—
60,710	20	2/0	Direct United States Cable, 1877	9¼	9¾	9¼	9¾	4 0 5	Jan., Apr., July, Oct.	9 7/16	9¾
400,000	10	5/6	Eastern	16¾	17¼	17	17¼	3 15 4	" "	17 1/16	16 15/16
70,000	10	6%	Do. 6 per Cent. Preference xd	17¾	18¼	17¾	18¼	3 5 9	" "	..	..
£1,297,857	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	126	129	126	129	3 2 0	May and November	129	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899 xd	107	110	105	108	4 12 7	February & August	105½	..
250,000	10	2/6	Eastern Extension	17⅜	17⅞	17⅜	17⅞	3 10 4	Jan., Apr., July, Oct.	17⅝	17⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	127	130	127	130	3 1 7	February & August	..	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	102	106	102	106	4 14 4	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	102	106	102	106	4 14 4	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.) xd	107	110	105	108	3 11 1	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	112%	115%	3 10 2	May and November	..	—
180,227	10	2/3	Globe Telegraph and Trust	10¼	10½	10¼	10½	4 1 0	Jan., Apr., July, Oct.	..	—
180,042	10	6%	Do. 6 per Cent. Preference	17	17½	17⅛	17⅜	3 10 1	" "	..	—
150,000	10	5 0	Great Northern	21¾	22¼	21¾	22¼	3 16 3	Jan., April, and July	22	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue xd	105	108	105	108	4 12 10	March & September	..	..
17,000	25	37/6	Indo-European	49	52	49	52	4 16 2	May and November	51	50
37,548	10	2/6	London Platino-Brazilian	5	7	5	7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	107	111	107	111	5 10 7	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	107	110	107	110	3 13 9	..	—	..
11,839	8	4/0	Reuter's	3½	4½	3½	4½	..	April and October	—	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	125	130	126	131	4 15 0	" "	129	..
15,609	10	2/0	West African Telegraph xd	5½	6½	5½	6½	..	January and July	..	..
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	104	107	104	107	4 15 3	March & September	..	—
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	104	99	104	7 13 10	June and December	..	..
88,321	10	6d.	West India and Panama	¾	1	¾	1	..	..	¾	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10	10½	5 14 3	May and November	..	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	6 13 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110	113	110	113	4 8 6	June and December	..	..
64,242	15	6/0	Western and Brazilian	10½	11	10½	11	4 1 11	May and November	..	—
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	—	..	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4¼	4¾	4¼	4¾	..	..	..	..
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910 xd	104	108	101	105	5 14 3	February & August	..	—
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910 xd	104	108	101	105	5 14 3	" "	..	—
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	18	..	May and November	..	—
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	..	March & September	..	—
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	3	4	3	4	..	..	—	..
224,850	10/0	1½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	—	May and November	..	—
171,504	£1	8·2 5d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	⅝	..
484,597	5	2/6	National	6	6½	6⅛	6⅜	3 13 5	June and December	6 5/16	6⅛
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	16	17	6	8	3 6 8	" "	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	" "	..	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅜	6⅛	5⅞	6⅜	4 0 0	—	6¼	..
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	105	107	105	107	3 5 5	January and July	106¼	..
58,000	5	3/0	United River Plate	2½	3	2½	3	..	" "	..	..
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	92	97	92	97	5 3 1	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	14	15	14½	15	1 13 4	—	14¾	..
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid) xd	16	16½	15½	16½	3 12 9	—	16⅝	..
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	131	134	131	134	3 12 9	June and December	133½	133
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/6	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	—	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		—		..	—	..	..
8,322	£5	..	House-to-House Electric	—		—		..	—	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		—		..	—	—	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	—	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7⅝	7¾	7⅝	7¾	..	—	..	..
111,000	5	..	London Electric Supply	5/16	7/16	..		..	—	..	—
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	10¾	11¼	10¾	11¼	2 13 4	..	..	—
£150,000	Stock	4½%	* Do. 4½% Debs.	116	119	116	119	3 15 11	June and December	..	..
6,452	£10	2 0	Notting Hill Electric	8½	8¾	8½	9	..	—	..	—
19,980	£5	2 0	St. James and Pall Mall xd	8	8½	8	8½	..	—	8¼	..
20,000	£5	7%	Do. 7 per Cent. Preference xd	9	9½	9	9½	3 13 8	—	..	..
59,900	5	2/6	Westminster Electric Supply (fully paid) xd	7¾	8¼	7¾	8¼	3 0 7	—	..	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2	2¼	2	2¼	6 11 7	—	2⅛	2 1/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	—	2 5/16	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	112	115	112	115	3 19 8	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	2	2½	1	2	..	January and July	..	—
12,139	5	..	Edison and Swan United	2	2½	2	2½	..	..	2⅛	..
£100,000	Stock	4½%	Do. 4% Mortgage Debenture Stock	104	107	104	107	4 4 1	..	103½	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		..		..	..	—	..
120,000	2	..	Electric Construction	¾	1	¾	1	..	..	—	..
12,845	2	2/9¾	Do. 7 per Cent. Cumulative Pref.	2	2½	2	2½	..	..	—	..
91,195	2	10/0	Elmore's Patent Copper Depositing	⅞	1⅛	⅞	1⅛	..	..	⅞	—
20,000	5	..	Fowler-Waring Cables (fully paid)	¼	¾	¼	¾	..	..	..	..
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	19	21	19	21	4 15 3	February & August	..	..
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	..	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..	—	..	..
16,000	£10		Do. 8 per Cent. Preference	—		..		..	December and June	..	..
20,000	9	1/0	Manchester Edison-Swan "A" (£1 5s. paid)		½	⅜	⅝	..	..	½	..
37,350	12	12/0	Telegraph Construction and Maintenance xd	43	45	43	45	..	March and July	44½	..
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	..	January and July	..	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£63,[illegible]70	10	6/0	W. T. Henley's Telegraph Works Ordinary xd	10½	11½	10½	11½	..	..	11½	11½
£30,000	10	..	Do. 7 per Cent. Preference	15	15½	15	15½	4 10 4	..	15	..
£[illegible]0,000	Stock	..	Do. 4½% Mortgage Debenture Stock	104	107	104	107	..	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1½%	City and South London Railway	41	43	41	43	2 18 2	May and November	41	..
7,000	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	..	..	..	—
£67,130	Stock	4%	Do. 4% Perpetual Debenture	133	135	133	135	..	May and November	..	..
87,500	£10	2%	Liverpool Overhead Railway	10 7/16	10 9/16	10 5/16	10½	1 18 1	—	10⅜	10 5/16
6,295	10	5%	Do. 5% Preference	15	15½	15¼	15¾	3 4 6	—	15½	—
1[illegible]5,000	Stock	4%	Do. 4% Debenture	110	112	111	113	..	January and July	—	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 900. [No. 18. Vol. XXXV.] FRIDAY, AUGUST 16, 1895. PRICE SIXPENCE.

NOTES.

By the casting vote of the Chairman the St. Pancras Vestry last week decided to pervert its administrative powers to the crushing out of a possible competitor with a commercial venture of its own—to wit, its electric supply system. The London Hydraulic Power Company sought permission to lay a pipe in order to work an already erected lift in Charlotte-street. This permission was refused at the instance of the Electricity and Highways Committees. The impropriety of this action is self-evident. It is to be hoped that, unless the St. Pancras Vestry is quickly shamed into a more broad-minded, public-spirited frame of mind, the legality of its veto will be tested. The cloven foot of electrical municipalisation has taken even less time than we anticipated to show itself.

If proof were wanting of the shortsightedness displayed in the matter of the salaries by many of the Municipal Authorities who have undertaken the supply of electric current, it would be found in the remarks made by Mr. Holder, the Chairman of the Hull Electric Lighting Committee, in announcing the resignation of Mr. A. H. Gibbings, who has recently been appointed Corporation electrical engineer at Bradford. Mr. Holder said that Mr. Gibbings' resignation had taken him quite by surprise, and he presumed that it was purely a question of remuneration. The resignation had taken place at a most disadvantageous time for the Committee, as they had plans and contracts in hand for new machinery, the specifications and all the details connected with which were prepared on suggestions from Mr. Gibbings. The Committee had now lost by resignation two electrical engineers, and it appeared to him (Mr. Holder) that the Corporation were not paying a sufficiently large salary to induce first-class men to retain the position. Awkward incidents like this will, we trust, hasten the day when the salaries of engineers in charge of municipal stations will be regulated with some regard to the work and responsibility imposed.

Some time ago the electric light was introduced into the composing rooms of the *Dundee Advertiser*. Inverted Crompton-Pochin arcs were adopted by the advice of Mr. Thomas Reid, of University College, eight of these lamps being used in the case-room alone. The electric light is also used in the proof-readers' boxes and in the literary and commercial departments, and experiments have been made in the machine and despatch rooms, which have proved so satisfactory that it is probable that the electric light will shortly be extended to these departments. Current is obtained from the Corporation mains. In some composing rooms objection has been taken to the electric light, but the compositors on the *Dundee Advertiser* are, we believe, very pleased with it. Unquestionably during the summer months the electric light is of great advantage in printing offices, but we fear that, during the winter, compositors, whose fingers are seriously affected by the cold, will, at any rate in the early hours of work, call for some means of procuring artificial warmth. Where the current is readily available proprietors of printing offices should be approached by wiring contractors with the object of inducing them to put down electric radiators, which have only to be tried to prove their great value from the point of view of healthiness and adaptability to special circumstances. As usually arranged, it is necessary with gas or hot-water apparatus, in order that the men working in the centre of the room may be warmed, to overheat the space round the walls; moreover, the air in a steam-heated composing room is painfully dry, unless the usually-neglected precaution of having open vessels well filled with water is observed. In any case, it is inexcusable to foul the air with the products of coal-gas combustion in order that a work-room may be properly warmed as well as properly lighted. The ideal arrangement would be electric lighting and electric radiators; the next best arrangement would be electric lighting and properly-arranged gas stoves. Insurance companies, we understand, do not encourage the use of gas-stoves in printing works, and are inclined to look askance at electric radiators generally; but, provided good work is put in, in neither case is there much justification for this timid attitude.

We would call the attention of our readers to an article on "A Graphical Method of Analysing Harmonic Curves," by Mr. E. Basil Wedmore, which we publish this week. The investigation of alternate-current waves has given a great impetus principally to the analysis of complex single-valued harmonic waves and curves; though this is by no means the only physical application where even a theoretical interest arises. The costliness of apparatus and instruments for mechanically analysing complex harmonics into their simple harmonic constituents is so great, that the majority of students

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who wish to pursue this branch of research are compelled to adopt some more or less laborious and complicated geometrical process of analysis. Recently we have described several of these graphic processes; and now yet another is contributed by Mr. Wedmore. The sole material for the operation of Mr. Wedmore's method is a Cartesian curve representing one single cycle of the harmonic wave to be analysed. This curve is subdivided in equal strips parallel with the axis of the function, commonly denoted by y; and the superposition of these strips on the same base, with the algebraic addition of the ordinates, gives a resultant curve from which certain of the components of the harmonic wave have become eliminated. This subdivision resembles the use of a group-reagent in chemical analysis; since it separates out a family of harmonic components. The use of successive subdivisions, increasing by the series which is the prime numbers, gives a succession of these families of components. And, from the families the individual components themselves are to be separated out. Mr. Wedmore's method is no doubt capable of yielding good and useful results if great care is taken in drawing and superposing the curves; but it is a laborious process, and where there are many component harmonics to be isolated it is one that must take up a great deal of time.

The type of dynamo described by Prof. Elihu Thomson in the Paper which we reprint this week, is of interest as illustrating the capability of an armature to supply part or the whole of its working field. The Sayers dynamo has lately shown that this possibility can be practically utilised, and in the present case the result arrived at was the over-compounding of the dynamo, so that its terminal voltage rose considerably as the load was increased although there were no series coils. No novel method of commutation was involved, and the brushes were given a forward lead in the usual fashion. Prof. Thomson expressly disclaims any thought of applying the design to commercial practice; indeed, a dynamo, which in its action is bipolar, is given what is to all intents a four-pole field, and such an arrangement could hardly compete in economy with ordinary compounding coils unless the required rise of pressure was a very large percentage of the no-load volts. Two of the poles have no winding, and are entirely idle at no load, but when the armature supplies current and the brushes are given a forward lead, these unwound poles come into play as additional paths for useful magnetic lines. In the dynamo of which constructional details are given, the area of face presented by the unwound poles to the core was actually larger than that of the wound poles, yet the terminal volts which were 84 at no load did not rise to more than 104 at full load—a rise large indeed, but not unattainable by ordinary methods. The idea, however, suggests itself that a similar arrangement of unwound but smaller poles might be combined with a Sayers armature so as to give a reversing field which should automatically increase in strength in due proportion to an increasing armature current.

Mr. Addenbrooke has done good service by calling attention this week, in his article on "The Telephone in England," to the fact that the outdoor work of the telephone business in this country is not nearly so highly paid when compared with Continental countries as many believe, whilst the exchange operators are actually paid less. At the same time, it does not necessarily follow from this, even if we admit Mr. Addenbrooke's assumption as to the greater cheapness of telephone material in this country, that telephone lines can be erected and worked at practically the same cost in England as on the Continent. Money wages are not by any means a complete criterion of the cost of labour to the capitalist. We must also know something as to the "efficiency" of the labourer, and something as to general prices. Mr. Addenbrooke tells us there is "a general idea that an Englishman gets over the ground rather quicker" than a foreigner. We sincerely hope he does, but we do not know that he does. These general ideas as to the innate superiority of the British workman had no doubt a considerable basis of fact half a century or more ago, but we suspect they are nowadays for the most part as grave a delusion as that held by the Spaniards of to-day on the subject of their national greatness. However, be this as it may, Mr. Addenbrooke has pointed out the proper path to the indefatigable but inaccurate assailants of the National Telephone Company. He has proved that the money wages paid by the Company to be in many cases less, in most cases but little higher, than those paid on the Continent. It is for him or others to prove that the cost of erecting, maintaining and working a telephone system is in the same state, that the Continental concerns honestly pay their way, and something over; that the money paid for patents, experiments, and amalgamations was, at the time of payment, extravagant. Then, and not till then, will the National Telephone Company be convicted of wanton over-capitalisation and gross mismanagement, and deservedly condemned to lower its tariffs and further improve its service irrespective of its dividends. We should like nothing better than a good telephone service at a cheap rate, but we should like also to be able to accept it with a clear conscience.

Dr. v. Kowalski read a Paper on a new accumulator at the general meeting of the German Electrochemical Society lately held at Frankfort, and detailed its capabilities while only partially describing its construction. Such points as appear to be of interest are here transcribed. The frame consists of celluloid and an acid-resisting paper; the negative plate is of antimonial lead surrounded with oxides of lead and antimony; this is dipped in a solution, cautiously characterised as "an electrolyte," whereby great virtue is imparted to the coating of lead and antimony oxides. The electrode, after sojourning for one day in the magic bath, is fit for use, and is presumably opposed to another electrode possibly of similar nature; on general grounds it may be guessed that both electrodes are immersed in "an electrolyte." Nothing but morbid curiosity could desire fuller information. With regard to the capabilities of the new accumulator, it is stated that by repeated formation with a current of three amperes, an output of 20 ampere-hours per kilogramme of electrode is attained, rising to 25-27 when the formation is prolonged to eight days. When experimentally agitated to simulate the conditions

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obtaining in an electric tram, the value falls to 17-18 ampere-hours, but the amount of detritus from the plates is inconsiderable. Dr. v. Kowalski considers that the new accumulator will prove particularly useful for tram propulsion and railway carriage lighting.

Personal.—We hear that the Order of the Eagle has been conferred upon Mr. Nikola Tesla by the Prince of Montenegro.

Salford.—The electric supply station of the Salford Corporation was formally opened by the Chairman of the Gas and Electric Lighting Committee last Wednesday week, the 7th inst.

Cable Interruptions:—

	Date of Interruption.
Accra-Kotonou	August 9th.
Accra-Lagos	August 12th.

Telegraphic Communication in the Congo.—Work has lately been completed on the first line of telegraph in the Congo—between Borna, in the Lower Congo, and Matadi, the starting point of the Congo Railway.

Electric Conductors of Aluminium.—The French Société Electro-Metallurgique has, it is stated, recently supplied to M. E. C. Grammont an electric conductor made of aluminium, to be used in an electric power transmission at the Plaine and Pont de Cherny works of M. Grammont.

Durham College of Science.—Complete courses of instruction in mechanical, marine, electrical and civil engineering, naval architecture, mining and metallurgy are given at this College. The session commences on September 23rd, and further particulars appear in our advertisement columns.

Electro-Chemistry in Switzerland.—A company has just been formed at Turgi, Switzerland, to be known as the Société Anonyme d'Electrochimie. The new concern will establish plant for the production of chlorate of potash according to an electrolytic method invented by Dr. F. Oettel, who will manage the new works.

The Private Letters of Sir W. F. Cooke.—It may interest our readers to know that the Queen has been pleased to accept a copy of the extracts from the private letters of the late Sir W. F. Cooke, relating to the invention and development of the electric telegraph, recently published by permission of the Institution of Electrical Engineers.

Deaths by Lightning.—At Billingham on Saturday last a man was killed by lightning while taking refuge in a brick-kiln.——On the same day at Alfriston, near Lewes, a carter and his wife, while walking home, were struck by lightning. The man was killed right out, but the woman was only rendered unconscious, and recovered after a time.——At Douglas, Isle of Man, on the same day, the Woodbourne Hotel was struck by lightning, and all the electric fittings were destroyed.

Chicago Exhibition.—The President of the United States has issued, under the authority of a special Act of Congress, a complimentary diploma to the commissioners of the countries which took part in the Chicago Exhibition. The representatives of Great Britain who have received these diplomas, which acknowledge "the grateful appreciation of the Government and people of the United States of America for their valued participation" in the Exhibition, are Sir Richard Webster and Sir Henry Trueman Wood, the chairman and secretary of the Royal Commission.

Electrical Communication with Lighthouses and Lightships.—The members of the Royal Commission on Electrical Communication to Lighthouses and Lightships started on a tour of inspection to Denmark and the Baltic on Tuesday, 13th inst. All the principal Danish lightships and lighthouses, both in the Baltic and North Sea, will be visited. The Post Office authorities have placed their cableship "The Monarch" at the disposal of the Commission for this tour. The Commission expect to return to England about Friday, 23rd inst.

Utilisation of Water Power on the Rhone.—The prize competition for the best scheme for the utilisation of the water-power of the Rhone at the Canal du Jonage, to the extent of 20,000 H.P., intended for transmission to Lyon, which was offered by the Société Lyonnaise des Forces Motrices du Rhône, has just been decided in favour of the Compagnie de l'Industrie Électrique of Geneva and Paris for the electrical part, and Escher, Wyss and Co., of Zurich, for the hydraulic part. The jury consisted of Profs. Ferraris, Gérard and Picou. It may be of interest to note that the two firms named obtained also first prizes in the Niagara competition.

Niagara.—Those of our readers who are interested in the utilisation of water power at Niagara will be glad to know that a special number of *Cassier's Magazine* is devoted entirely to an account of this scheme. Ten special articles describing the various sections of the work have been written by the men directly concerned. These articles are profusely illustrated, there being no less than 200 views and portraits, and scale drawings of machinery. In view of the emphatic support which the first vice-president of the Cataracts Construction Company, Mr. F. L. Stetson, has given (see *The Electrician*, August 9th, p. 480) to the claims of Prof. George Forbes in connection with the design of the Niagara plant, we are astonished to find that Prof. Forbes' portrait does not appear in this otherwise complete account of the Niagara enterprise, nor do we find any but the scantiest reference to him, the most important member of the consulting staff.

The Institution of Junior Engineers.—The annual summer meeting of this Institution, whose headquarters are in London, takes place from August 17th to 24th, the rendezvous being Belgium. The towns to be visited include Antwerp, where the municipal docks, M. Kryn's diamond-cutting works, and other places of interest will be opened to members' inspection. At Ghent, MM. Carel's engine works, M. de Hemptinne's cotton spinning works, and M. Van Houtte's nursery gardens will be seen; at Brussels, the electric lighting station; whilst at Liége the works of the Société Cockerill, the Vieille Montagne zinc works, the St. Leonard locomotive works, the Val St. Lambert glass works, the small arms factory, and the electric tramway installation will be visited. An excursion to Verviers, where the Chamber of Commerce will entertain the visitors, is arranged for the purpose of seeing works in connection with the woollen cloth industry. Here MM. Peltzer's works, and those of M. Duesberg-Delrez, La Vesdre, and M. Hauzeur Gerard Fils will be opened. A visit to the celebrated Gileppe Reservoir, from which Verviers receives its water supply, is also included in the programme.

Electric Traction in Chicago.—According to the *Western Electrician* the three principal tramway companies of Chicago will have, when the work under way is completed, as it will be in a few months, electric lines having a total "trackage" of 335 miles. To supply power to the car motors on these lines, engines and generators aggregating in capacity 27,500 H.P. have been or are about to be installed. In addition, the four elevated railway companies, which have in operation or under construction about 85 miles of track, are certain to make use of electric power. One already does so, another has just awarded the contract for electrical equipment, a third, under construction, was planned from the first as an electric line, while the fourth, the oldest of all, must replace its steam locomotives by electric motors to place it on a paying footing. The steam railway companies that handle the bulk of Chicago's enormous suburban passenger traffic are, according to our Chicago contemporary, also considering the advisability of substituting electric power for the existing steam service, and one or two have decided to do so. This change has been brought about within a period of three years. "Chicago was slow in adopting the electric railway, but once the decision was made the work was pushed with characteristic energy and vigour."

An Interesting Electric Power Transmission Plant.—The town of Carcassonne has enjoyed the advantages of an electric system of distribution since 1890. The generating house is situated close to the River Aude, some five miles from the town, and comprises two 100 H.P. turbines, driving two 2,000-volt alternators. The demand for current having increased, M. Sicre, the owner of the plant, constructed a sub-station in his works at Carcassonne, comprising an Oerlikon 50 H.P.

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2,000-volt alternator and a continuous-current dynamo. The coupling connecting the alternator and dynamo is in the shape of a pulley, which can be geared to a 100 H.P. steam engine by means of a belt. Under ordinary circumstances one of the generators at the generating station drives the motor-alternator at Carcassonne, the dynamo charging a battery of accumulators, and furnishing them with a current at a pressure of 160 volts. During the evening this transmission is suspended, and the battery supplies current to a special installation of 500 glow lamps. In times of extra high or extra low water, the machines at the sub-station come to the assistance of the main generators, the 100 H.P. steam engine being brought into use to drive both the continuous-current dynamo and the alternator, the former supplying current at 110 volts to the circuit usually supplied by the accumulators, and the altrnator working inp arallel with the 2,000-volt alternators five miles off.

Refuse Destructors as Steam Generators.—Last week, at the meeting of the British Institute of Public Health, at Hull, Mr. E. Manville read a Paper entitled "Refuse Destructors as Applied to Electric Lighting Purposes," in which he stated that having experimented on a large scale with samples of ash-bin refuse, collected at a season when household fires were not much in use, he had found the refuse extremely rich in carbon indeed; when the unsorted refuse was burnt directly in a boiler it evaporated 3lb. of water from and at 212°F. In his opinion the steam required could be obtained from the burning of this refuse in a properly designed arrangement of destructor cells and boilers, if only one-third of the calorific value of the refuse was utilised in the boilers, due allowance being made for the complete combustion of the ash-bin refuse and its gases. Mr. Manville then went on to refer to the Shoreditch scheme of utilising a refuse destructor combined with Mr. Druitt Halpin's thermal storage system, in which he stated that pressures of 200lb. to the square inch would be used. Mr. W. Holder, of Hull; Mr. R. S. Roundthwaite, of Sunderland; and Mr. S. Beaman, of Warrington, agreed in thinking that there was no field for the refuse destructor in this connection in places where coal was reasonably cheap. Mr. Manville, in closing the discussion, said that he admitted that power could not be generated as cheaply in this way as with coal, but asked his audience to remember that if the refuse had to be burnt, whatever useful heat they could obtain from it was pure gain.

Brazil and Trinidad.—At a meeting of the Balloon Society, held last Wednesday evening, Senor Juan Sanchez-Villegas contributed a Paper entitled "Gleanings of the History of Brazil and Trinidad." Senor Sanchez-Villegas described Trinidad as a barren volcanic islet situated some 700 miles from the southern part of the Brazilian coast and occupied by sea birds and land crabs. In the year 1700 Capt. Halley, who afterwards became the celebrated astronomer Dr. Halley, took possession of the islet in the name of the English monarch, and made an unsuccessful effort to stock it with pigs and sheep. The islet then serving no purpose, it was soon afterwards left to the Portuguese, who perhaps had first discovered it. The recent action of the British in taking possession of it again had wounded the patriotism and the pride of the Brazilians and led them to give expression to their feelings in public demonstrations, but it was hoped that the matter would soon be satisfactorily ended through diplomatic channels. The object in view was to render our telegraphic communication with the southern countries of South America independent of Brazil, our only cables to these parts of the world now having their termini on on the northern coast of that country. By means of Trinidad as an intermediary station we might communicate with the Argentine Republic, Chili and Peru direct. A cable could also be laid between those countries and the Cape of Good Hope viâ Trinidad and St. Helena. The following bombastic resolution was then passed:—"That having regard to the unique and influential position of Great Britain in promoting the progress of humanity throughout the world, and the high character of the statesmanship by which her world-wide affairs are directed, it is desirable, in the interests of the nations at large, that she should retain possession of the island of Trinidad, as well as other convenient stations which are necessary and contributory to the fulfilment of her high mission; and when it is considered that Great Britain owns seven-eighths of the submarine cables of the world, and that she has invested capital therein to the amount of £300,000,000, the commanding importance of the matter as a practical necessity cannot be exaggerated."

Researches on the Electric Discharge of the Raia Torpedo.—At the meeting of the Académie des Sciences on the 15th inst., M. d'Arsonval communicated the main results of some investigations on the electric discharge of the Raia Torpedo, which he has recently been carrying out at the Maritime Zoological and Physiological Laboratory at Concarneau. M. d'Arsonval's main object was to obtain accurate electrical measurements, which he points out should throw light upon the intimate connection between the electric discharge of this fish and the discharge obtained from ordinary muscular contraction; the discharge of the electric organ being, in his view, nothing more than an exaggeration of the oscillations which are noticed when muscles are contracted. Two registering devices were employed. The first, which M. d'Arsonval calls a "galvanograph," was nothing more than a d'Arsonval-Deprez galvanometer, the suspended coil being wound on an aluminium bobbin and attached to the centre of the india-rubber membrane of a Marey air drum, this drum being connected by an india-rubber tube to a second and smaller magnifying drum, actuating a short lever which marked a smoked cylinder. M. d'Arsonval also employed a hot-wire instrument, consisting of a silver wire of about 0·1mm. in diameter and 40cm. to 50cm. long, stretched between two rigid supports. Connected to the centre of this suspended wire was a second wire, kept in tension by an india-rubber spring, and carrying a pointer moving over a recording cylinder. The fish to be experimented upon was placed in a vessel with a metallic bottom, containing sea-water to the depth of about 1cm. Two tinfoil electrodes having the same shape as the electric organs were applied to the fish above and below, being connected together at one end through a strip of tinfoil, and at the other through the measuring instruments; the upper electrode being negative and the lower positive. To provoke a discharge, the fins were lightly pinched. The tracings obtained on the "galvanograph" showed that the discharge was not continuous but consists of six to ten successive discharges at intervals of about $\frac{1}{100}$th of a second, the strongest discharge being the third. The current was always in the same direction, and the curves had precisely the same form as those obtained from muscular contraction. The mean duration of a discharge varied between $\frac{1}{10}$th and $\frac{1}{20}$th of a second, at a temperature of 19°C. From torpedos having a diameter of from 25cm. to 35cm., which had been kept in the laboratory tanks for a week, M. d'Arsonval obtained electromotive forces of from 8 to 17 volts and currents of from one to seven amperes. With a view of visibly showing to an audience the energy of this animal's electric discharge, M. d'Arsonval has experimented with four volt glow lamps taking one ampere. On pinching the animal a lamp of this kind is momentarily incandesced to white heat, and if the pinch is too severe the lamp is often burnt out. Under favourable conditions three such lamps can be placed in series and incandesced. The needle of a Deprez-Carpentier ammeter, the scale of which went up to five amperes, was frequently sent off the scale. If the electric organ is discharged through a small Ruhmkorff coil, Geissler tubes are illuminated. The two organs work synergetically and with the same intensity. The power of a discharge is soon exhausted. If only one half of the organ has been used, and a glow lamp is then connected with the other half, a powerful current is obtained, proving that voluntary nervous excitation is not sufficient to exhaust the organ, and that the electric discharge is produced in the organ itself and not in the nervous system. After five or ten minutes rest, the organ is as vigorous as ever. On placing a stethoscope on the organ during a discharge, a note was given corresponding to 100 vibrations per second, showing that the organ is a seat of vibration, as is the case with muscles during voluntary contraction. If two discharges are taken simultaneously from one half of the organ, one from the front end and one from the back, there is a lag of about $\frac{1}{25}$th of a second between them, that from the front leading. When at rest, no difference of potential can be discovered between the two halves of the organ.

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MAGNETIC UNITS.

The following are letters received from Mr. Heaviside, the first being the one referred to on page 11 of Dr. Lodge's pamphlet,* already circulated to members of the British Association Committee on Electrical Standards :—

"Paignton, January 28, 1895.

"DEAR LODGE: I had some idea of marking your paper all through, in the way of simplifying it mainly, but I gave it up when you got immersed in the 4π muddle. You (the B. A. Committee I mean) are in a beautiful state of muddle by reason of refusing to complete your work properly. You cannot say you did not know you were wrong till after the 'legalisation'; you cannot put it on to International Conferences; you began it, and the blame is yours—all the more so from your refusal to put it right, or even to make the beginning of an attempt to put it right, by open admission of error, and recommendation of a revision, and by properly discussing it at your B. A. meetings and at Chicago. There is no way out of the muddle than by my radical cure, I believe. When practicians get to be a little more enlightened than they are, the B. A. system will be something for them to laugh at and damn, if it is not already. Even in pure theory, it has been the cause of much mischief, of which I could give examples in the theories of eminent men. Swinburne has suggested in *Nature* that I am very likely wrong in this matter. What is more suggestive is that Magnus Maclean, of Glasgow, who wrote on Units in the *Electrical Engineer* lately, had the assurance to dismiss my reform with the condemnation that my reasons were unwarranted. The geographical suggestiveness is obvious, though perhaps equally unwarranted. But then *you* are a rationalist, and so is FitzGerald, and Larmor, and perhaps many more. Perhaps a majority on the B. A. Committee are rationalists. Then why do they not do the proper thing, and complete their work properly? You cannot get out of the muddle in any other way.

"Voltage and gaussage. I dare say practicians will not like them. Gaussage especially. (Sausage?) I do not admire them myself *very* much, on account of the 'age,' but I took voltage as I found it, and extended the meaning. (How about voltation and gaussation?) Accepting these words voltage and gaussage, however (or others), it should be noted that they stand for E.M.F. and for M.M.F., *not* for falls of potential (electric or magnetic), because the latter are exceptional, and in fact often become meaningless and quite wrong. Practicians are quite up to circuitation; the E.M.F. in a circuit, for instance, is the sum of the elementary effective parts of the real electric force. I think, then, that they should speak of the gaussage or the voltage in a circuit, or along a line, or from *a* to *b*, &c.; not gaussfall, which I do not like at all.

"I think 'intensity of' may be dropped altogether. I maintain that **E** and **H** *are* forces, dynamically (generalised, of course); specify them as the electric force and the magnetic force, and you are all right, and dynamically sound. Their factors **D** and **B** in the energy density are the corresponding fluxes.

"I think your opening part could be simplified a good deal. After that, when you bring in 4π and 10^{-1} and $\frac{10}{4\pi}$, and so forth, I would not presume to criticise. I would rather not concern myself with such a bad job.

"About the meaning to be given to inductance, permeance, &c., when you take in iron, and *do not* keep to very small forces or small variations in big forces. Here the practical requirements of the practician have to be consulted undoubtedly, but if they are let alone they may do it in some way that they will be sorry for afterwards. The difficulty seems to me to be that there is no definite connection between H and B. In § 192 of 'Electromagnetic Theory' I have tried to indicate how we may perhaps come to a good magnetic theory, in which, however, it would be necessary to discriminate; thus, $\mathbf{H}=\mathbf{F}+\mathbf{h}$; **F** *only* to be free, such that the curl of **F** is the current density.

"But as regards the extended meaning of μ: suppose we do take a definite connection between **H** and **B**, ignoring hysteresis, and that we have

$$-\operatorname{curl}\mathbf{E}=\dot{\mathbf{B}}.$$

How put $\dot{\mathbf{B}}$ in terms of **H**? It seems to me that the best theoretical way would be

$$\dot{\mathbf{B}}=\frac{d\mathbf{B}}{d\mathbf{H}}\frac{d\mathbf{H}}{dt}=\mu\dot{\mathbf{H}},$$

so that $\mu=\frac{d\mathbf{B}}{d\mathbf{H}}$ and $\mathbf{B}=\int\mu\, d\mathbf{H}$. [Similarly $\mathbf{D}=\int c\, d\mathbf{E}$.] [This is like saying that the volumic heat capacity of a body is

$$c=\frac{d\mathrm{H}}{dv},\quad \text{so that}\quad \mathrm{H}=\int c\,dv,\quad \text{and}\quad \dot{\mathrm{H}}=c\frac{dv}{dt},$$

H being the heat per unit volume, v the temperature. It goes well in the diffusion of heat.]

"Then, similarly, we should have in a circuit, (N = total induction),

$$\mathrm{E}=\dot{\mathrm{N}}=\frac{d\mathrm{N}}{d\mathrm{C}}\frac{d\mathrm{C}}{dt}=\mathrm{L}\dot{\mathrm{C}};$$

so that $\mathrm{L}=\frac{d\mathrm{N}}{d\mathrm{C}}$ and $\mathrm{N}=\int \mathrm{L}\,d\mathrm{C}$. The activity $\mathbf{H}\dot{\mathbf{B}}$ per unit volume would give

$$\dot{\mathrm{T}}=\mathrm{H}\dot{\mathrm{B}},\qquad \text{or}\qquad \mathrm{T}=\int\mathrm{H}\,d\mathrm{B}$$
$$=\mathrm{H}\mu\dot{\mathrm{H}},\qquad =\int\mathrm{H}\frac{d\mathrm{B}}{d\mathrm{H}}d\mathrm{H}=\int\mu\mathrm{H}\,d\mathrm{H};$$

and by volume integration, we should get for a coil,

$$\dot{\mathrm{T}}=\mathrm{C}\dot{\mathrm{N}}=\mathrm{CL}\dot{\mathrm{C}},$$
$$\mathrm{T}=\int\mathrm{C}\frac{d\mathrm{N}}{dt}dt=\int\mathrm{C}d\mathrm{N}=\int\mathrm{CL}d\mathrm{C}.$$

"But whether this is likely to be convenient for the iron people, I would not presume to say. Perhaps they do not want any of these quasi-scientific ways of trying to represent facts which are not definite in themselves; *i.e.*, $d\mathrm{B}/d\mathrm{H}$ is not a mere function of H."

"Paignton, February 3, 1895.

"DEAR LODGE: In my last, commenting on your report, I had doubts as to whether the $d\mathrm{B}/d\mathrm{H}=\mu$ definition would be convenient for practicians. It is obviously theoretically recommendative. On consideration, I again doubt it. Further than that, I do not think that quasi-official or conferential decisions are desirable on moot points involving unsettled theory. (That, however, is not a new opinion.) For the case is peculiar. There is no theory of magnetism, but only the beginnings of one. It is an excellent theory, too, only the application is limited. Now the effect of iron on the magnetic field is in general theory only a side matter, a secondary phenomenon, like many others. Commercially, it assumes exaggerated importance, so much so, that one is apt to overlook other and more important considerations in general theory. Practicians swallow camels in their 'predetermination' work. It is based on theory, in fact on the precise theory, but is modified empirically by characteristic curves, percentage allowances for waste by hysteresis and leakage (which is a big camel). They do their swallowing with complacency, so I suppose they do not suffer ill effects. If I were a practician, I would swallow camels too, if I found that they agreed with me, and sacrifice rigour to expediency. Not being a practician, though, I should very much like to see a good theory of magnetism with variable μ, and leave practicians to work any way they like, with fictitious make-believe permeances and reluctances, and lumping together of independent variables."

"Hysteresis is the theoretical trouble. Along with this, waste of energy. Now it is not enough to know how much waste there is in a cycle; I want to know how the waste comes in in different parts thereof, and on what it depends. Is it *invariably* associated with a change of the intrinsic magnetism (intrinsic *pro tem.*), or only accidentally, as a secondary matter? There is a curious case in last week's *Electrical Engineer*, in a paper by Mavor. The stuff is *called* steel, but is said to be chemically

* See *The Electrician*, August 2nd, p. 449, *et seq.*

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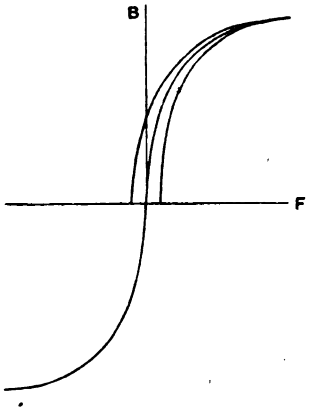
pure iron. It gives relatively small waste, but large hysteresis, and large μ in the ordinary sense. Say as in the figure. It is imaginable that *quite* pure iron would make the loop become of insensible area. As it is, it is suggested to ignore the loop, and take the median curve; but if we do that we have B vanishing with H, a regular $\mu = dB/dH$ system, with energy stored and no waste. But owing to the extreme steepness of the curves we see that there is very large intrinsic B when H is zero or small, and this will be so even when the loop is made of smaller and smaller area. It seems quite absurd to take B/F to represent permeability, or dB/dF either. Here F is what the practicians call H; it belongs to the coil; curl $\mathbf{F} = \mathbf{C}$; not curl $\mathbf{H}$. But say $\mathbf{H} = \mathbf{h} + \mathbf{F}$, so that curl $(\mathbf{H} - \mathbf{h}) = $ curl $\mathbf{F} = \mathbf{C}$. We *must* allow for distinction between $\mathbf{H}$ and $\mathbf{F}$ in theory. As B is not a function of F only, we must have *at least* one other variable quantity. Perhaps h would be enough for a practical theory under limitations. But we need to know how h varies with F, or how much of B at any moment is con-



nected with F and how much is independent *pro tem.* I think this is the right way to look at it, because, first, this way satisfies Poisson's old theory (greatly simplified in expression) of induced magnetisation, and also the more modern view of the same, induced and intrinsic together (intrinsic constant though) (also simplified in expression), and if h could be considered given (as a function of the time for instance) with a given connection between B and H, we should still have a workable theory, a generalisation of the present. But practically we do not have h as a given datum (constant or variable). It comes in through the action of F, and, it seems, not in a regular or constant way. For the symmetrical loop is only got after many reversals, putting the iron into a peculiar state. If there were no waste (or it were insensible), it might be the same, but I am inclined to think there must be waste in the initial settling, even if there is none finally (in a suggested pure iron).

"I should think Ewing ought to have the material at his disposal, and the proper realisation of the facts, to be able to discriminate between B total and intrinsic, and to get a sort of normal true inductivity curve (quite different from the commonly assumed) and so come to a sort of theory."

A GRAPHICAL METHOD OF ANALYSING HARMONIC CURVES.

BY E. BASIL WEDMORE.

For the application of this method it is only necessary that an accurate sketch be obtained of one complete period of the curve. The result of the analysis is to give the component sine curves, each in its relative position with respect to the original curve.

The principle of the method is as follows:—If N periods (N being = or > unity) of a given sine curve be taken, and divided into P equal parts, and the P parts superposed and added algebraically, then the result will be, first, zero, if N does not equal P or a multiple of P; or secondly, will be a curve of a periodicity equal to that of the original curve and of an amplitude equal to P times that of the original curve, if N does equal P or a multiple of P. Thus, in Fig. 1 we have four curves of various periodicities. The figure is divided into two parts (*i.e.*, P = 2), and in Fig. 2 the parts are superposed, Fig. 3 showing the result of the algebraical addition. Here it is seen that curves 1 and 3, having respectively 1 and 3 periods, have been reduced to zero, 1 and 3 not being = P, or a multiple of P, while 2 and 4, where N = respectively P and a multiple of P, have been reproduced with their amplitude doubled—*i.e.*, multiplied by P.

Now, it will be clear that if we take one complete period of a curve consisting of a combination of sine curves of various periodicities and amplitudes, and having divided it into P parts, we superpose and algebraically add them, we shall obtain a curve which, when divided in amplitude by P, will consist only of a combination of those curves whose periodicity as compared with the original curve = P, or a multiple of P, all

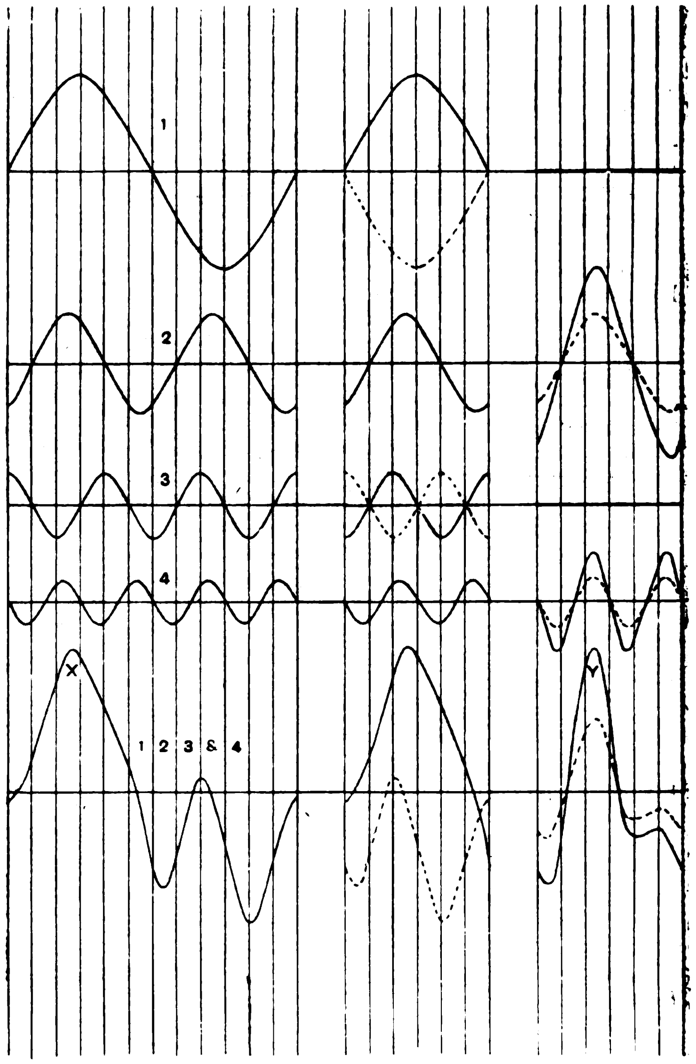


Fig. 1. Fig. 2. Fig. 3.

To show the Effect of Superposition on the various Components of a given Harmonic Curve.

other curves having become eliminated. Thus X in Fig. 1 is one period of a combination of curves having periodicities = 1, 2, 3, and 4 times that of X, and represented by curves Nos. 1, 2, 3, and 4. Curve X has been divided into two parts and the two parts superposed (*see* Fig. 2). The result is a curve Y (Fig. 3), which is seen to be composed only of curves 2 and 4, with their amplitude doubled. This is the first step in the analysis. If we reduce the amplitude of Y by half, and subtract it algebraically from X, we obviously obtain a curve composed only of curves 1 and 3.

Fig. 4 represents a complete analysis of the same curve. Here the dotted curves are superposed parts, the dot and dash

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curves are curves as first obtained, the full line curves being the same, reduced in amplitude where necessary to their normal size. The curves are numbered in the order that they are obtained. Curve 2 is the same as Y, which we have already seen. Curve 3 = 2 reduced in amplitude, and represents a combination of curves having periodicities = 2, 4, 6, &c., times that of X. Curve 3 is bisected, and the two halves being superposed, we obtain 5, which being reduced by $\frac{1}{2}$ gives 6 = a sine curve having a periodicity = four times that of X, and is one of the components of X. Curves 7 and 8 are 3 and 1 superposed, the result of subtraction being 9, which represents a combination of curves of periodicities = 1, 3, 5, &c., times that of X. Curves 10 and 11 are 6 and 3 superposed, and subtraction gives us 12, another component. We now divide curve X into three parts and superpose the parts (13 and 14), curve 15 being the result, which divided by three gives us 16,

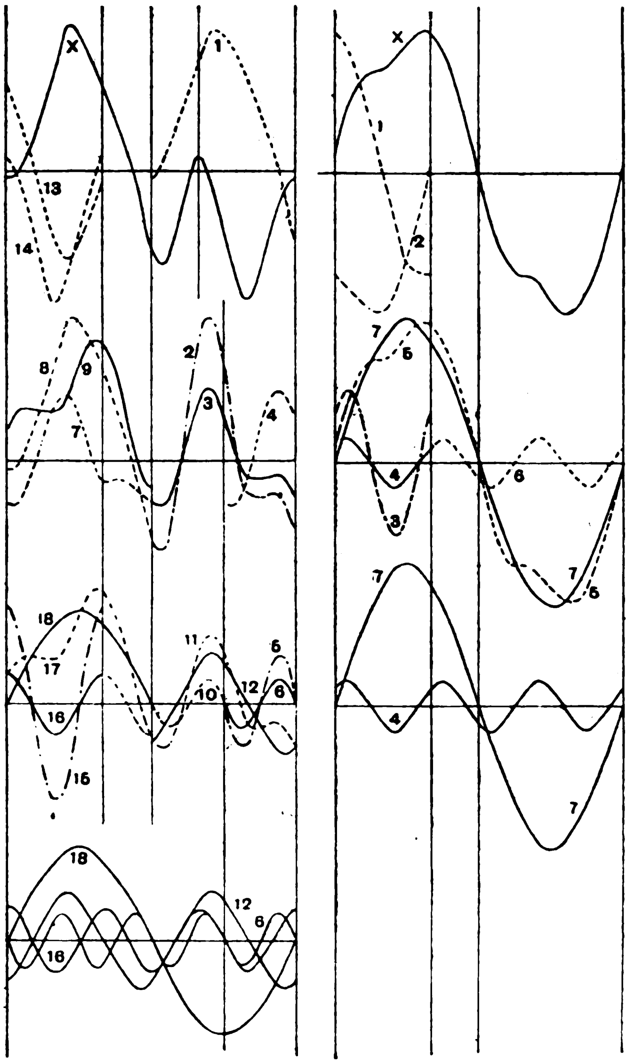

Fig. 4. Fig. 5.

The complete Analysis of the curves of two given Harmonics. Fig. 5 might be a Transformer Curve.

another component, which subtracted from 17 (17 = 9) gives us 18, the last component. For the sake of clearness, the four components 6, 12, 16 and 18 are reproduced at the bottom. It will be seen that they are the same in every respect as curves 1, 2, 3 and 4 (Fig. 1).

In the other example given (Fig. 5) it is obvious that if the curve were bisected and the parts superposed the result would be zero. Therefore there are no components with a periodicity = an even number as compared with X. We therefore divide into three parts, and proceed as before. If any residue remained unseparated we should next divide into five parts, *i.e.*, the next prime number.

THE TELEPHONE IN ENGLAND.

BY G. L. ADDENBROOKE.

During the course of the writer's preparation for the review of Mr. Bennett's work on the telephone systems of the Continent which appeared a short time since in this journal, some points were brought into prominence which did not appear to come within its scope, but which nevertheless appeared of importance. These were accordingly reserved, and a portion of them are now published, as they form an apt and fitting comment on the chairman's speech at the recent general meeting of the National Telephone Company.

Scattered through Mr. Bennett's book are the rates of wages paid in each country. It occurred to the writer to extract these in the form of a table. To these he has added the rates which are paid by the Telephone Company and Post Office in England. Mr. Bennett has himself kindly checked the table to see if it was a really fair statement to deduce from his figures. The English figures have also been seen by Mr. Preece at the Post Office, who expressed his general concurrence with them. That they represent fairly the National Company's wages the writer has also reason to know. It has been a little difficult to make a fair comparison because of dietary and other allowances given on the Continent and not in this country, but, if anything, the comparison is in favour of England.

The table has been got out in the form of shillings per week, neglecting fractions to admit of ready comparison.

Table showing Wages paid per week in Shillings.

Country.	Outdoor operatives. Foremen.	Wiremen.	Labourers.	Switch-room operatives.
Austria	28	20	16	8 to 10, to 14 in 3 years.
Belgium	32 to 40	14	11	8 to 16
Denmark	40	26	21	5·5, 4 hours, to 14·5, 6 hours.
Bavaria (Germany)	40	23	17	12, boys.
France, Paris	40*	30	...	12 to 20
France, Provinces	36	24	...	10 to 18
Holland	30 to 40	24	18	6·6 to 10
Norway & Sweden	27	20	15	11 to 19
Switzerland	30 to 36	22	15	15 when fully competent.
England, London	38 to 45	28 to 34	24	About 10 average.
England, Pr'vinces	27 to 42	23 to 26	20 to 23	About 9 average.

* And allowance.

Besides its bearing on the telephone industry this table has a wider interest, because the wages in telephony approximate in all cases to the wages paid for line work in telegraphy in all the countries, and these wages again are about the same to those paid in the allied electrical industries. These wages are therefore some indication to electrical engineers of the relative scales current in the chief countries on the Continent. It is only fair to remark also that the writer has good reason to believe that, with exception perhaps of Paris, house rent is cheaper all over the Continent than in England, and the price of commodities generally rather less. The foreign workman is therefore generally in rather a better position relatively to his English *confrère* than the figures show, while on the other hand there is, it is well known, a general idea that an Englishman gets over the ground rather quicker. When these matters are taken into account, it will be seen how closely the reward of labour, in this industry at any rate, approximates in this country. Belgium seems to form the most remarkable deviation.

Returning to telephony, the remarkable points about this table are that foreign wages for outdoor work approximate in many cases closely to English; while for switch-room operatives, who are mostly ladies, the wages paid abroad are, if anything, higher than our English rates. It is clear, therefore, that there is no argument from these items that English exchange subscription rates should be more than a slight percentage above foreign; since the labour in erecting lines is nearly as much abroad as in England, while the cost of operating—the real criterion, as it is a continual charge—is even less in England than on the Continent.

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As regards the price of instruments and telephone material, they are pretty much the same everywhere, and, if anything, the advantage should lie with England.

The rates of annual subscription on the Continent and in England are as follows, the amounts being taken to the nearest shilling to make the table clearer and afford a readier means of comparison :—

——	Annual subscription.	Capital payment (if any).	Distance.
	Shillings.	£ s. d.	
Austria	*83*	4 3 4	500 metres [extra for extension]
Belgium—Antwerp	200	...	3 kilometres
Brussels	200	...	3 kilometres
General State rate, (double wires)	...	...	...
Denmark—Copenhagen	166	...	...
Provinces	40 to 90	...	..
Germany	151	...	5 kilometres
Holland—Amsterdam	195	...	...
Dordrecht	84	...	...
Breda	66	...	..
Hungary—Buda Pesth	250	...	...
Other towns	100	...	...
France—Paris	320	...	...
Lyons	240	...	...
Co-op. Societies	*40*	£8 to £10	...
Italy	160 to 56	...	...
Norway—Christiania	90	...	...
Provinces	66 to 28	..	...
Sweden—Companies	*111*	2 15 7	...
Government	*89*	2 15 7	...
Switzerland—First year	96	*	...
Second year	80	*	...
Third year	61	*	...
United Kingdom—London	400	...	...
London, Five years	340	...	...
London, Private residents	240	...	...
Principal towns	200	...	¾ mile.
Few small centres	180	...	...

If, then, from what has been said above, a telephone line can be erected nearly as cheaply in England as on the Continent, if the materials for the line and the instruments at the subscribers' end and at the exchange are the same price, and if the line, after it is erected, can be operated quite as cheaply in England as on the Continent, it is clear that there must be some other reasons why a satisfactory telephone service can be provided at so much cheaper rates in many cases on the Continent than the National Company allege is possible in England.

* 800 calls per annum, extra has to be paid on additional calls.

MOTIVE POWER AND GEARING.†

BY E. TREMLETT CARTER.

(*Continued from page 317.*)

The Steam Engine in Relation to Electric Power.

In the introduction the general conditions attending the working of electric power plant were summarised. Two distinct cases were shown to exist, viz. : (1) in electric lighting and power supply ; and (2) in electric traction. In the subsequent parts of this treatise the principles of steam plant have been discussed, and the behaviour of that plant under various conditions examined. We have seen under what conditions steam plant will work economically, and under what conditions it cannot be economical. We have also studied the various auxiliary apparatus by which its economical working may, under stated conditions, be improved. We have noted the relation of steam plant economy to such various considerations as : (1) the character of the fuel and of the water ; (2) the amount of load imposed on the plant; (3) the suitability of the plant, &c. We are now, therefore, in a position to enter upon a study of the relation of steam plant to the actual conditions met with in electric supply, in the two cases already named. In other words, we shall endeavour, in so far as it is possible on general grounds, to show in what ways the problem stated at the outset may be solved, when steam plant is used.

† From a forthcoming work to be published by *The Electrician* Printing and Publishing Company. All rights are reserved.

Electric Lighting and Power Supply.

In the case of electric light and power supply works we shall make the following principal considerations, viz.: as to (1) the total amount of boiler and engine power which it is good practice to provide ; (2) the subdivisions of these total boiler and engine plants ; (3) the influence of storage plant upon the foregoing considerations ; (4) the initial cost of these works ; and (5) the working costs.

Total Capacity of Plant.—In all these considerations we cannot do better than examine the state of affairs at the best and most modern of electric supply stations throughout the world, and note the advice given by the most experienced engineers in the matter. For in this matter, experience is everything : mere theorising is useless. Table XIX. presents at a glance the provisions made at some of the most important London and provincial stations, and also compares these provisions with the actual demand made upon the machinery. As far as has been possible, the author has endeavoured to avoid including stations which are so new that a fair proportion of the steady demand has not yet arisen. It will be seen that at many of the stations the ratio given in the last column is less than unity; and it will be observed that in the majority of cases these stations are provided with storage plant. The explanation is that by the use of electrical storage the generating plant has been able to work more throughout the period of low lamp demand than would otherwise be the case ; the factor of underloading of the plant is consequently reduced, which implies that the same total daily output can be obtained from a smaller plant.

Table XIX.*—*Mechanical Equipment and Capacity of Some London and Provincial Electric Supply Stations.*

Places.	Aggregate H.P.		A = equivalent of 8 c.p. lamps connected.	B = plant capacity in 8 c.p. lamps.	Ratio $= \frac{B}{A}$
	Boilers.	Engines.			
City of London Electric Lighting Co.'s Station, Bankside	15,430	8,240	136,000	170,000	1·250
Kensington and Knightsbridge Electric Lighting Co.'s Station	2,080	2,720	80,000	52,000	0·650†
London Electric Supply Corporation's Deptford Station	12,000	5,500	75,000	137,000	1·826
St. James's and Pall Mall Co.'s Stations	3,920	3,740	74,000	74,800	1·011
Westminster Electric Supply Corporation's Stations	(?)	5,420	168,500	96,100	0·570†
Bath	750	740	7,900	10,000	1·265
Brighton	1,800	2,000	38,000	25,000	0·658†
Bristol	2,300	1,750	14,200	27,000	1·928
Glasgow	2,654	2,600	60,000	41,000	0·683
Liverpool	5,700	4,400	45,000	50,000	1·111†
Manchester	(?)	2,800	60,520	56,000	0·925
Portsmouth	(?)	1,320	12,600	26,500	2·103
Sheffield	2,000	1,250	20,726	22,000	1·061

It must be explained that the ratio given in the last column of Table XIX. covers the loss of power due to distribution over the network of mains. In many cases it would be found that when the power thus lost was deducted, there would be absolutely no surplus of engine power or of boiler power. Such stations depend for reserve plant upon a curious fact, which it will now be necessary to explain. Fig. 2 (Vol. XXXII., p. 159) shows a typical load diagram at a station of the kind we are now considering. Had this diagram been supplemented by a horizontal line indicating the total lamp capacity of the station, it would have been found that the irregular curve always lay far below that line. Even at the point of maximum demand, it is rarely if ever that the diagram approaches

* The data upon which this and subsequent Tables in this chapter have been compiled have been taken principally from "The Electrician" Electrical Trades' Directory and Handbook.

† These Stations are provided with electrical storage plant.

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closely to the maximum possible demand. Many lamps are wired, but comparatively few are used at the same moment of time. The generating plant, if there is no storage, must be capable of coping with the total possible demand. As it never has to do so, the balance of power constitutes a sort of reserve. It cannot be said, however, that this is good practice; and the most experienced engineers recommend a reserve plant of from 20 to 25 per cent. in excess of the plant required for the maximum of actual work, when the station is properly filled up to the normal number of lamps.

Choice of Types.—Before passing on to consider the subdivision of the plant, a few words may be said in regard to the choice of a type of boiler or engine. Practice in this respect is very varied, but tends to run in grooves. In America slow-speed geared horizontal and vertical engines are largely in use, and water-tube boilers, mostly of the Babcock and Wilcox type. In Germany and France and other European countries, the direct-coupled slow-speed horizontal engine is most commonly met with; and the various water-tube boilers of Continental firms. In this country there are two distinct lines of practice—the metropolitan and the provincial. The former includes London and large cities; the latter represents the practice in small towns and villages. Table XX. shows the proportion of various types of boilers in London and in the provinces, this latter including all cities outside of London. It is interesting to note the preponderance of the compact water-tube boiler in London, and of the more bulky Lancashire boiler in the provinces. Here is evidently a competition between smokeless and bituminous coals, modified by considerations of the price of land and the cost of coal haulage. Table XXI. represents in a similar manner the London and provincial distribution of steam engines.

Table XX.—*Analysis of Boilers in Electric Supply Stations in the United Kingdom.*

Type of Boiler.	London: (Total = 184).		Provinces: (Total = 238).	
	Number of Boilers.	Percentage of Total.	Number of Boilers.	Percentage of Total.
Water-tube	128	69·5	53	22·3
Lancashire	10	5·5	144	60·5
Locomotive Multitubular	22	11·9	21	8·8
"Economic"	8	4·4	7	2·9
Marine Multitubular	3	1·7	2	0·9
Return Tube	13	7·0	—	—
Tubular	—	—	11	4·6

Table XXI.—*Analysis of Steam Engines in Electric Supply Stations in the United Kingdom.*

Type of Engine.	London: (Total = 166).		Provinces: (Total = 318).	
	Number of Engines.	Percentage of Total.	Number of Engines.	Percentage of Total.
Willans, direct-coupled	101	60·84	125	39·30
Other direct-coupled high-speed engines, excluding steam turbines	22	13·25	42	13·20
Direct-coupled, low-speed	2	1·20	6	1·90
Geared, vertical	26	15·66	87	27·38
Geared, horizontal	15	9·05	42	13·20
Steam turbines	(?)	—	16	5·02

Subdivision of Plant.—It is only necessary to compare a typical load diagram with the diagrams representing the law of steam economy at various loads, to deduce that the supreme guiding principle in the choice of engines for electric supply stations must be, to provide that the engines which will be in use at any one time shall be as nearly fully loaded as possible. Ideally, an engine ought to be either fully loaded or not running. Thus much is conceded everywhere; but on the matter of the amount of subdivision opinions are divided. Evidently, however, the unit of plant is not so much fixed at a certain horse-power as at a certain *proportion* of the full horse-power. In a large station the unit will be larger than in a small station; but in every case it must be small enough to carry the station through the hours of minimum demand without the engine being very much underloaded. It is not necessary, nor does it occur in many of the best designed stations, that every item of plant shall be equal to the unit of plant. In this country the practice of having multiple units of plant is largely in vogue; in other countries, especially where subdivision is not carried to any great extent, it is not so common, though in all the large Continental and American stations single and multiple units generally are to be found. An idea of the amount of subdivision of the plant in British and foreign stations may be gathered from Table XXII. It is scarcely necessary to remark that to a great extent the choice of the type of engine and the amount of subdivision of the plant are dependent upon one another.

Table XXII.—*Subdivision of Plant at some British and Foreign Electric Supply Stations.*

Place.	Boilers.	Engines or Steam Dynamos.
Amberley-road, London	5 Locomotive.	5 of 100 kilowatts.
Blackburn	3 Lancashire.	2 of 120 kilowatts. 2 of 45 kilowatts.
Brighton	6 Lancashire of 300 H.P.	4 of 360 kilowatts. 2 of 120 kilowatts. 2 of 45 kilowatts.
Burton-upon-Trent	3 Lancashire.	3 of 125 H.P.
Hampstead	4 Lancashire of 200 H.P.	1 of 300 H.P. 2 of 150 H.P. 1 of 30 H.P. 2 of 25 H.P.
Manchester	6 Lancashire.	6 of 240 kilowatts. 6 of 60 kilowatts.
Portsmouth	5 Lancashire.	3 of 212 kilowatts. 1 of 150 kilowatts.
Scarborough	3 Lancashire.	2 of 150 kilowatts.
Amsterdam	8 Water-tube.	3 of 600 H.P. 1 of 300 H.P. 1 of 125 H.P.
Brooklyn, N.Y.	(?)	2 of 750 H.P. 6 of 250 H.P.
Chicago (one station)	2 of 280 H.P.	Three sets.
Christiania	3 Water-tube.	2 of 600 H.P. 1 of 260 H.P. 1 of 130 H.P.
Cologne	8 Water-tube.	3 of 600 H.P. 1 of 125 H.P.
Frankfort-on-Main	8	4 of 500 kilowatts.
Los Angeles, Cal.	3 of 200 H.P. 8 of 100 H.P.	1 of 500 H.P. 3 of 200 H.P.
North Attleboro, Mass., U.S.A.	1 of 250 H.P. and extra steam from pumping station.	1 of 175 H.P. 1 of 100 H.P.
South Norwalk, U.S.A.	1 of 125 H.P.	1 of 100 H.P.

Table XXIII.—*Approximate Initial Costs of Mechanical Plant for Electric Supply Stations.*

Place.	Description of Plant.	Approximate Cost.
Aberdeen	4 Babcock-Wilcox boilers of 650 H.P. aggregate	£1,494
	5 Willans engines of 320 H.P. aggregate, and 5 E.C.C. dynamos	5,044
Blackburn	3 Lancashire boilers of 750 H.P. aggregate	2,330
	2 steam dynamos of 120 kilowatts each, and 2 steam dynamos of 45 kilowatts each	4,820
Brighton (Extension)	3 Lancashire boilers of 300 H.P. each	1,476
Cheltenham	3 Willans-Siemens sets, 180 kilowatts aggregate capacity	3,695
	Condensing plant for station	590
	2 Galloway boilers	438
Halifax	3 Lancashire boilers of 1,000 H.P. aggregate	1,688
	2 large and 1 small engines of 500 H.P. aggregate	1,860
	Furnace economiser plant	489
Portsmouth	1 steam turbine of 150 kilowatts	1,750
	Boilers, engines and alternators for aggregate of 424 kilowatts	21,780
Stafford	3 engines of 360 H.P. aggregate	2,288

Initial Costs.—Some difficulty is unfortunately met with in an attempt to obtain extensive information regarding the

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initial cost of plant, owing to the non-publication of and the reluctance of contractors to publish the exact amount of plant and work represented by the actual sum paid. As a rule the original sum tendered for is modified on account of subsequent changes in the plant. Table XXIII. will, however, furnish a fairly accurate guide to the actual costs of steam plant supplied for electric supply stations.

Working Expenses.—The actual expenses incurred, in running a large steam-driven electric supply station in the United Kingdom, are tabulated in Table XXIV. The data here given are based upon the annual accounts published by the various electrical concerns, and they are condensed from the large and comprehensive tables published with *The Electrician* of June 28 and August 9, 1895. It may be briefly remarked that all the items of expense are considerably above the lowest possible limit which would be reached if the plant could be worked under the most favourable conditions. Prof. Kennedy has stated, as recently as in July, 1895, that the actual load factors of steam engines in electric supply stations do not generally exceed 80 per cent., but vary from that figure down to as low as 55 per cent., only the time of running being counted.

Table XXIV.*—*Table showing the Working (Generating) Expenses at Steam Engine Electric Supply Stations in the United Kingdom for the year 1894.*

	—	Expenses in pence per Board of Trade unit.				
		Coal.	Oil and waste, &c.	Salaries and wages.	Repairs and maintenance.	Total working (generating) expenses.
Maxima.	Maximum of provincial companies	1·99	0·43	1·18	0·82	4·22
	Maximum of London companies	2·11	0·39	0·94	0·73	3·85
	Maximum of provincial municipalities.........	1·94	0·47	0·95	0·86	3·30
	Maximum of London municipalities.........	0·99	0·15	0·55	0·35	2·C6
Minima.	Minimum of provincial companies	0·57	0·04	0·25	0·16	1·61
	Minimum of London companies	0·63	0·12	0·42	0·11	1·64
	Minimum of provincial municipalities.........	0·60	0·01	0·39	0·07	1·52
	Minimum of London municipalities.........	0·99	0 15	0·55	0·35	2·06
Averages.	Average of all provincial stations	1·02	0·19	0·55	0·34	2·10
	Average of all London stations	1·18	0·21	0·65	0·38	2·42
	Average of all stations in the United Kingdom	1·08	0·20	0·58	0·36	2·22

It is instructive to contrast Mr. Crompton's ideal working expenses with those actually incurred by existing concerns. The following ideal data are taken from Mr. Crompton's Paper on "The Cost of Electrical Energy."

Ideal Standard Works Cost.
Cost per Unit Sold.

	d.	d.
Works cost—		
1. Fuel—2·5lb. Welsh coal at 20s.	0·27	
2. Water	0·01	
3. Petty stores	0·02	
4. Wages	0·10	
5. Superintendence	0·10	
	—	0·5
Maintenance—		
6. Material on repairs	0·20	
7. Wages on repairs	0·15	
8. Superintendence	0·05	
	—	0·4
Management....................................		0·42
Total expenses		1·32

* The stations included in this table are those only which are included in the two supplements to *The Electrician* published on June 28 and August 9, 1895. All stations having a lower output than 100,000 units for the year are, therefore, excluded from the above data.

COMPOUNDING DYNAMOS FOR ARMATURE REACTION.*

BY ELIHU THOMSON.

Considerable attention has recently been drawn to the subject of means for counterbalancing or preventing armature reaction in dynamo generators or motors. The valuable Paper† of Messrs. H. J. Ryan and Milton F. Thompson, read before the Institute at its meeting on March 20th, called forth considerable discussion as to the actual utility or need of added devices, which undoubtedly render a machine more complex, but which can certainly be made to obliterate armature reaction or overcome its effects. The opinion which seems to prevail amongst engineers is that, by taking advantage of the best principles of design, the output of our machines is not limited by armature reaction, but rather by heating, or the capacity to diffuse that heat which is sure to be produced during operation. The writer's views are in accord with the general sentiment indicated by the discussion of the Paper in question, excepting that he conceives that it may on occasion become desirable to possess a structure, either generator or motor, in which a load which would inevitably overheat the machine if continuous, may be borne without destructive results for short periods only. The development of engineering work may in fact demand, occasionally, machines which would be regarded as emergency machines, to be operated with the highest possible loads for short periods. It is sometimes desirable that a dynamo be adapted to driving at different speeds while maintaining the same potential at the terminals, as in the case of direct-driven dynamos coupled with engines of different makes and speeds. Such an adaptation would require a change in the armature turns, or in the field excitation, the former demanding a reconstruction amounting to the production of a special type, while the latter, change of field strength, might involve such a weakened field at the higher speeds as would be incompatible with proper commutation. In such cases means and methods for securing proper commutation and neutralising reaction may become quite useful. The subject itself has been worked upon by the writer as far back as 1879. At first a peculiar disposition of the field coils and pole-pieces was selected, unfavourable to armature reactions, and later in a patent applied for by the writer in the year 1885, the series coil of a compound-wound machine was so disposed as to add, under load, a magneto-motive force to the field in the region of armature opposition, and as a consequence to diminish somewhat the magneto-motive force of the field where the reaction of the armature was positive or assisting. In the present Paper, however, the writer desires to bring to the attention of the Institute a different type of dynamo, worked upon by him some three or more years ago, in which there is no series winding whatever, though the machine is in effect compounded, or over-compounded at will. It is expressly to be understood at the outset that the present Paper is not intended to advocate the disposition described as a desirable commercial structure, or even as one which will be likely to come into practical use on any scale. On the contrary, it is believed to be open to objections which would take it out of competition with ordinary types, in which the compounding effect is secured by the series coil or load circuit wound, as usual, as a part of the field-energising conductor.

The machine is, however, interesting as bringing out forcibly the capability of the armature current to neutralise its own effects in a proper structure and maintain, or even increase, the potential at the brushes under heavy loads. In fact, the current in the armature in the type of machine herein treated is made to react under load to magnetise a portion of the field structure which at no load is neutral, or nearly so. The reaction may thus be made to give rise to a magnetic flux sufficient, or more than sufficient, to compensate for its effect in diminishing the flux of the other or excited portion. The result is accomplished by dividing each field pole into a portion which is left unwound and a portion which is wound and excited in shunt or separately. At no load only, the wound polar portions act to generate the open circuit E.M.F. As the load is put on, the unwound or dead poles become active, in consequence of a magnetic flux developed in them by the armature currents themselves—that is, in consequence of the M.M.F. generated by the current in the winding of the armature itself. The disposition of the poles in a bipolar structure would be represented by Fig. 1, where A A are the excited poles, or wound field cores, under the fringe of which commutation is effected, while D D are the "dead" poles or sections of polar surface unenergised at no load. A dotted line, *a a*, may pass through the neutral or non-polar portion of the armature iron, threaded by all field lines on one side, while the lines *b b* may indicate the diameter of commutation on which the brushes rest. In such a structure, by choosing the

* Paper read before the American Institute of Electrical Engineers at Niagara Falls, 1895.

† See *The Electrician*, April 19, 1895, p. 765.

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position and spread of the "dead" poles in relation to that of the wound or excited polar portions, and adjusting the M.M.F. of the initial field relatively to the turns on the armature and the speed of driving, the effect of compounding or over-compounding may easily be obtained. The "dead poles" may be made adjustable in position so as to vary the effective M.M.F. of the armature upon them, and various changes in relations of the parts are conceivable.

In Figs. 2 and 3 an attempt has been made to represent the magnetic flux under no load and under load respectively. In Fig. 2 the flux in the air-gap between the excited poles A A and the armature may be considered as of uniform density, except at the edges, while in Fig. 3 it is, under the same poles, somewhat diminished towards the diameter of commutation. In Fig. 2 the dead poles are without flux across the air-gap, while in Fig. 3 the density increases from one edge to the other in the direction of rotation.

A dynamo constructed on this principle was multipolar, having four wound poles and four dead poles alternating in position around the armature. The latter was of standard iron projection type, being in fact identical in construction and dimensions with the armatures used about three years ago in regular four-pole dynamos of the marine type of the Thomson-Houston Electric Company.

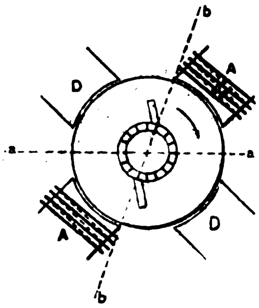

Fig. 1.

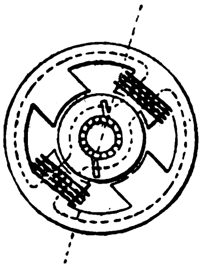
Fig. 2.

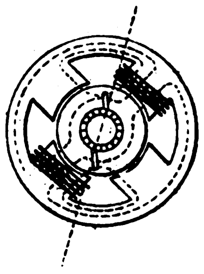
Fig. 3.

The principal data of the armature construction are as follows:—

Diameter over all	17 inches
Length (laminations)	8 „
Radial depth of laminations	4 „
No. of projections	87 „
Width of slots	0·34 inch
Depth of slots	0·75 „

The armature was series drum wound and had two conductors in each slot. The commutator had 87 segments. The new field system was constructed of two rings of cast open hearth steel having heavy lugs, four in number, projecting laterally from each ring on one side, and forming the dead poles when assembled in the machine. Separate castings for carrying the field coils and constituting the active poles were made, wound and bolted between the two ring castings of the field. The arrangement will be understood at a glance from an inspection of Figs. 4 and 5. Fig. 4 is a section of the field in a plane passing through the dead poles and the axis of the armature, and Fig. 5 is a similar section through the active or wound poles. The wound cores have a section of 3½in. × 8in. and are of steel. The field was bored to 17¼in., thus giving a clearance of ⅛in. around the armature. The excited or wound poles covered each about 5in., the dead poles each 5½in., leaving spaces between wound and dead poles of about 1½in. The face of each dead pole is 5½in. by 8in.

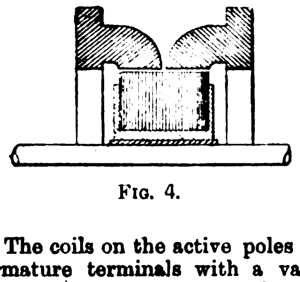
Fig. 4.

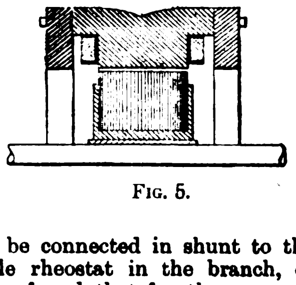
Fig. 5.

The coils on the active poles can be connected in shunt to the armature terminals with a variable rheostat in the branch, or separately excited as desired. It was found that for the purposes of test that the latter arrangement was most satisfactory, as the exciting current could then be adjusted to any given value, and would remain undisturbed by variations in the potential difference between the brushes or terminals of the machine.

Fig. 6 shows the relation of volts at the terminals to varying exciting current at no load (full line) and at 30 amperes load (dotted line) with a speed of 800 revolutions per minute. It will be noted that the load has caused an increase of voltage particularly at the relatively higher excitations. The normal current of full load for the armature, as constructed and used in the regular multipolar field, was 140 amperes, and it was found that as the load was increased steadily during a run, the potential was not only maintained but increased with each increment of load, thus showing an over-compounding effect. This effect was less marked when the initial excitation was weak, as when less than 3 amperes traversed the field coils. The over-compounding under load was, of course, still more increased when the field coils were connected in shunt to the armature. Thus, at a little over 750 revolutions per minute with an exciting current of four amperes, the open circuit volts were 84, rising to 104 when a load of 130 amperes was put on with an increase of the exciting current to 4·8 amperes.

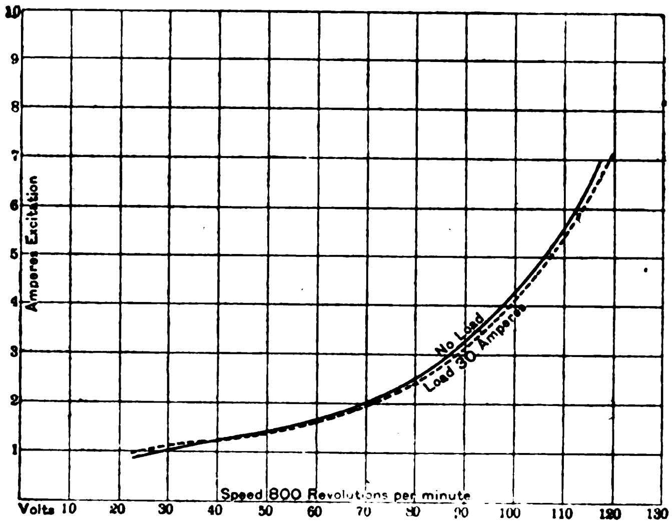

Fig. 6.

It was noticed that on any considerable increase of load being made, the potential rose in some cases as much as 5 or 6 volts above the point at which it would remain, or which it would reach after a short interval. Similarly it was found that the sudden taking off of load caused a temporary fall below the stable voltage under the new or diminished load conditions. This curious effect was traced to the difference of time between that needed to build up or cut down the flux in the dead poles, as compared with that required to cut down or build up the excited poles, which, being wound with wire, were naturally more sluggish under the conditions of use. Currents would be induced in the coils under each change of flux, which change itself would thereby be rendered more gradual. The dead poles being unwound could respond more rapidly. Any increase of load would, of course, tend to break down the wound poles and to increase the flux in the dead or unwound poles, and the taking off of load would have the opposite effect.

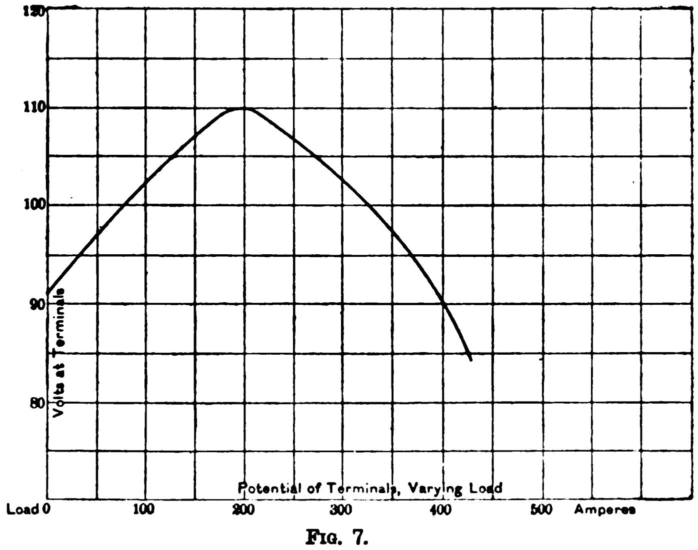

Fig. 7.

Fig. 7 shows a compounding curve obtained under a constant excitation of 4 amperes at a speed of 790 revolutions, the load being varied from 0 up to more than thrice the full load. It will be noticed that the potential at first increases, and only breaks down under extremes of load. The final breaking down is doubt-

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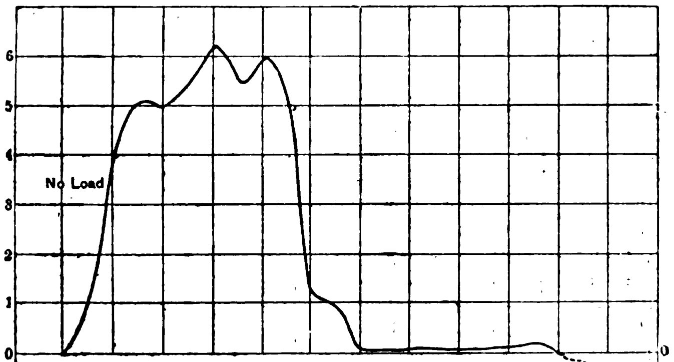
less due to saturation of the forward portions of the dead poles, together with the armature core projections. Part of the drop was undoubtedly due to resistance at the brushes, which were of carbon, and by no means fitted to conduct off such heavy currents. Taking this drop and the drop over the armature conductor itself, it is not surprising that at the high loads the potential should fall off.

Fig. 8.



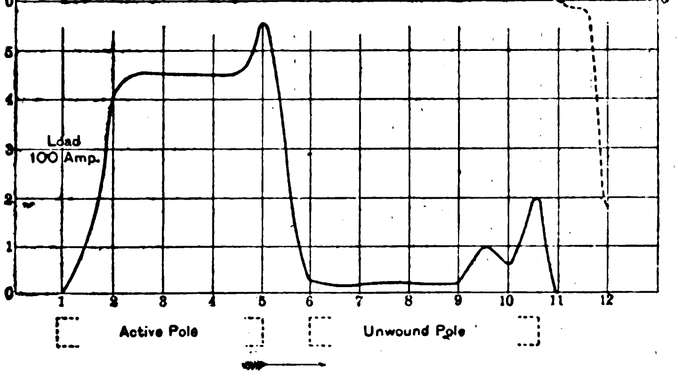
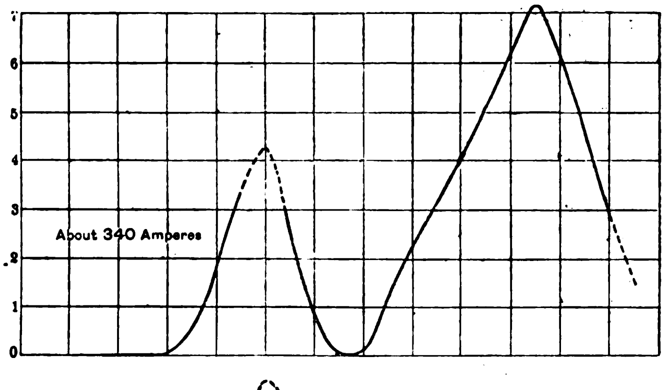


Fig. 9.

A horizontal plotting of the potentials generated in the armature coils under no load, obtained by the two-brush method of Dr. S. P. Thompson, is given in Fig. 8, the relative positions of the wound and "dead poles" being marked in dotted lines, and the arrow indi-

Fig. 10.



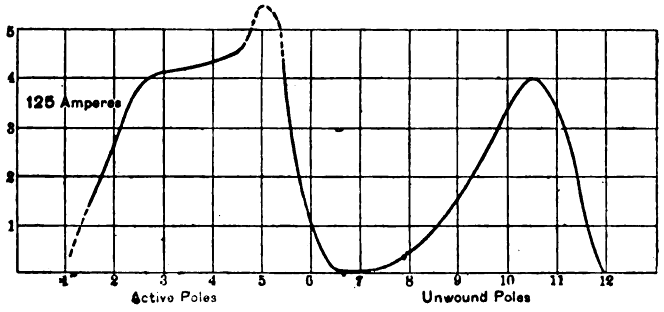


Fig. 11.

cating the direction of movement of the armature relatively thereto. Fig. 9 gives the same plotting under a load of 100 amperes, and accentuates the effect of the armature reaction in magnetising the dead poles. The curves are only approximate indications, owing to the fact that the number of points at which readings were taken was less than was desirable, and because in some cases it was difficult to maintain all conditions unchanged, particularly with the very heavy loads. Figs. 10 and 11 show a similar plotting for abnormal or extreme loads. The former shows how completely the wound pole has been broken down by armature reaction, and how the unwound poles have now become the chief working field poles, or rather how the armature winding itself has furnished the field for its own cutting. A calculation of the flux density at the forward edge of the unwound pole shows that the magnetisation has risen to saturation. The other parts of the pole are shown to be still susceptible of increase of flux, but their relation to the armature is far less favourable for its generation.

The machine described is probably chiefly interesting from a theoretical aspect. Still, it shows clearly that so far as the effect of the series field on compound-wound machines is concerned, the electrical engineer has other resources at his command giving similar results. It cannot be doubted also that the design of armature and field might be considerably improved with special regard for the particular feature of compounding. A feature of the machine which developed itself when carbon brushes were used, was that even at heavy loads the brushes could be set back from their maximum position, or true diameter of commutation in this case, and that the movement was attended with little, if any increase of spark, while the potential steadily went down. It was thus easily possible to adjust the potential by a backward movement of the brushes in the space between the unwound and wound poles, while the slight sparking under the carbon brushes was not increased thereby. The writer has never noticed this effect in so pronounced a degree in any other structures, but thinks that it may not be peculiar to this machine. A further interesting consideration is the effect of dispensing with the wound poles altogether, and either neglecting to employ any reversing or commutating field while maintaining the brushes near the forward edge of the field poles which now remain, namely, the unwound poles, or employing commutating arrangements similar to those used by Mr. Sayers, that is, returning the leads through slots in the armature under the strong induction of the forward edge of the pole as the armature leaves it. In such a case it would appear from theoretical considerations that the machine should, if it possessed any permanent magnetism, excite itself as a series dynamo entirely without any winding on the field and solely by the action of the armature winding itself. This fact was, I believe, first pointed out by Drs. J. and E. Hopkinson. In conclusion it may be stated that tests of the machine used to generate single-phase and three-phase alternating currents in its armature winding were made by dispensing with the commutator and substituting rings and connections common in such cases. The results indicated a substantially similar effect of compounding, but to a less degree, owing, no doubt, to the fact that the phase of the electromotive force generated by the wound pole flux would not coincide with that due to reaction on the dead poles, since the position of the poles with relation to any portion of the moving wire is different at the same instant.

THE NEW WESTINGHOUSE WORKS AT EAST PITTSBURG.

The Power Plant and Two-Phase System of Current Distribution.*

The power plant at East Pittsburg is almost identical with one that might be used for the supply of high-potential long-distance transmission circuits, but as all the energy generated at this plant is used within a few hundred yards of the station, the potential is restricted to only a few hundred volts. On account of the nearness of the points of distribution, polyphase currents have no advantages over the direct current in the way of transmission and distribution, but their superiority is quickly apparent when the simplicity and ease of handling the generators and motors is considered. A com parison, for example, of the direct and polyphase generators in the power house illustrates the point in question. Though the direct-current machines are of the most improved type, their commutators of necessity have daily required a certain amount of attention, while the polyphase machines have needed hardly a half-hour's care since they began operating some five or six months ago. Again, the motors require no starting box or controller when starting, as they are entirely self-contained, and it is only necessary to throw the short-circuit switch after they have gotten under way, in order to have them take up and carry their regular loads. The absence of commutators and starting boxes obviously makes the polyphase motors in every way preferable to direct-current machines for use by the average workman.

Another of the features in the operation of the East Pittsburg plant is the coupling of direct-connected alternators in multiple.

* Abstract from the *Electrical World* of New York, to whom we are also indebted for the blocks illustrating our abstract. For general description of these works see *The Electrician* of July 5th.

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The power house is 206ft. in length by 76ft. wide. The building is of brick, resting on 16ft. stone foundations laid in concrete. All beams, girders, &c., are iron, and the roof of slate, so the building is completely fireproof. At present there are five batteries, each of 500 H.P., Pierpoint vertical water-pipe boilers. Steam is generated at 130lb. pressure, and is delivered through wrought-iron feeders equipped with Pratt and Cady valves to a 20in. main which runs along the west wall of the boiler house. The main passes into a 20in. Stratton steam separator, and is perhaps the largest separator ever made for low-pressure steam; the pipe then dips below the floor and passes up on the other side of the fire wall to the distributing pipes supplying the engines. The mains and steam pipes are all supported by roller bearings. The boilers are each fired by two Roney automatic stokers, fed with coal from cylindrical iron tanks suspended from the roof trusses. The stokers are all driven by a single Westinghouse standard 5 H.P. engine. The grates of the stoker form a series of steps, to which the coal is fed from the dead plate by a pusher having a vibratory motion; each step of the grates is given a rocking motion, the grate surface thus alternately forming a series of steps and an inclined plane with the grates partly overlapping like the shingles of a roof. In this manner the fuel is worked down, and at the same time broken up. The rocking motion is slow, being from 7 to 10 strokes per second, according to the kind of coal. Coal is brought to the power house by means of an elevated railway track, from which it is dropped through a shoot into bins located at the east end of the power house. On its way to the bins the coal passes through a crusher if necessary. From the bins the fuel is hoisted 60ft. by means of a chain-bucket elevator, which empties it into a conveyor that carries it to the tanks feeding the stokers. The capacity of each of these tanks is 8 tons, and the total capacity of the bins about 150 tons. A 15 H.P. electric motor drives the conveyor, and a 20 H.P. motor operates the lift and runs the crusher when required. The feed water for the boilers may be fed under reservoir pressure directly to the boilers, or run into the feed-water heater, from which it is forced into the boilers against pressure by means of duplex double-acting pumps. The pumps are each fitted with a counter, and there is also a water meter connected to the supply pipe, so that all water furnished the boilers is accurately measured. Part of the exhaust steam from the engine is used for supplying a Warren-Webster vacuum heater, which raises the temperature of the feed water to 200 to 210°F. Exhaust steam is also used for heating the buildings, and the condensed water from the radiators and heaters is returned to an elevated tank near the eaves of the boiler house by means of a Warren-Webster vacuum pump, which maintains from 10in. to 15in. vacuum on the heating system, thus relieving any back pressure on the engines. From the elevated tank the water flows by gravity into the feed-water heater, where the level is maintained by a float. When the returns of the heating system are insufficient to supply the demands, the float automatically admits cold water. There is also being put in the boiler house a 20in. by 12in. by 16in. Snow underwriters' high-pressure fire pump, which is to obtain its supply of water either from the city mains or from a large reservoir recently sunk just outside the power house. Furthermore, there are in the boiler room several Westinghouse air pumps for maintaining air pressure used in the manufacturing departments.

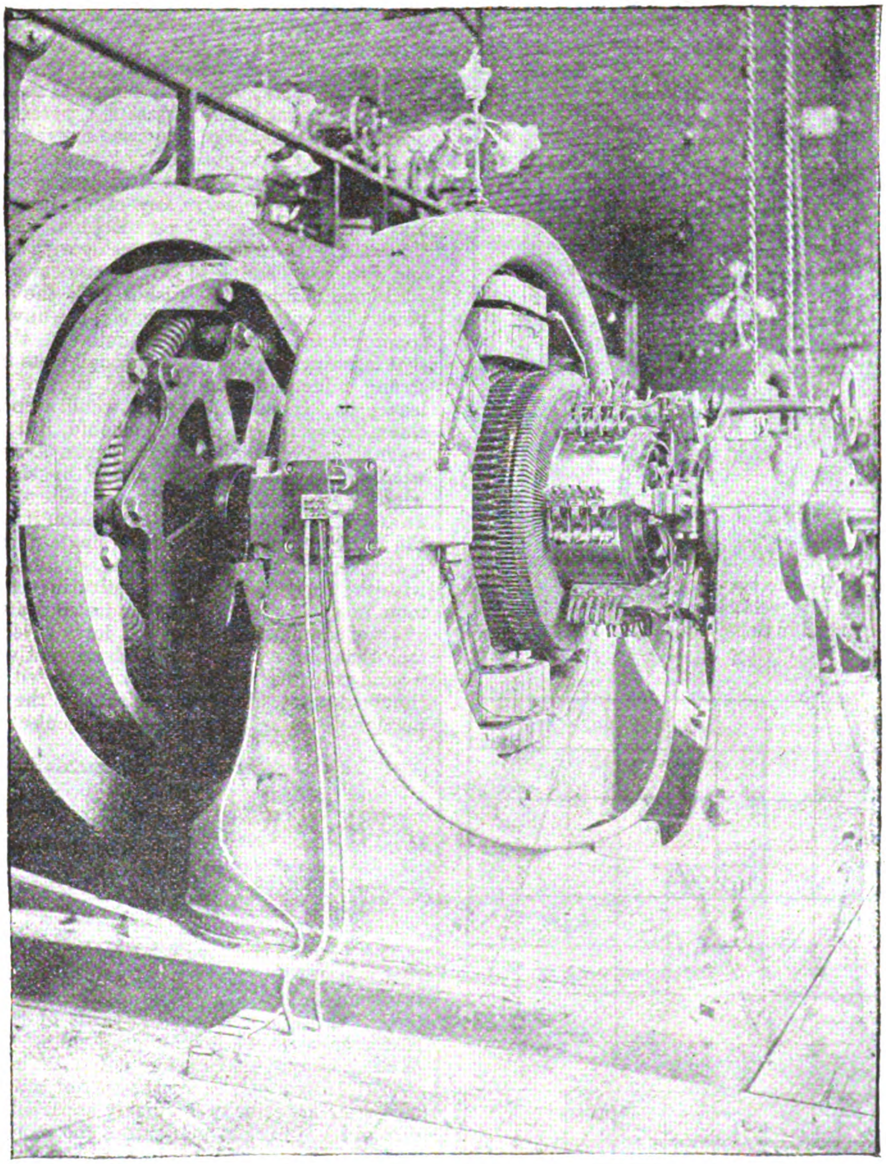

Fig. 1.—500 H.P. Direct-Connected D.C. Generator

The five engines already in operation are of the regulation Westinghouse compound type.

The dynamo room at the west end of the building is 76ft. by 70ft., and completely separated from the boiler room by an 8in. fire wall. The equipment consists of three 500 H.P. two-phase generators and two 500 H.P. direct-current machines, each connected to a 500 H.P. Westinghouse compound engine. These machines are already in

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operation, and there is being erected an additional 500 H.P. direct-current generator, direct connected to a 500 H.P. steeple compound Westinghouse engine of a new type. Each of the generators rests on a bed-plate in common with its engine, to which it is direct connected by means of a flexible coupling. The space occupied by the steeple engine and its dynamo is only 17ft. by 8ft. 6in. ; the other five units occupy a space 22ft. by 8ft. 6in. There is also installed a revolving transformer, or two-phase motor, used for driving a direct-current arc lighting machine, and also for supplying the exciting current for the fields of the polyphase generators.

The direct-current generators (Fig. 1) are all of the Westinghouse standard type—that is, they have a slotted, ventilated armature and a cast-iron yoke with inwardly projecting pole-pieces of laminated steel. The general dimensions are 7ft. 10in. by 8ft. 8in. and 8ft. 3in. in height. The armature winding consists of bars of copper threaded through slots in the core, and so connected as to give a two-circuit winding, which at all times ensures equal distribution of current throughout the coils. The armature is 46in. in diameter, keyed and pressed to a 7in. shaft, which is 104½in. in length and 48⅞in. between journals. The commutator, 26in. in diameter, with a 10½in. face, is of the best grade copper, properly tempered, and built up with Canadian mica. The current is collected by means of a six-arm brush-holder carrying three carbon brushes per arm. The bearings have a spherical seat, so that they are at all times self-aligning. Below the bearings are large reservoirs for oil, which is carried up to the shaft by means of brass rings, thus affording automatic lubrication. The pole-pieces are built up of sheet steel punchings riveted together; thus constructed they are sent to the foundry and there have the yoke cast solidly about them. The lower half of the field yoke and the bearing supports are cast in one solid piece, thereby securing rigidity and strength. The field winding is, of course, compound, the series coils being copper strips of ¾in. cross-section. The machines develop 750 amperes at 500 volts when running at normal speed, which is 215 revolutions per minute. The points of commutation are constant under all loads, and the machines will carry, for short periods, as high as 75 per cent. over-load without damage or undue sparking.

The polyphase generators (Fig. 2) are of the same general form and dimensions as the direct-current generators. They have 14 laminated steel pole-pieces, built up and cast into the yoke in the same manner as described above. The exciting coils have but a single winding, as regulation is secured through a rotary transformer which supplies the total field current. The armature is very similar to the direct-current hub or spider, the whole design providing for thorough ventilation during operation. The periphery contains some 92 slots, in which the bar winding used is held in position by strips of rigid insulating material secured by grooves inside the slots. It is of the continuous type, and the four connections are brought out at points 90deg. from each other, to four collecting rings, where the current is collected by means of copper brushes. The collecting rings are 5½in. in diameter, with a 1½in. face. There are four brush-holder arms, two per circuit, which carry two brushes to each arm in order to ensure efficient contact. The polyphase machines run at the same speed as the direct generators—215 revolutions per minute. They generate current of 3,000 alternations (25 ∿) at a potential of 240 volts. Their normal output is 400 amperes on each of the two circuits. These generators are usually run in multiple, operating as perfectly and satisfactorily as any direct-current machines.

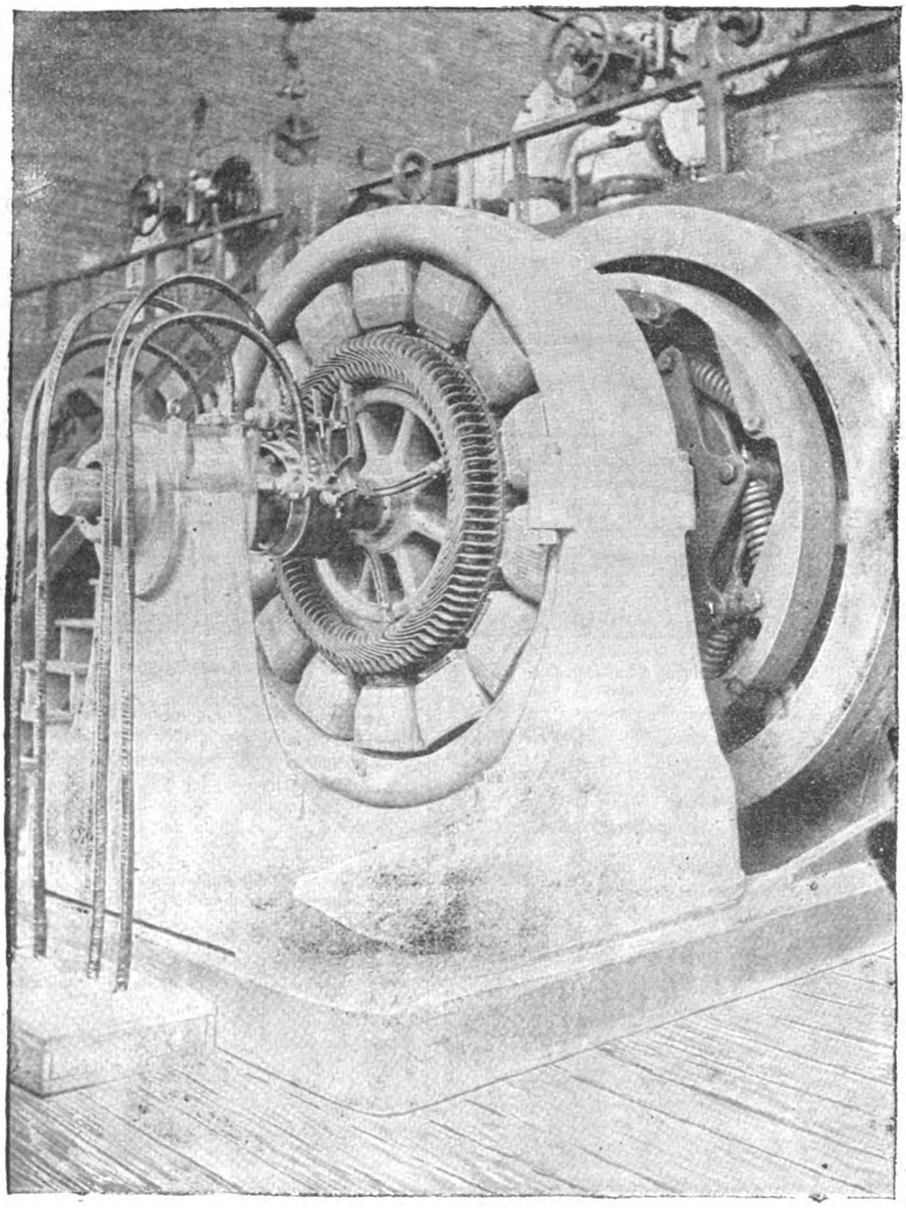

Fig. 2.—500H.P. Direct-Connected Two-Phase Generator.

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At present there are installed two temporary switchboards, which will be replaced by handsome Italian marble incombustible boards, one for the direct-current and one for the polyphase system. These

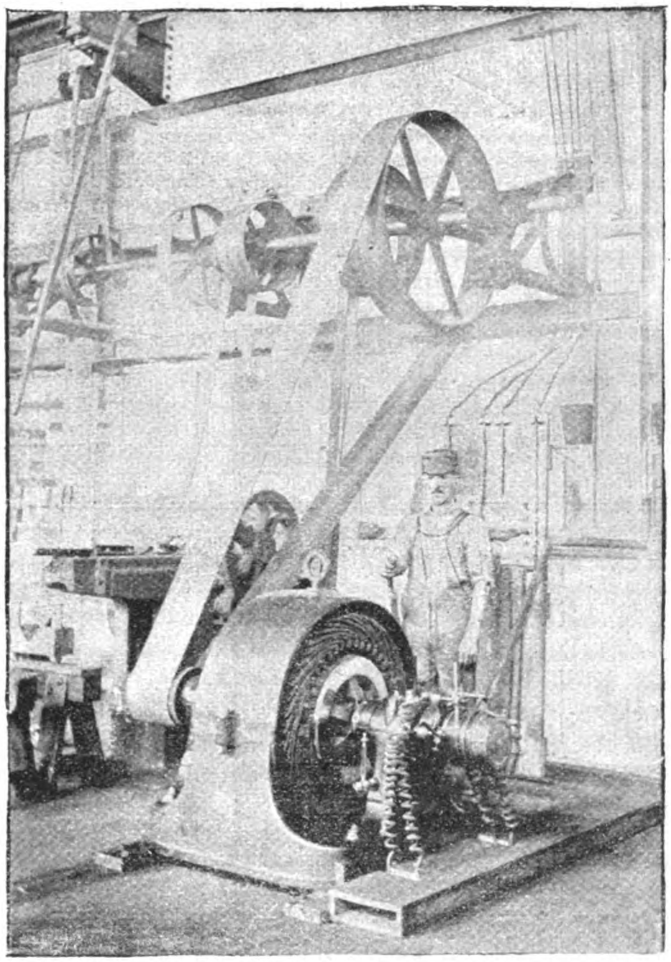

FIG. 3.—60 H.P. Two-Phase Motor Driving Shafting.

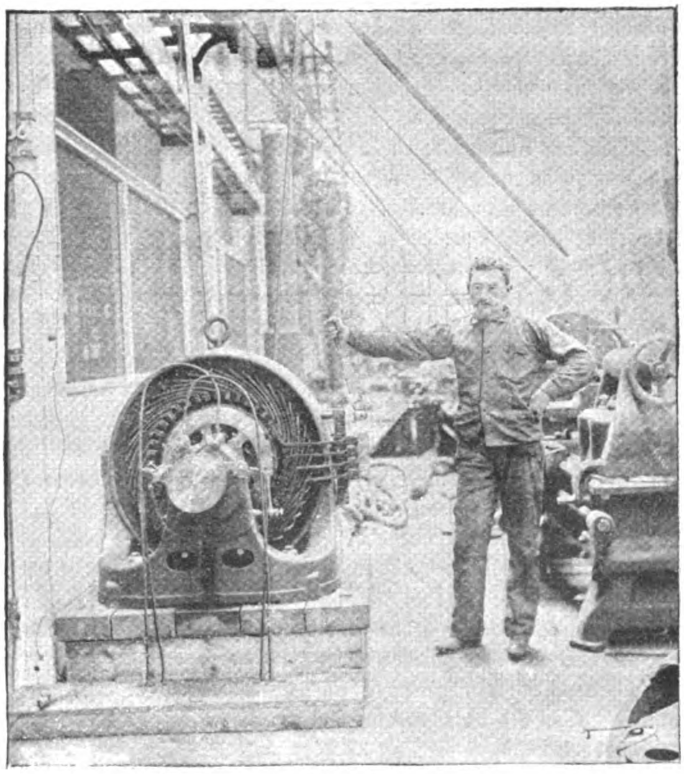

FIG. 4.—40 H.P. Two-Phase Motor Driving Shafting.

boards will be of a new and improved type, a single marble slab over 5ft. long, 2ft. wide, and $1\frac{1}{4}$in. thick, taking the place of a number of smaller units. The apparatus will be mounted directly on the face of the marbles, which will be supported by iron bracings against the wall. Each board will consist of one load, five generator and five feeder panels. The load panel will be equipped with wattmeters and voltmeters for measuring the total output of the machines in multiple. Each of the dynamo panels will contain signal lamps, main switches, voltmeter and ammeter switches, ammeters, rheostats, and synchroscopes or phase indicators on the polyphase board for throwing in multiple. The feeder panels will be equipped with lamps, ammeters, fuses or circuit breakers, switches, &c.

Up to the point at which the current leaves the switchboard for supplying the transmission circuits, the installation is identical with that which would be used for long distance work. If the energy were to be used, for example, at Johnstown, Pa., 75 miles distant, it would only be necessary to connect in converters and transform the potential from 240 to perhaps 10,000 or 15,000 volts. In the Westinghouse plant the current is distributed through copper cables covered with simple waterproof insulation. These are carried on heavy iron brackets. The wires are arranged to avoid mutual and self-inductive effects.

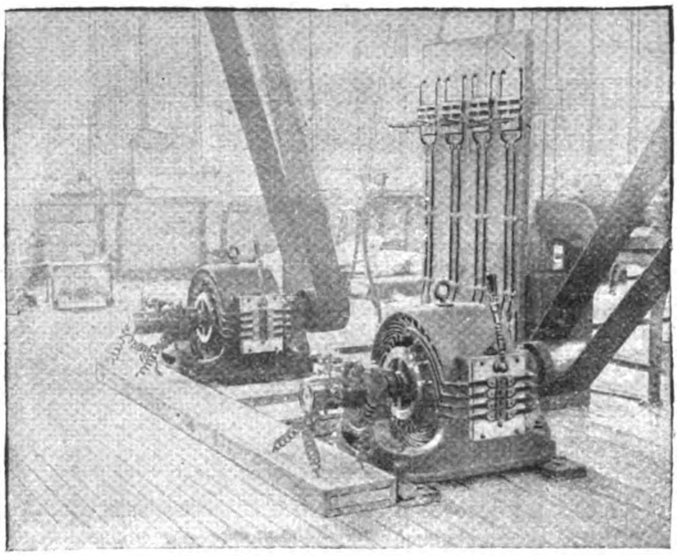

FIG. 5.—Two 30 H.P. Motors Driving Shafting.

As a rule the Tesla motors are belted, as shown in Figs. 3, 4 and 5, to short lengths of shafting from which the machinery is driven. The location of the motors and their horse-power is given in the appended table :—

220-volt Polyphase Motors.

—	Horse-power.									Total H.P.
	10	15	20	25	30	40	60	75	Motors.	
Machine shop	2	1	4	1	9	8	1	...	26	790
Detail department	2	...	4	...	...	...	...	...	6	100
Blacksmith shop...	1	2	3	...	...	1	..	...	7	140
Punch shop.........	2	...	2	...	1	...	...	...	5	90
Brass foundry......	2	...	1	...	...	...	...	...	3	40
Carpenter shop ..	1	...	2	...	1	...	...	1	4	155
Paint shop	2	1	2	..	...	...	...	...	6	85
Totals	12	4	18	1	11	9	1	1	57	1,400

500-volt Direct-Current Multipolar Motors.

—	Horse-power.			
	$3\frac{1}{2}$	5	$7\frac{1}{2}$	10
Two 30-ton Shaw cranes, 67ft. span............	2	...	2	2
Two 10-ton Sellers cranes, 32ft. span	2	2	2	...
Two 10-ton ,, ,, ,, ...	...	6	...	...
Two 10-ton Gale and Towne cranes, 22ft. span	2	2	2	...
Totals	6	10	6	2

Throughout the factory there are 17 electric, freight and passenger elevators which were at first operated by direct current; these are rapidly being replaced by multiphase motors. The elevators are all belt-driven, but there is no objection to their being direct connected whenever so desired. The motors vary from 20 to 30 H.P. capacity.

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The Oldest Electrical Journal, 1861–1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "Coutts and Co."

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GRADUATION IN BUSINESS.

SOCRATES taught that the essence of knowledge is definition; and it has been said by more than one wise man in later times that the beginning of science, which is correlated knowledge, consists in measurement. Be all this as it may, it is certain that one of the earliest attempts of science or knowledge was to put a measure upon itself, to define the degree of success with which a votary may have mastered it. Indeed, long before science could claim to be "exact," in the modern meaning of the term, its students sought to proclaim their status by a series of carefully and exactly defined labels, commonly called degrees. In earliest times these degrees were few in kind, and they served rather to indicate the extent of a student's mental expansion than to represent his qualification for special practice. Nowadays, however, degrees are not only more numerous in kind, but there is distinct differentiation to be made between those of the ancient type and those which are a product of the latter-day utilitarian spirit. The former are the index of a man's education; the latter, the ostensible guarantee of his proficiency in some one or other line of business.

This important distinction between two classes of degrees, entirely opposite in their intention, is not always as carefully attended to as might be by authorities in educational matters. There is noticeable sometimes a tendency to give to the modern business degree that same wide latitude which is reasonable enough in degrees of a more purely ornamental character. When a man wishes to widen and deepen his general education by a course of study in the Arts, it matters little or nothing whether his mind is expanded by this or by that form of intellectual labour. To-day he may choose Latin and Greek; had he lived in ancient Athens he might with equal mental advantage have chosen Egyptian and Chaldean. But when it is the purpose of the man to practise the business of, say, administering drugs to his fellow man, the sublimest knowledge of the classics cannot compensate for ignorance of the effects of one single drug; or, if he intends to practise as a mining engineer, the utmost proficiency in chemical analysis cannot avail in place of a thorough knowledge of the practice of mining.

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No doubt these things seem trite enough and perfectly obvious; yet our attention has recently been drawn to a "Prospectus of Elective Studies," issued by the Michigan Mining School, in which such trite and obvious things have been ignored. Far be it from us to seem to explain what is meant by "elective studies," when the exposition thereof fills a pamphlet of fifty pages, and is complicated enough to occupy the time of an intending student for the first month of his college tuition. But we cannot refrain from descanting upon one or two of the peculiarities of this elaborate educational device, which impressed us after we had successfully wrestled with the contents of the said pamphlet. In the first place, education at the Michigan Mining School is measured in terms of that *fin de siècle* thing, a unit. "The unit of the system is a study taken three times a week for 34 weeks"; which is very like making one *mauvais quart-d'heure* the unit of misery. That much settled, the next thing is to offer the student three degrees,—we will notice only one of these, viz., that of E.M., or Mining Engineer; and to affix the number of "units" which will qualify for a degree. There are numerous subjects, many not connected with mining, taught at the Michigan Mining School; and each is worth so many units, or fractions of a unit; and the game—for it is not unlike a species of game—is to "pass" in enough units to win a degree. To qualify as a Mining Engineer at the Michigan Mining School you must "pass in 22 full courses, including subjects 20 and 21," which means that you must get 22 units anyhow you please, except that decimal-two of a unit will have to be obtained by studying "elementary geology," and decimal-three of a unit by passing in "elementary principles of mining." And then you are a full-blown E.M., and may bore holes in the ground, and put up ricketty machinery, which will presently fall down and kill somebody.

It is folly to expect that a young man just entering college or a technical school can properly draw up a list of the subjects to qualify him for his intended profession. Yet, at the the Michigan Mining School he is required to do so before he enters, nor can he subsequently depart from his initially-chosen path of study without a great deal of fussy correspondence with the governors and staff. In one case out of every hundred a student, older and more experienced in worldly affairs than the rest, might be able to map out a line of work for himself; but the majority would certainly be ignorant both of the duties of their intended calling and of how they ought to prepare to discharge them properly. It is true that at this extraordinary institution a pupil may, if he likes, seek aid in drawing up his course of studies; but the error lies in giving him any choice in the matter. We do not wish to seem to imply that a student is at no time during his studies to select one or the other of two or more possible courses. In our opinion, it is necessary for every technical student to make such a choice, but not at the outset; not, in fact, until he has covered the essential groundwork of his profession. The first two years' work of a three years' course ought to be absolutely rigid; the student should have no power to alter it; its syllabus should be defined by competent teachers alone. The later and specialising studies will, of course, naturally be selected by the student himself.

It will be useful to inquire still further what it is that may reasonably be expected of a student before he shall be entitled to one of these modern business degrees. It may be assumed that the purpose of such a degree, whether in Medicine, Mining or Engineering, or any other business, is ostensibly to indicate that the graduate is competent to practise. Beyond doubt, the real value of a degree of this kind will be directly proportional to the truth with which it indicates the graduate's practical capabilities. However high sounding it may be, and however respectable the institution from which it may have emanated, the degree will sink speedily into discredit and become an object of scorn, if its only basis be a vellum certificate bolstered up by a pile of college note-books and a three-years' course of lectures. The recognition of this by the Faculty of Medicine has led to the invaluable requisition that the intending graduate shall gain a certain number of years' actual practical experience before he can qualify for the M.D. degree; and it would be well if a like restriction were imposed upon engineers wherever university or college engineering degrees are granted. The undergraduate in engineering should be called upon to leave his Alma Mater and go forth into the rough and tumble of actual practice; nor should he be permitted to return and graduate, until he can show by some years of experience that he is worthy of the name with which the degree would label him.

NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(Continued from page 446.)

49. Clark's Fall of Potential Test (*continued*).—Mr. Herbert Taylor (of Messrs. Clark, Forde and Taylor) has devised the following method by which, without alteration to the usual ship and shore connections during submersion, the fall of

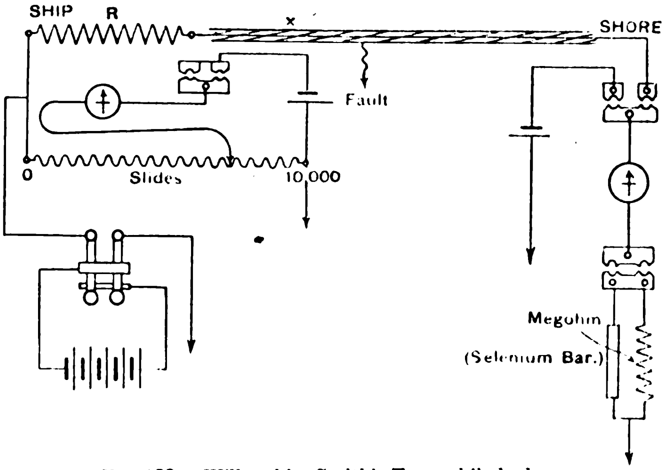

FIG. 152.—Willoughby Smith's Test, while laying.

potential test can be immediately applied in the event of a fault appearing in the submerged portion. The usual ship and shore connections are on Willoughby Smith's system, the apparatus, so far as affects the present test, being arranged as shown in Fig. 152. The slides are connected as in the bridge test, the current from the testing battery dividing between the fixed resistance R and cable on one side and the slides on the other. The galvanometer is connected as shown with one contact movable on the slides. The zero end of the slides is connected to the testing battery end, so that when balance is obtained the insulation resistance of the submerged portion is indicated continuously and is equal to

$$R\left(\frac{10{,}000}{s} - 1\right) \text{ ohms,}$$

where s is the slide reading. The ratio $\frac{10{,}000}{s}$ can be found at once by a table of reciprocals—that is by finding the reciprocal of s and moving the decimal point four places to the right.

Mr. Taylor adds a standard cell to each end and a megohm to the end on shore, with suitable commutators to plug them in as required (Fig. 153), without in any way altering the Willoughby Smith connections. Should a fault occur in the

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submerged portion, ship's balance on the slides is at once thrown out and shore's galvanometer deflection falls, so that both ends are immediately aware of the fact. The potentials are distributed as in Fig. 154, the potentials P and p being measured on board and p_1 on shore. The ship then obtains a fresh balance, say of s divisions, equivalent to the potential

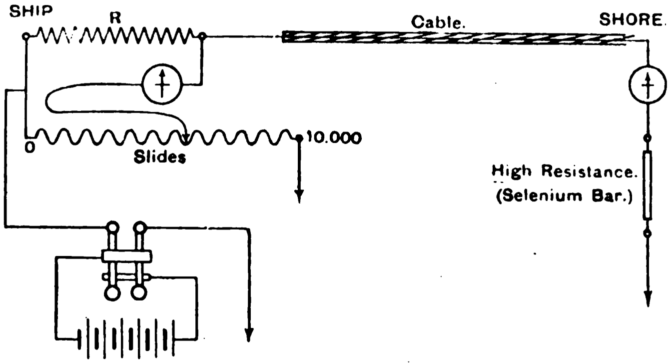

FIG. 153.—Herbert Taylor's Test for Localising Fault paid out while laying.

p, and then changes commutator plug over to connect the standard cell to slides. As the zero of the slides is at the battery end, the readings must be subtracted from 10,000. Say the reading with a standard cell of e volts is n divisions.

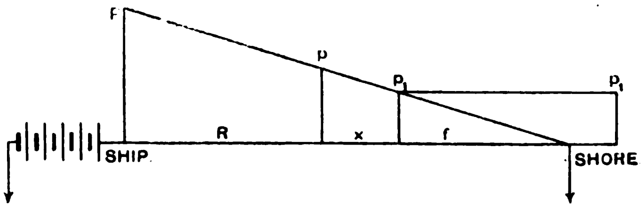

FIG. 154.

For convenience, let $10{,}000 - n = m$, then the potential per division is equal to

$$\frac{e}{m} \text{ volts.}$$

and the potential p is equal to

$$(10{,}000 - s)\,\frac{e}{m} \text{ volts;}$$

also the potential P is equal to

$$10{,}000 \times \frac{e}{m} \text{ volts.}$$

The values so determined are then used in the formula

$$x = \mathrm{R}\left(\frac{p - p_1}{\mathrm{P} - p}\right) \text{ ohms,}$$

where x is the cable resistance to the fault. Or the above values may be first substituted in the formula, which then becomes in its complete form

$$x = \mathrm{R}\left(\frac{10{,}000}{s} - 1 - \frac{p_1 m}{e s}\right) \text{ ohms.}$$

The shore simultaneously determines the potential p_1 in volts by comparing the deflections through one megohm produced respectively by this potential and by the known E.M.F. of a standard cell. Shunts must, of course, be allowed for if used. It will be noticed that the expression comprising the first two terms within the brackets multiplied by R is identical with that given above as representing the whole resistance in circuit, which, when a fault is present, is the resistance from ship to earth through the fault. And, since the whole formula represents x, the distance in ohms to the fault, it follows that the remaining term

$$\frac{\mathrm{R} p_1 m}{e s} \text{ ohms}$$

represents the resistance of the fault.

In the latest form of slides (by Kelvin and Varley) the contact stops, instead of being side by side on one circle, as in the usual form, are arranged as in Fig. 155, which allows more room, and therefore better insulation, between them.

The illustration shows the numbering of the coils, which in this form of slides is arranged for reading from the right-hand pointer b, instead of, as usual, from the pointer a. The terminals A and B of this box are connected to the contact stops numbered 100 and 99 respectively. As the pointers stand in the illustration the reading is 600. The improvements in the construction of the slides and the various uses of this important piece of apparatus are admirably treated upon in a work by Mr. W. A. Price, entitled "A Treatise on the Measurement of Electrical Resistance."

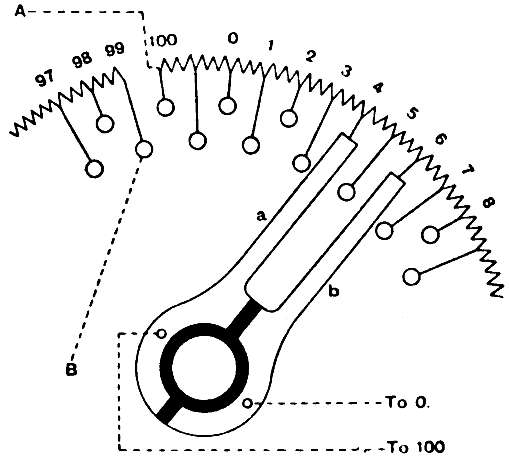

FIG. 155.—New form of Slides.

50. The Polar Test.—True as it is that improved protective covering on cables has led to a reduction in the number of faults with a corresponding increase in their resistance, rendering them difficult to localise, it is nevertheless the case that cables are as much as ever subject to fractures in shallow water. Ships' anchors are, in fact, the cause of more faults and breaks on the Atlantic cables than any causes at work in deep water. A comparatively large area of exposure is a general feature in such faults, and they are consequently much easier to deal with. Polarisation is small in amount and slow in action, and the ordinary bridge balance can be satisfactorily obtained, using

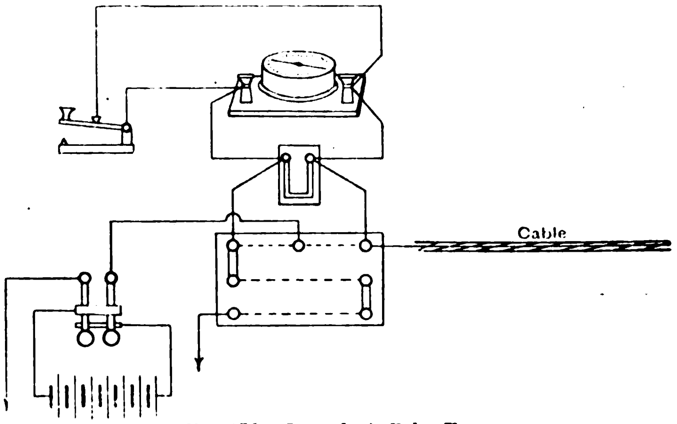

FIG. 156.—Lumsden's Polar Test.

both directions of current—that is, zinc continuously and copper for the short periods necessary. The negative or zinc current cleans the fault and lowers its resistance, while copper polarises it, or causes a deposit of salts (chloride of copper), which raises the resistance. Having balanced for copper, the spot moves off the scale in the opposite direction quicker or slower, according to whether the fault is of small or large area, and the rate of movement of the spot during the first second or two of polarisation is a guide to an experienced electrician what to allow for the fault.

On faults of this class the polar test, devised by Mr. Lumsden, is not infrequently adopted if time permits. The test is usually made with a horizontal galvanometer having

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astatic pivoted needles, the connections being as in Fig. 156, and the distant end of cable being free (unless it is a fracture). The fault must first be thoroughly cleaned by a strong zinc current, using a battery as large as permitted by the rules. The time this should be kept on depends upon the behaviour of the fault. If it is noticed that the resistance no longer falls, but becomes steady, it shows the fault to be clean; but it may take several hours before this is observed. After the cleaning period, the fault is just sealed over by about one minute's application of copper current, and then the important part of the test begins. The zinc current is put on, causing a gradual fall in the resistance, and the plugs in the bridge are adjusted quickly to keep pace with the fall. This diminution of resistance arises from decomposition of the salts at the fault, and immediately a passage is opened through the coating, hydrogen is set free, the resistance is increased, and the needle moves rapidly away from its position of balance. At the moment before the evolution of gas occurs the resistance unplugged is that required, namely, the resistance up to fault plus the lowest resistance of fault obtainable. On repeating the test it is only necessary to apply the zinc current for a few minutes.

Other methods in use to which the reader is referred are Fabie's Test (Kempe's "Handbook of Electrical Testing"), and a method by Messrs. Harold W. Ansell and Julian E. Young in *The Electrician* March 15, 1889, entitled, "On the Localisation of a Partial Earth Fault in a Submarine Cable by the Fall of the Fault's Natural Potential."

(To be continued.)

ARMATURE REACTION.

In the course of the discussion which took place at the American Institute of Electrical Engineers on the Paper by Prof. H. E. Ryan and Mr. M. E. Thompson on "A Method for Preventing Armature Reaction" (see *The Electrician*, April 19, 1895, p. 765) Mr. E. A. Merrill suggested a method of graphically representing the nduction through a dynamo armature. Fig. 1 shows the relative

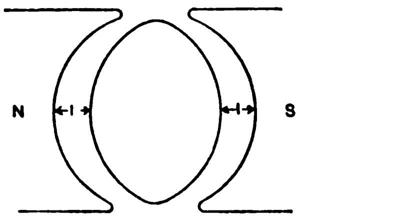

Fig. 1.

induction for every point at no load, the induction being uniform over a wide area and diminishing midway between the poles to zero, the distance I from the pole to the curve along the radial lines being proportional to the induction. If a strong current is passed through the armature the curve may assume the form shown in

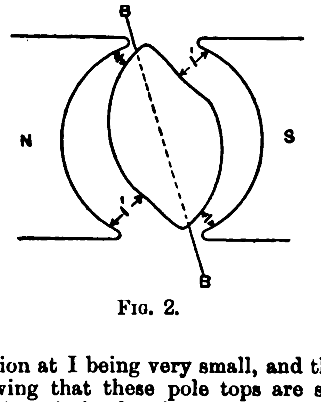

Fig. 2.

Fig. 2, the induction at I being very small, and the induction at I' very strong, showing that these pole tops are saturated. If, in addition, the position of the brushes and the line of commutation at B are indicated, the diagram graphically shows the strength of field where commutation takes place, and whether the voltage tends to be increased or diminished.

TECHNICAL RESEARCH.*

Every engineer is engaged in technical research, sometimes at his own expense, but oftener at the expense of his clients. The more important and commanding his position the greater is the proportion of his work that lies outside the boundary of assured knowledge. The ordinary everyday problems in construction are confided to the journeymen of the craft, who, out of the records of their experience, can generally find a fitting solution, or can even go one step in advance of what has been done before. But when not one, but many, stages have to be travelled into the unknown, there is needed something more than a general knowledge of the subject, and fair ability to reason by induction. Then it is that the real art of the engineer—an instinctive power in adapting the forces of nature to new ends—comes into play. If the matter be one dealing with machinery, it is generally possible to try small scale experiments in regard to a few, if not all, of the points of issue, and thus to eliminate some of the doubtful points in the subject. But there are many matters that are submitted to engineers the difficulty of which arises mainly from their magnitude, and which have to be treated entirely from a new standpoint. Only full-sized experiments would be of use, and therefore the whole affair becomes a gigantic piece of research work, for which the promoters find the funds, and on which the engineer stands to gain or lose reputation. Generally he gains it. It is perfectly wonderful with what a large measure of success new and difficult work is accomplished, and how exceedingly few are the serious failures. The mishaps that do occur are mostly connected with details that could be studied on a small scale if the engineer had time and money to investigate them. But while promoters will risk tens of thousands of pounds on a project, it is practically impossible to get them to provide a few thousands to be spent solely in acquiring knowledge on points that are apparently of subsidiary importance. They consider that technical research is no part of their business, and they decline to spend money in increasing the general stock of know ledge, although the first-fruits would be reaped by themselves.

Great advances in engineering practice wait more often upon details than upon principles. The conception of the compound marine engine is old enough, but it was not until a satisfactory surface condenser was produced that it became commercially possible. As long as the boiler was fed direct from the sea, 30lb. per square inch was the limit of practicable pressure, and compounding offered no advantage under this condition. The surface condenser, as now made, is a simple enough affair, yet it took many years to arrive at, because neither marine engineers nor shipowners were willing to spend the necessary money over a series of comparative experiments. Occasionally a sanguine individual ventured to try one, and when he found it unsatisfactory he generally preferred to face the known loss of abandoning it rather than enter into a series of experiments to perfect it. The triple-expansion marine engine furnishes another example. Up to about 1881 there was scarcely an engine of this kind constructed, and after that date there were very few built of any other kind. The deterrent cause in this case was a misgiving as to the possibility of finding a satisfactory material for boilers carrying 160lb. to 180lb. pressure, and complying with the requirements of marine service. Shipowners held back from making experiments for the benefit of the trade. For years they stuck to the compound engine, well knowing that a 20 per cent. economy was available, if only certain preliminary difficulties, by no means insuperable, could be overcome. But, naturally, no one was willing to pay for experience that would be immediately public property.

It is only under the protection of a patent that a manufacturer can afford to institute researches and pay the cost of experiments. It is a matter of common knowledge that some subjects which it would be advantageous to the public to have pursued are allowed to sleep because it is known to be impossible to secure a broad patent for any improvements that may be devised in connection with them. In years past attempts have been made to discover the best methods of bringing certain processes or materials into practical use, and, although success has not been attained, yet the way has been so far pointed out that it is hopeless to try and discover an entirely new means of attaining the end. The solution is a matter of degree rather than of principle, and as such does not lend itself to be secured under the provisions of the Patent Law. Superheating furnishes a case in point. It is generally believed that we are on the verge of a revival of superheating, and that it will be successful. But in years past there was a very determined attempt to use superheated steam. Apparatus was fitted in a large number of instances, particularly on board ship, and after extended trial was abandoned for several reasons. First and foremost, there was the difficulty of finding a lubricant that would not decompose under the influence of very hot steam. The introduction of mineral oils and vaseline has removed that source of failure without any effort on the part of mechanics. Then there

* From *Engineering*.

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was the chance of the superheater becoming encrusted with salt carried over from the boiler with priming water. But salt in boilers is, or should be, a thing of the past, now that evaporators are so common, and thus a second source of failure has disappeared. The other difficulties were chiefly mechanical, and individually were not serious. But, taken in the aggregate, they are fairly formidable, and it is certain that they will take some time and a liberal expenditure of money to entirely overcome. As our columns have shown, attempts are now being made on a practical scale to introduce superheating. The attitude of the profession is one of expectancy; the majority are waiting to appropriate the result of other people's experiments, certain that nothing can be discovered that will furnish grounds for anything but a narrow patent.

It would be possible to adduce examples in many other departments of engineering to show that science languishes and progress is delayed because our predecessors advanced far enough to demonstrate the principles on which we should act, and yet fell short of attaining a commercial success. The last step, which they failed to take, often from not having the requisite material available, is capable of many solutions, and, therefore, seldom can be made the subject of a paying patent. A man may devise half-a-dozen means of attaining the end, and may fancy that he has closed every avenue to his competitors; but no sooner has he published his plans than alternative methods, of which he never dreamed, start forth like the ghosts at Macbeth's banquet. The man of business acumen waits and lets other people make his experiments for him, relying on his commercial ability to secure a fair share of the results, even if he be a little late in getting a start.

There is, however, one class of men who find it to their interest to make experiments without the hope of direct gain. We refer to professors in technical colleges. They are very favourably circumstanced for making researches, in that a large amount of apparatus is at their disposal, and that they have, to some extent at least, the command of funds for the purpose. Further, they generally have a considerable amount of leisure in the session, while the vacations are far in excess of what is necessary for physical and mental recuperation. They actually get more holiday than the school usher, who has not only to instruct his pupils, but who has also to undertake the formation of their characters and to join in their games. From morn till night, Sunday and weekday, the unfortunate assistant schoolmaster is boy-ridden. He eats with him, he walks with him, he plays with him, and often he sleeps with him. In spite of three intervals of rest per year, he grows narrow and petty, and his society is avoided by men of the world. But the professor is not subject to such contracting influences. He has his lectures to prepare and deliver, and then he is free. If he is to be something more than an animated text-book—a retailer of other men's ideas—he must experiment to furnish himself with original matter, or at any rate with novel illustrations. Further, if he have ambitions beyond the teaching of youths he must provide for a larger audience than that contained in his class-room. We once heard a civil servant say, "The way to make a reputation in the office is to make a reputation outside it," and that is true of others than those that work for the Crown. The engineering professor, until he has made himself a name by original work, is like a figure set up in a fair for every clown, who has learned to chip and file, to have his fling at. He is a mark for the cheap gibe of the man who has never attempted enough to find the depths of his own ignorance. If he would meet the world with a smiling face, untouched by such petty annoyances, he must be sustained by the esteem of the profession. The only way to earn this is by practical work, either in the way of construction or of research. The former avenue is often closed, and even if it be open, it is difficult of entrance to a man who has a permanent engagement which cannot be set aside at will. But at research the professor is on his native heath, and the profession is deep in his debt for much valuable information that has been evolved by a great expenditure of time and thought. Possibly all of it is not immediately applicable in daily life, but that which cannot be used to-day will be available at some future time, as the scope of our knowledge increases. If the total amount of engineering data that has been evolved in scientific colleges and schools could be separated from that obtained from other sources, and presented to us in bulk, we should be amazed to find how great and wide-spreading it is.

The powers of the technical laboratory are, however, distinctly limited. Full-sized experiments are beyond its scope. If no other consideration intervenes, there is always expense to be considered. In spite of the constantly rising fees charged for tuition, educational establishments share in a marked degree in that "eternal want of pence" that troubles the greater part of humanity. The available funds have to be spread over the largest possible area, like boarding-school butter. Investigations on a really large scale can, therefore, not be attempted. There is very little chance of getting these done elsewhere in a systematic manner if, as we have already pointed out, the results cannot be secured to the experimenter under the patent laws. One notable exception, however, is found in this country to this rule. We refer to the researches undertaken by the Institution of Mechanical Engineers. On these there have been spent hundreds—possibly thousands—of pounds, and the results have been freely given to the world. The researches made by the Institution on riveting, on friction, on steam engine economy, and on alloys, are splendid monuments of the large-mindedness of the Council. We know that certain Continental societies have carried out similar inquiries, but not, we believe, with the same completeness. It is doubtful if any private person could obtain similar results, since, were his purse ever so deep, he would not be able to command the harmonious and zealous assistance of a number of men of equal ability to those serving on the research committees. He could not offer them such an honourable position as that of being the chosen representatives of a large and influential professional body. He would be obliged to content himself with the services of one man of the first rank, assisted by others of less eminence.

It is strange that such a splendid example should be almost solitary. There is ample scope for other societies to undertake work of this kind without incurring the reproach of being imitators, or of trenching on each other's territory. Next to the necessary work of holding meetings and publishing their *Transactions*, there is no purpose to which their funds could be applied so directly valuable to their members and so remunerative to the profession. It is not necessary that a scientific body should have great accumulated resources. It is prudent, of course, to have something in hand to tide over a few years of bad trade, but that is quite a different matter to accumulating a vast estate. Engineers are not usually men with a long tale of ancestors, whose memory bids their descendants repay the benefits they inherit by making an ample provision for posterity. On the contrary, they have usually made their own way in the world, and are but little indebted to their forefathers. It is contrary to their instincts to make elaborate provision for those that will come after. If the next generation cannot maintain an institution for themselves in average times, they are not likely to derive much benefit from one existing on endowments. If a father have but a moderate sum to bestow on his family, it is far better that he should spend it in setting them up in life with all the advantages of education, rather than he should leave them in comparative ignorance with a limited fortune which is less than a competence.

On all sides we hear the cry for technical education. But if it be good for the youth to have knowledge gathered up for him, and carefully tabulated and codified, surely it is also advantageous for the grown man to have the knotty points of science unravelled for him, so that he may lay out his clients' money with advantage. Economists tell us that cheapening of production increases demand, and this does not apply only to manufactured goods. Scores of pieces of engineering construction are left unattempted because it is known that the cost so often exceeds the estimate. The reason is that the engineer has not the necessary data to guide him, and has largely to guess at his figures. The capitalist naturally declines to pay for the necessary research, since it is not his business to instruct the profession he employs; the private engineer has neither the time nor the money to undertake it; the professor finds the means at his command inadequate for the task. And so matters stand still, waiting till the investing public forget the smart of their last loss, and gather confidence for another plunge. In the meantime the average technical society reads Papers, distributes its sessional volumes, and congratulates its members on their wealth. It is a pity it does not do something to enable them to increase their individual incomes, by enabling them to furnish positive categorical assurances to their clients as to the efficiency of their designs and the reliability of their estimates.

It is easy, we know, to raise a host of objections to research work being undertaken by societies. It may be suggested that some departments of the profession will be aided and others will be neglected; that the council will consider the needs of their own practices and neglect those of the rank and file; that reputations will be created at the general expense and so on. It is so much easier and so much pleasanter to find objections than to undertake the work. But the fact remains that the Institution of Mechanical Engineers has now pursued its experiments for years, on a very extensive and liberal scale, and that no complaints have been made. A large amount of most valuable information has been gained, and there is the prospect that more will be added. But, we ask, why should it be left to one society to furnish funds and time and labour for the entire profession? The possibility and success of these researches have been demonstrated, and it is time that other bodies undertook them as well.

Crystal Palace Old Students' Society.—An association of old students of the Crystal Palace Engineering School, with the above name, has recently been formed.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *July 27, 1895.*

Electric Railway Depreciation.—An officer of the principal electric street railway company of Brooklyn, while recently giving testimony in proceedings instituted to reduce the tax assessment of his company, stated that since January, 1892, its electric railway plant had depreciated to the extent of $5,000,000. This depreciation was explained to be due partly to natural wear and tear, partly to the rapid superannuation of electrical machinery necessitating the purchase of new types, and partly to the fact that a power house costing $700,000 had been abandoned on account of unfavourable location. In answer to a question as to the usual percentage of depreciation of electric street railway plants, he stated it to be from 60 to 70 per cent. While this testimony was *ex parte*, a reduction of taxation being the end in view, yet the exaggeration is not so startling as might be thought. Though few electric railways were installed previous to 1890, very many of our present roads are already suffering from serious depreciation, both of the track and of car and power house equipments. It has been found that the track suffers apparently out of all proportion to the increased speed of electric over horse cars, and many of the latest roads have adopted steam railway track construction. In the power house the wear and tear on the boilers and engines has also been very great, and the earlier roads have besides found it necessary to go to the expense of installing new types of engines and generators. The result of this is that the large returns so confidently expected through the substitution of electric for horse traction, and which in the first years were realised, are found to be illusory, and street railway investors are commencing to pass through the same process of disenchantment to which central station stockholders have in the past been subjected.

The Two-Carbon Arc Lamp Patent.—Judge Showalter, of Chicago, a few days ago rendered a decision denying the broad claims of the Brush patent on two-carbon arc lamps; but as the patent in question will expire in September of next year, the decision lacks the great force it would have had even a few years ago. It recalls, however, the singular monopoly the two-carbon lamp has had in this country, and which resulted in huge returns to the Brush Company, which collected $5.00 from every such lamp made by other manufacturers. Being the earliest arc lighting concern in the field, this Company set the fashion, and the public in time came to believe that all night lighting with single-carbon lamps would be an absurdity to attempt. Though a number of attempts were made to introduce the single-carbon lamp, at the present day its use in this country is practically unknown, and even with the fear of litigation gone, it will doubtless take some time to overcome the prejudice in favour of the double lamp for street lighting.

Electrical Method of Determining the Velocity of Projectiles.—Prof. A. C. Crehore has recently been conducting some interesting experiments at Fortress Monroe on the measurement of the velocity of projectiles, in which the principle of the magnetic rotation of the plane of polarisation of light is employed. The method consists in connecting the usual electrical gun screen in circuit with a closed coil, within which is a tube containing carbon bisulphide. As the screen is shot out of circuit, the intensity of the current is changed, with a corresponding change in the magnetic strength of the field of the coil, and a consequent change of the plane of polarisation of light passing through the tube. The apparatus is so arranged that when the circuit is broken a ray of light passing through the tube is extinguished by polarisation, by means of which a photographic record is enabled to be secured much more correctly than by the employment of a mechanically moved camera shutter.

NEW YORK, *August 3, 1895.*

Polyphase Electric Railway System.—It is rumoured that one of the large electrical manufacturing companies will before long put on the market a polyphase electric railway system. Polyphase-current street railway traction is a subject to which little or no attention has been given in this country by the general electrical engineering profession, doubtless for the reason that the action of induction motors has been much mystified by a treatment which has been almost exclusively mathematical. Engineers, therefore, were somewhat surprised some months ago when Dr. Bell asserted that such motors were entirely adapted for street railway use, and more recently Steinmetz, in an Institute discussion, went even further, saying that polyphase motors were much superior to continuous-current motors for electric traction.

Public Franchises.—Before the advent of the present reform government in Brooklyn the majority of the Council of that city, which became known as the "Cold Thirteen," carried on a very profitable traffic in street railway franchises. Among the franchises which they disposed of to their own personal gain was one to a clique of professional politicians, who received it gratis, though an existing street railway company had offered the sum of $250,000 in payment for the privileges which it conferred. The Flynn Grant, as it is known, was quickly disposed of to capitalists, who, after expending about $3,000,000, were thrown into consternation by a decision from a Court declaring the franchise void on account of the improper means by which it had been secured. After a lapse of some months, during which all work was stopped, another Court has just reversed this decision, and work is again proceeding. The loss of money through the stoppage of work would have been much more than sufficient to have, by honest means, secured the franchise by purchase from the city, and we cite the case as an example of many others in which it has been found that corrupt means of securing public privileges do not pay.

CORRESPONDENCE.

MAGNETIC UNITS AND NOMENCLATURE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Engineers will look with dismay at the six columns of new electrical units proposed by the Electrical Standards Committee of the British Association, and printed in your current number. One of the new units proposed is the "weber." Practical men are accustomed to use the C.G.S. or absolute unit of magnetic quantity, and have found it quite sufficient for their wants. This unit has, however, had a variety of names. It is often called a "line" or "magnetic line." Swinburne called it a "scot," and Evershed a "gauss." Other writers have used the terms "thom" and "hop," presumably abbreviations of the names of two distinguished electricians. I generally use the term "mag," which is short for "magnetic unit."

If the British Association would adopt a short and simple name for this unit, instead of new complications in the way of nomenclature, they would, I am sure, earn the gratitude of electricians, both practical and scholastic.

It has always appeared to me to be a doubtful compliment to take the name of a distinguished engineer or scientist, spell it with a small initial letter, as "watt" or "weber," and, in addition, may be, mutilate it like "farad," and use it to denote a perhaps extremely insignificant quantity. It is well known that one distinguished living electrician has declined the honour of having a unit named after him; and I venture to ask if Prof. Lodge would consider it a compliment to find mathematicians using the "lodge" as a unit of permeance or some equally abstruse quantity?—Yours, &c.,

London, August 2, 1895. J. A. KINGDON.

BELFAST GAS ENGINE ELECTRIC SUPPLY STATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with much interest your description of the above station appearing in *The Electrician* for July 26th. It was, however, disappointing to myself and probably others to find that no official test of the gas engines taken at Belfast

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is given in your article; although we are given to understand that a six-hours trial was carried out at the contractor's works, and it was found that the consumption of Kilmarnock gas did not exceed 24 cubic feet per electrical horse-power-hour. This has, however, nothing to do with the conditions of the contract, as it was most distinctly put that the engines must undergo a six-hours test running continuously at full power, and that the consumption of Belfast gas per electrical horse-power at the terminals of the machines must be less than 26 cubic feet per hour.

To take Kilmarnock gas as the test is unfair to the other firms who tendered for this work, as Kilmarnock gas, according to the "Gas Engineers' Annual," is of 28 c.p., and that of Belfast 17½ c.p., which would make the consumption of the engines at Belfast nearer 28 than 26 cubic feet per electrical horse-power per hour.

It would also be interesting to know how much cooling water is consumed when the engines are working at full power, as the provision for running the water directly through the cylinder jackets, and the use of a circulating pump, in addition to the ordinary cooling tank, point to a rather large consumption of water, and consequently increased expenditure in the working of the engines.

It would be most interesting to know something more about the points I have raised, as it is on these that the success or otherwise of electric supply stations driven by gas engines greatly depends.—Yours, &c., J. Robson.

August 2, 1895.

STANDARD SCREW THREADS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Mr. Elphinstone, in a letter in your current issue, has brought forward a subject that certainly is of immense importance not only to manufacturers, but to *purchasers* of apparatus.

That not only no two makes of B. A. threads are alike, but that consecutive deliveries by the same maker differ considerably, has been and is a source of constant annoyance and loss, which is only lessened by rigorous examination and rejection. This should not be; and not only users, but the manufacturers themselves would welcome the construction of accurate standards for comparison, as at present each user as well as manufacturer has one of his own, which is supposed to be *absolutely true*.

Mr. Crompton has had the subject in hand for some years, as the majority of makers are aware, and it is his intention to bring the matter before the British Association at their forthcoming meeting. It is to be hoped, therefore, that he will, as Mr. Elphinstone suggests, receive the support not only of those who, like himself, are interested in high-class work, but also of the manufacturers themselves in the solution of what is at present an anything but satisfactory state of things.—Yours, &c., W. Clark Fisher.

August 13, 1895.

INDIRECT ELECTROLYSIS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your number of to-day you have a "Note" on what is called "indirect electrolysis." Is this anything more than the well-known fact that if a metal plate be interposed between the poles in any electrolyte its two sides are respectively + and –, metal being deposited at the latter and oxygen or its equivalent set free at the other?

It is probable that in the case of a carbon plate being immersed in the central compartment gold would only be deposited if the impressed E.M.F. were sufficient both to decompose the solution of salt and the gold cyanide; below this point, although the salt might be decomposed, the energy would be insufficient to decompose the gold cyanide, and no gold would be deposited. The fact observed by Mr. Andreoli is taken advantage of in a well-known copper refining process, and also in Prof. Crookes' gold amalgamating process by reversing currents, every minute particle of gold between the two poles being alternately cleaned at the + side, and amalgamated by deposition of mercury on the – side.—Yours, &c., W. Stepney Rawson.

August 9th.

LEGAL INTELLIGENCE.

Consolidated Telephone Construction and Maintenance Company (Limited).

In the Chancery Division on Saturday last an application was made to Mr. Justice Chitty to sanction an alteration in the Memorandum of Association of this Company, which was incorporated in 1881 with a nominal capital of £300,000, in £1 shares, but owing to various alterations, the present nominal capital was £234,938, divided into 47,363 Six per Cent. Preference shares of £1 each, 224,850 Ordinary shares of 10s. each, and 75,150 Ordinary shares of £1 each. All the Ordinary 10s. shares had been issued as fully paid. There was now a prospect of profitable trading in matters which were not considered to be covered by the Memorandum of Association, and it was proposed to alter them so as to give the Company power "to manufacture, buy, sell and deal in articles, apparatus and inventions in connection with electricity or to which electric power may be applied, and to manufacture and deal in mechanical apparatus and inventions whether connected with electricity or not," and to alter the title of the Company to "The Consolidated Telephone Construction and Manufacturing Company (Limited)." The petition stated that owing to the expiration of patents belonging to the Company, and to the extensive importation of telephonic apparatus, the manufacture of telephones and apparatus connected therewith had become less lucrative than formerly, and the plant and appliances of the Company were only partially employed. The Company, therefore, proposed to engage in the manufacture of scientific and mechanical instruments, &c.

His Lordship sanctioned the proposal.

British Insulated Wire Company (Limited) v. Prescot Urban District Council.

In the Court of Appeal, before the Master of the Rolls and Lords Justices Kay and A. L. Smith, an appeal by the plaintiffs from the judgment of the Divisional Court (Mr. Baron Pollock and Mr. Justice Wright), on a special case stated in this action, was heard. Particulars of the action will be found in our issue of the 2nd inst., where it will be seen that, without calling upon defendants' counsel, the learned Judges gave their verdict in favour of the District Council, and declared the agreement entered into by the parties in November, 1892, as not binding, owing to the absence of a penalty clause.

During the course of the argument in the appeal, it was announced that defendants were willing to make the payments, but that the district auditor and the Local Government Board had refused to sanction such payments.

The MASTER of the ROLLS said that, this being the case, it was just and right that the arrears should be paid, and that the Local Government Board would doubtless allow this to be done. A new contract could then be entered into containing a penalty clause.

The case was adjourned to enable the parties to appear before the Local Government Board, and it was subsequently stated that the Board would sanction the payment of the arrears. It was further arranged that a new contract should be entered into in substitution for the present one, its terms to be settled, in case of disagreement, by some third party. Upon these terms the appeal was dismissed.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices:—*

Laboratory Notes and Forms.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett (*now ready*). Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

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A Large-Sheet Table, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s. —each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

A Sheet Table showing Total Capital Outlay and Receipts and Expenditure for the year 1894 of the Statutory Electric Supply Undertakings of the Metropolis is now ready, printed on thick paper, price 6d. each.

A Sheet Table giving similar particulars in relation to Provincial Statutory Electric Supply Undertakings is now ready, printed on thick paper, price 6d. each.

"The Work of Hertz."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. nett, is now ready.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d. post free (abroad 11s.).

"Electrical Engineering Formulæ," a pocket-book by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"Drum Armatures and Commutators."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson, price 6s. 6d., post free.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

"Electro-Chemistry."—This useful work, by Dr. G. Gore, is still on sale, the price being 2s., post free.

Tenders Invited.—Tenders are invited by the Vestry of Hammersmith, London, W., for complete schemes for public and private lighting, and for the supply of motor power in the compulsory area of the Vestry's Provisional Order. Particulars can be obtained of Mr. H. Mair, Surveyor to the Vestry. Tenders have to be sent in by 6:30 p.m. of Wednesday, Sept. 4th.

——— The Vestry of St. Mary, Islington, London, N., invite tenders for the wiring of the Vestry Hall and municipal offices. Particulars can be obtained from the electrical engineer to the Vestry (Mr. Albert Gay), 50, Eden-grove, Holloway, N., to whom tenders must be sent by 12 noon on Tuesday, 27th instant.

——— The Commissioners for the Control of Lunatic Asylums, Dublin, invite tenders for wiring the Killarney District Lunatic Asylum for the electric light. Plans and specification may be seen at the Asylum or at the Office of the Engineer, Mr. W. Leake, 30, Victoria-buildings, Manchester, and tenders, addressed to the Secretary, Board of Control, Custom House, Dublin, must be in by 10 a.m. on the 30th instant.

——— The Electric Lighting Committee of the Wakefield Corporation invite tenders for the supply and erection of (*a*) boiler and fittings, mechanical stokers and engine, economiser, feed pump, injector, &c.; (*b*) steam alternators, condensers, oil filter, fittings, &c., steam, exhaust, feed, blow-off and sundry pipes, valves and water tank, &c.; (*c*) main switchboard and instruments; (*d*) cables, junction boxes, culverts, and trenching, &c.; (*e*) transformers and switchboard, &c.; (*f*) arc lamps and posts; (*g*) meters, and (*h*) overhead crane. Tenders, addressed to the Town Clerk, must be in by 2 p.m. on August 24th.

——— The Portsmouth Town Council invite tenders for wiring the police stations at Buckland, Southsea, Portsmouth and Portsea, for the electric light. Tenders by the 27th inst. to the Town Clerk (Mr. A. Hellard), Town Hall, Portsmouth.

——— The Selby District Council require tenders for the erection of three lightning conductors for the water tower and chimney at their waterworks. Tenders to the Surveyor, Town Hall, Selby, Yorks, by the 19th inst.

——— The Municipal Authorities of Braila, Roumania, invite tenders for the concession for (*a*) lighting about 64 kilometres of public streets by both electricity and gas, and (*b*) 64 kilometres of public streets by electricity alone, and also for the concession for the construction and operation of a network of electric tramways in the principal thoroughfares. Tenders to the Maire, Hôtel de Ville, Braila, by October 2nd.

——— The Municipal Authorities of Strasburg invite tenders for an electric travelling crane. Tenders by the 24th inst.

Tenders Accepted.—The Walsall Town Council have accepted the tender of the Walsall Electrical Company for wiring, supplying and fixing 82 incandescent lamps at the Town Hall, for £139. The tender of Messrs. Fallowes and Wheatcroft, for wiring and fitting up the police station for the electric light, has also been accepted.

Tender Accepted.—The Bradford Town Council have accepted the tender of Mr. G. A. Steinthal, of Bradford, for the supply of two switchboards for their electricity works, for the sum of £185.

Tenders Received.—Eight tenders in all were received by the Ministre des Chemins de Fer, Postes et des Télégraphes for the supply and erection of plant for the electric lighting of the Schaerbeck-Nord railway station. The lowest was that of MM. Mulmann and Forkel, of Brussels (£2,012), the highest being £4,564.

Appointments.—The Stafford Town Council have appointed Mr. J. S. Highfield, of Clifton, Manchester, electrical engineer at their supply station. The salary is only £120 per annum. Mr. T. D. Clothier, of London, has been appointed electrician at a salary of £80 per annum.

——— The Bradford Town Council on Tuesday last adopted the report of the Gas and Electricity Committee recommending that Mr. A. H. Gibbings, electrical engineer to the Hull Corporation, be appointed electrical engineer at their electricity works at a salary commencing at £300 per annum, and that the salary of Mr. Dalton, assistant engineer to the same department, be advanced from £150 to £180 per annum.

——— Lieut.-Col. Petroff, Director of the Russian Police Department, has been appointed Director-General of Posts and Telegraphs in place of Gen. Besack.

——— The Islington Vestry (London, N.), have appointed Mr. C. H. Yeaman assistant electrician at their electricity works, Eden-grove, Holloway.

——— The Tunbridge Wells Town Council have appointed Mr. E. J. Stuart-Menteath assistant engineer at their electricity works.

Appointments Vacant.—The Governors of the Woolwich Polytechnic are willing to receive applications for the posts of lecturer in physics (salary £110 for a session of about eight months) and lecturer in mechanics (salary £70 for a session of about eight months). Some further particulars are given in our advertisement columns, and applications must be sent in by the 23rd inst.

——— The Governing Body of the Northampton Institute, Clerkenwell, E.C., are prepared to receive applications for the appointment of a principal. The salary attached to the office has been fixed at £600 per annum. Applications must be sent in by September 4th to Mr. J. J. Lambert, 8, Dowgate-hill, Cannon-street, London, E.C.

——— Messrs. Drake and Gorham invite applications for the post of head clerk in their goods department, with a commencing salary of £140 per annum.

Removal.—Owing to pressure of business Messrs. Russell and Lennard have removed from 22, Charing Cross, to more commodious premises at 135, Victoria-street, Westminster, S.W.

——— Messrs. Conze and Simon, "wholesale purveyors to the electrical trade," have removed their offices from 37, Queen Victoria-street, to 52, Queen Victoria-street, London, E.C.

Dissolution of Partnership.—Messrs. Roberts, Adlard and Co., who have hitherto carried on business as makers of slate switchboards, &c., at 47, Eastcheap, E.C., and 26, Bermondsey-wall, S.E., have dissolved partnership.

Partnerships.—Mr. G. L. Addenbrooke informs us that he has taken Mr. Ernest Scott into partnership. Mr. Scott served his time with Messrs. John Fowler and Co. (Leeds), and was afterwards with Messrs. W. T. Goolden and Co. and the Brush Company, while for the last year he has been chief of the drawing office department at the Electric Construction Company's works, Wolverhampton. Messrs. Addenbrooke and Scott request that letters to the firm be addressed to 21, Lichfield-street, Wolverhampton. Mr. Addenbrooke will, as hitherto, be frequently in London.

——— Mr. William Heath Merriman, A.I.E.E., has joined the firm of Slade, Templeton and Co., telegraph and electrical engineers and contractors, and the firm intend shortly to greatly enlarge and extend their business.

Liquidation.—It was resolved on July 4th that the Electric Trust (Limited) be wound up voluntarily. This resolution was confirmed on July 29th, and Mr. F. Cross, of 9, Bridge-street, Westminster, S.W., was appointed liquidator.

Iron and Steel Institute.—The annual meeting of this Institute is to be held in Birmingham next week, under the presidency of Sir David Dale, Bart. Arrangements have been made for visits to be paid to (amongst many others) the works of the Electric Construction Company, Thomas Parker, Tangyes', Elkington's, Osler's, and the station of the Birmingham Electric Supply Company. A number of interesting Papers will be read on subjects of interest to the iron and steel industries, including a Paper on "The Production of Iron by a New Process," by Mr. R. A. Hadfield; on "The Thermo-Chemistry of the Bessemer Process," by Prof.

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W. N. Hartley; on "Tests of Cast Iron," by Mr. W. J. Keep (Detroit, U.S.A.), and Mr. T. D. West (Sharpsville, U.S.A.); on "The Estimation of Oxide of Iron in Steel," by Mr. A. E. Tucker; and on "The Use of Nickel in the Metallurgy of Iron," by Mr. H. A. Wiggin.

AGENCY.—Messrs. Hodges and Todd, electrical instrument makers, &c., of 30, Hampstead-road, London, N.W., have appointed Messrs. Wm. McGeoch and Co., Argyle-street, Glasgow, their sole agents in Scotland. A stock will be kept in Glasgow of Messrs. Hodges and Todd's well-known specialities.

THE LESSING DRY BATTERY. — Messrs. Krupka and Jacoby, of Queen-street, London, E.C., are now supplying an improved form of Dr. Lessing's dry battery. The new form is shown by the accompanying illustration. The battery is having a large sale.

ELECTRIC CLOCKS.—Mr. F. Hope-Jones notifies us that after some years of study and experimental work by himself and Mr. G. B. Bowell, these gentlemen claim to have succeeded in "dispensing with the complicated mechanism of the ordinary clock," and at the same time have secured reliability and time-keeping qualities never before attempted. The Synchronome Company has been established to work this system, and has issued a price list, which can be obtained of the Company, whose offices are at Birkenhead. The Synchronome system consists of one pendulum, kept in motion by means of two wheels and an electromagnet, which derives its energy from a small dry cell, the object of the pendulum being to transmit electrical impulses at regular periods along a single wire to any number of clock-faces. Amongst the advantages claimed by the system is that the only attention necessary is that the batteries alone require attention.

ASYLUM LIGHTING.—The various buildings and departments of the new Newcastle City Lunatic Asylum at Gosforth are to be lighted throughout by electricity. Electric motive power is also to be adopted for driving the domestic machinery, ventilating vans, &c. The work is to be carried out by the Corlett Electrical Engineering Company.

BLANTYRE (GLASGOW).—A discussion arose at the last meeting of the District Council on the lighting question. A proposal to light the district by electricity was defeated by the casting vote of chairman, and it was finally decided to adopt gas lighting.

BUXTON.—A letter to the District Council from the Brush Provincial Company, notifying their intention to apply for a Provisional Electric Lighting Order for this district, has been referred to a committee.

COVENTRY.—At their meeting on Tuesday the Town Council, on the recommendation of the Electric Light Committee, decided to adopt the Brighton method of charging for electric current.

CROYDON.—The Town Council have decided to purchase some three acres of land in Factory-lane to serve as a site for an electric supply station.

DERBY.—At the last meeting of the Town Council the report of the Electric Lighting Committee was presented, recommending the Council to make application to the Local Government Board for sanction to borrow £3,490 for building an annexe to the electricity supply station, and £524 for completing extensions of the electric light mains already undertaken. From the statement of the borough accountant, recently presented, it appears that the total capital expenditure on the electric lighting works to date is £49,657. 14s., and the total ordinary expenses for a period of eight months, from August 1, 1894, to March 31st last, amounted to £4,257. 3s. 1d. This sum, however, includes interest and repayment of loan for a whole year. The receipts for the same period amounted to £4,127. 12s. 1d., or a net loss of £129. 11s. (after the said repayment of interest, &c.). If the figures for the complete year's working were to hand, it is estimated that, instead of a loss, a profit of about £170 would be shown. A long discussion ensued, and Mr. Hart proposed an amendment, that the Council decline to authorise further expenditure until the existing arrangement with their consulting engineers (Messrs. Bramwell and Harris) was terminated, and that the Committee be instructed to dispense with the services of Messrs. Bramwell and Harris as soon as the boilers and coal sheds were completed. He thought that would be a suitable time to take the management of the works into their own hands. This amendment was, however, lost, and the Committee's report adopted.

DUBLIN.—The new Bar Library at the Four Courts is to be lighted by electricity. It is also intended to put the Library in telephonic communication with the various Courts. A deputation of ratepayers residing in the neighbourhood of Earl-street recently waited upon the Corporation to urge upon them the advisability of allowing the tramway company to extend their electric tram system from Annesley Bridge to North Earl-street and Nelson's Pillar. Mr. Nagle, who introduced the deputation, strongly supported the petition, and pointed out the inhabitants and frontagers along the line were unanimously in favour of the extension. The Lord Mayor, in reply, said that the Corporation were not in the slightest degree opposed to the introduction of the electric tramway system, and he himself was much in favour of it, but it was their duty to see that proper conditions were imposed upon the owners.

DUNDALK.—At the last meeting of the Town Commissioners a discussion arose on the unsatisfactory condition of the street lighting. It seems that the gas company, under the terms of their contract, do not light the street lamps on certain nights when the moon is at the full. When the moon happens to be obscured the terms of the contract are strictly adhered to and the town is left in total darkness. It will be remembered that the Commissioners obtained an Electric Lighting Provisional Order in 1885, and an unsuccessful attempt was made to introduce the electric light into the town. The Provisional Order expired in 1892, but a renewal was obtained, and the terms of the Order somewhat extended. The renewed Order will expire in about 12 months, and the Town Clerk has called a special meeting to discuss the electric lighting question.

ELECTRIC NOVELTIES.—A standard intended for night use has just been delivered from the Kiel dockyard for use on the German Imperial yacht "Hohenzollern." The flag is four metres square, and the design is traced in coloured electric lamps. The device is stated to work very satisfactorily.

ELECTRIC TRACTION IN FRANCE.—Two new electric traction companies have recently been formed in France, one by the Banque de Paris et des Pays Bas and the Société d'Eclairage Electrique du Secteur de la Place Clichy. The capital of this Company, which is to exploit the Siemens electric traction system in France, is 2,500,000fr. The second is the creation of the Paris branch of the Société Anonyme Bouckaert of Brussels, who are the representatives of the Elektricitäts Aktiengesellschaft vorm. Schuckert and Co. The Société Anonyme des Tramways Mécaniques de Paris et des Environs (St. Germains to Poissy) has increased its capital to 300,000fr. The Raincy Montfermeil Electric Tramway (25 kilometres from Paris) was inaugurated on the 15th inst. The contract has been carried out by the Compagnie Française pour l'Exploitation des Procédés Thomson-Houston, which has also received an order to electrically equip the tramways of Enghien, Montmorency and St. Gratien, small towns to the north of Paris.

ELECTRIC TRACTION IN THE MIDLANDS.—It is proposed to construct an electric railway between Ashbourne and Derby. The line is to pass Mackworth, Kirk Langley and Brailsford, a distance of more than 13 miles. The estimated cost is expected not to exceed £62,300. The line would be worked on the overhead system, with a generating station near the Brailsford Brook, about 7½ miles from Derby.

ELECTRIC TRACTION IN RUSSIA.—A contract for the construction of a network of electric tramways in the town of Nijninovgorod has, it is stated, just been placed with the Maschinenfabrik Oerlikon.

GLOUCESTER.—The Great Western Electric Light and Power Company have notified the District Council of their intention to apply for a Provisional Order. The matter has been referred to the Finance Committee.

HAMPSTEAD.—The Library Commissioners have decided to light the Public Library by electricity. The contract for wiring and fitting up the building has been entrusted to Messrs. S. Newton and Co.

LINCOLN.—The Brush Provincial Company have notified the City Council of their intention to apply for a Provisional Electric Lighting Order for this city.

MIDDLESBOROUGH.—The Town Council, on the recommendation of the Electric Lighting Committee, have decided to engage the services of an electrical engineer (at a fee of £50) to prepare a report on the question of the introduction of the electric light into the town.

NEW SUBMARINE CABLE.—It is stated that the French Government has given a contract to the Société Industrielle des Telephones, Paris, for the supply and laying of a telegraph cable between Obok and Djibonti, the contract price being £13,600.

NEWPORT (MON.).—The Town Hall and clock are to be lighted electrically.

NOTTINGHAM.—The electric light continues to grow in favour in Nottingham. The Town Council have decided to extend the electric light mains along Friar-lane for the purpose supplying

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current to the Castle Museum and to the Mechanics' Hall, where the billiard and reading rooms are to be lighted electrically. Some small extensions have also been made in the Theatre Royal quadrant, and the mains have been extended as far as University College along Goldsmith-street. The adoption of the electric light for the Masonic Hall is under consideration.

PRIVATE HOUSE LIGHTING.—The Tayler Smith Electric Company are carrying out an installation of the electric light at 6, Bowland-houses, London, W., for Admiral Sir Windham Hornby, K.C.B.——Messrs. Rashleigh Phipps and Co. are fitting Lord Dudley's new house in Carlton-gardens, London, for the electric light.

PORTSMOUTH.—It is stated that a scheme for the introduction of a system of electric traction on some of the existing tramway lines in Portsmouth is under consideration.

QUEENSTOWN.—At a special meeting of the Town Commissioners on Tuesday it was decided to prepare an advertisement inviting tenders to light this town by electricity.

SANITATION.—Engineers, in common with the rest of the public, are interested in all that affects the perfect sanitary condition of our homes and workshops. The Sanitas Company, who are well known as proprietors of a number of valuable sanitary preparations, have just issued a pamphlet entitled "How to Disinfect," which is a guide to practical disinfection under all circumstances, and which gives a large amount of very useful information and particulars how to use the Sanitas preparations The pamphlet can be obtained from the Sanitas Company, Three Colt-lane, Bethnal Green, London, E.

SOUTHBOROUGH.—The District Council have declined to give their consent to the application of the Guildford Electricity Supply Company for a Provisional Order for this district.

SOUTHPORT.—The principal streets are to be lighted by electricity for the first time to-day (Friday).

SPAIN.—An electric supply station is in course of construction at Hellin (Albacete). The plant is being put down by Messrs. Levi and Kocherthaler, of Madrid. A small station is also being erected at Herrera (Caceres). A station has just been completed and put in operation at Orense, Galicia. Plans have been prepared for the establishment of a supply station at Tarazona, a fortified town in Aragon. A contract has just been given to a Barcelona firm for the establishment of a supply station at Puigcerda.

THE ELECTRIC LIGHT AT WESTMINSTER ABBEY.—The organ loft at Westminster Abbey is to be experimentally lighted by electricity, and, if the light is approved, the Abbey will be fitted throughout for the electric light. The organ loft is at present lighted by gas. The success of the electric light at Westminster will probably induce the authorities of St. Paul's Cathedral to make another attempt to light that noble building effectively by electricity, a previous attempt having failed owing to the use of arc lights, which were found to be unsuitable for the interior of such a building.

THE EMPLOYMENT OF THE TELEPHONE BY THE CONSTABULARY.—The West Riding (Yorkshire) Joint Finance Committee have been considering two important schemes for installing a private service of telephones for the use of the West Riding Constabulary. The larger scheme provides for divisional headquarters at Wakefield, Barnsley, Rotherham, Doncaster, Pontefract, Goole, Sheffield, Tadcaster, Knaresborough, Otley, Leeds, Keighley, Bradford, Halifax, Saddleworth, Huddersfield, Dewsbury, and Todmorden, with sectional stations at Normanton, Penstone, Rawmarsh, Mexbro', Castleford, Hillsborough, Ripon, Harrogate, Ilkley, Bingley, Shipley, Pudsey, Cleckheaton, Brighouse, Elland, Holmfirth, Honley, Batley, Heckmondwike, Morley, Mirfield and Hebden Bridge. The smaller scheme only provides for the connection of the divisional headquarters. The cost of the larger scheme is estimated by Mr. W. E. L. Gaine, General Manager of the National Company, at £8,140, and the smaller scheme at £6,080, for labour only. The lowest annual charge which the National Company can make is £1,436, or £1,400 on a 15-years contract, in respect of the larger scheme, and £1,059, or say £1,000, on a like contract in respect of the smaller scheme. The sub-committee recommend the adoption of the larger scheme, subject to certain conditions, which it is suggested should include a clause that the wires and other connections shall be the property of the County Council at the expiration of the 15 years. The National Company agree to the County Council extending the system to other police buildings than the divisional head-quarters and the principal sectional stations named in the scheme. The Joint Committee have adopted the sub-committee's recommendation.

THE PACIFIC CABLE.—The very various Governments, firms, and persons who are about to lay or finance the Pacific cable have had a quiet time for quite a month past—probably enjoying seaside repose. According to Reuter's agency "it is stated here (Victoria, B. C.) that Mr. F. W. Mackay, the Canadian Pacific Railway, and a number of San Francisco capitalists are co-operating with a view to securing the contract for laying the projected Pacific cable." The name of the makers of the cable is not given this time.

THE PROPOSED JUNGFRAU ELECTRIC RAILWAY.—The preliminary surveys for the proposed railway up the Jungfrau will, it is anticipated, be completed as far as the Eiger station before the winter, and the construction of the section between Scheidegg and the Eiger glacier is to be commenced in the spring. Tenders are shortly to be invited for the laying of the permanent way, for the construction of the stations and other surface works, and for the supply of the necessary electrical appliances and rolling stock.

WALSALL.—The Town Hall and borough police station are being fitted for the electric light, and the Town Council have decided also to light the borough offices electrically, at an estimated cost of £62. 10s. The Council have decided to borrow money for extensions to their gas works, although Mr. Clare (a member) urged that the matter should be postponed for a year to enable them to properly judge of the progress made by the electric light.

WEYBRIDGE.—Electric lighting matters are in a somewhat confused state in this village. A public meeting was held last week which, however, arrived at no decision, but adjourned for another week. At the last meeting of the District Council a lengthy discussion arose on the subject, the members discussing a report from the sub-committee appointed to consider the subject, and a further report from Messrs. Spagnoletti and Crookes, who had been called in to give expert advice to the Council, but no decision was arrived at.

WIGAN.—The Local Government Board having sanctioned the borrowing by the Wigan County Council of the required sum for extensions to the gas works, the Chairman of the Gas and Electric Lighting Committee, at the last meeting of the Council, in reply to a question, said he was afraid the introduction of the electric light would have to be postponed for a time. He thought the Sub-committee appointed to consider the matter were making a mistake, and he wished them to be unanimous before any electric lighting proposal was placed before the Council for consideration. Mr. Fyans said that, although the Sub-committee could not agree, the ratepayers desired that the matter should be pushed forward. Owing to the injurious effects of gas the priceless treasures on the shelves of the Library were deteriorating steadily, and were they to understand that because one or two gentlemen on that Committee could not see the expediency of adopting the electric light that the Council in general were not permitted to express their opinion on the matter? He believed that the Council were almost unanimous in their support of it. Electric lighting would be of immense benefit to the local institutions, and if the question were delayed much longer they would only be giving other people the opportunity of doing what they had now the power to do themselves. Other equally strong opinions in favour of adopting an electric lighting scheme for the town were expressed by Ald. Phillips, Mr. Johnson and Mr. Laycock.

YORK.—At their last meeting the City Council once more considered the report of the Electric Light Sub-Committee, which recommended that the tender of the Electric Construction Company for supplying the necessary plant for the electric lighting of the city, and the working of the same for seven years, be accepted. The amount of the tender was £8,650. Mr. Ald. Agar moved the adoption of the report. After various opinions had been expressed as to the practicability of the proposed scheme, Mr. Scott, who favoured a continuous-current low-tension system, moved an amendment that Prof. Kennedy's opinion be obtained as to which system he considered best for the city. This was lost by 23 to 7. A motion for the adjournment of the discussion was then made and defeated, when a further amendment by Mr. Shaftoe, "That the matter be referred back to the Committee, with instructions to select an expert to advise them which system is the best, the Committee then to ask for tenders on the selected system, and to report fully to an early meeting of this Council," was adopted by 15 to 11.

BOOKS RECEIVED.

"The Management of Dynamos." By G. W. Lummis-Paterson. (London: Crosby Lockwood and Son. 3s. 6d.).

"The Gas and Electric Lighting Companies Directory and Statistics for 1895." (London: Hazell, Watson and Viney (Limited). Price 10s.

"Elektrotechnisches Wörterbuch," Englisch - Französisch - Deutsch." By J. Sack and Arthur Wilke. (Leipzig: Oskar Leiner. 1895.)

"Fourth Report of the Bureau of Mines." 1894. (Toronto: Warwick Brothers and Rutter.)

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PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

July 16, 1895.

13,618. S. F. BEEVOR. London. Improvements in or relating to electrically-actuated mechanism.

13,619. J. WETTER. London. Improvements in and connected with underground conductors for electric railways and tramways. (The Electrizitäts-Aktiengesellschaft vormals Schuckert and Co., Germany.)

13,635. H. G. GRIER, A. G. GRIER, and A. S. HOTTLE. London. Improvements in electric gas lighters.*

13,636. L. S. CRANDALL. London. Improvements in electric signalling apparatus.*

July 17, 1895.

13,663. J. PESCHEK. London. Improvements in connecting plugs and switches for electric lighting and power purposes.

13,670. H. COOPER. Manchester. Improvements in and connected with electrical incandescent lamps.

13,689. A. V. NEWTON. London. Improvements in the manufacture of incandescent electric lamps. (A. Nobel, France.)

13,702. H. PIEPER (FILS). London. Apparatus for regulating or measuring electric currents.*

July 18, 1895..

13,727. J. A. KINGDON. London. Improvements in or relating to combined alternators and dynamos and the like, and to the distribution of electricity thereby.

13,730. W. ROWBOTHAM and H. LEVETUS. London. Improvements in and relating to primary batteries.

13,760. C. RALEIGH. London. Improvements in and in connection with the working of electric tramways on the accumulator system.

July 20, 1895.

13,872. J. A. KINGDON. London. Improvements in or connected with steam alternators and the like, and in the mode of operating them for the distribution of electricity.

13,900. R. W. GORDON. London. Improvements in galvanic batteries, [Date applied for under Patents, &c., Act, 1883, Sec. 103. January 31, 1895, being date of application in United States.]*

July 22, 1895.

13,934. F. GRAY. London. Improvements in the method of generating electricity for lighting or motive power.

13,956. A. G. NEW. London. Improvements in trolley systems of electric propulsion and in apparatus therefor.

13,957. A. G. NEW. London. Improvements in trolley systems of electric propulsion and in apparatus therefor.

13,958. A. G. NEW. London. Improvements in trolley systems of electric propulsion and in apparatus therefor.

13,961. H. H. LAKE. London. Improved connector for the rails of electric tramways and railways. (The Compagnie de l'Industrie Electrique, Switzerland.)

July 23, 1895.

13,978. A. K. BONTA. Manchester. Improvements in the method of and means for stopping electrically-propelled cars.*

14,019. W. ACKROYD and W. BEST. London. Improvements in or connected with apparatus for electrically lighting miners' safety lamps.

14,021. E. SMITH. London. Improvements in and relating to phonographs and the like.

14,023. P. A. NEWTON. London. Improvements in writing telegraphs. (T. Ewing, jun., United States.)*

14,033. G. K. B. ELPHINSTONE, of the firm of Elliott Bros. London. Improvements in galvanometers. (H. Rowland, United States.)

14,049. D. HIGHAM. London. Improvements in electric arc lamps.*

14,051. B. PELL. London. A method and apparatus for electrically transmitting writings or drawings.

14,066. The Hon. C. A. PARSONS. London. Improvements in winding armatures for dynamos and electro-motors, specially applicable to alternators and alternate-current motors.

July 24, 1895.

14,114. J. HESSBERGER. London. Electrical apparatus having movements determined by variations of the electrical resistance of bismuth in a magnetic field.*

14,134. C. LANGDON-DAVIES. London. Improvements in rapid telegraphic transmission on cable lines.

July 25, 1895.

14,142. M. W. W. MACKIE. London. Improvements in apparatus for the recovery of gold by electrolysis from the sea.

14,147. R. C. SAYER. Bristol. Improvements in electric and other railways and in vehicles therefor.

14,158. W. ROWBOTHAM. Birmingham. Improvements in and relating to primary batteries.

14,160. E. W. LANCASTER. Birmingham. Improvements in conduits for electric wiring.

14,205. W. A. C. G. BIRKIN. London. Improvements in electric switches or parts for making and breaking circuits in electric machinery.

July 26, 1895.

14,233. E. WHITWORTH and B. DOYLE. London. Process of making acid-proof vessels and electric insulators.

14,246. G. E. DORMAN. Stafford. Improvements in alternating-current electric motors.

14,257. H. SCHIMPFF. London. Improvements in or connected with the arrangement of conductors for electrically-operated agricultural implements.

14,262. T. KARN and J. T. PAYNE. London. An improved electrical indicating or signalling apparatus.

14,267. G. F. DIECKMANN. London. Improvements in dynamo-electric machines.

14,275. H. EDMUNDS. London. Improvements in and connected with junction boxes for electric mains.

July 27, 1895.

14,313. R. H. COURTENAY. London. Improvements in the manufacture of carbon plate cylinders and cells for electrical purposes.

14,337. J. A. BARKER. London. An improved method of and means for working electric fire alarms.*

14,342. J. KOLB and A. D. A. LAMBERT. London. An improved electrolysing apparatus.

July 29, 1895.

14,355. C. BERRY. Huddersfield. A non-rotating terminal wire for wire or cable connections to electrical instruments and the like.

14,360. J. H. PENTLAND. Dublin. Improvements in bayonet-joint holders for incandescent electric lamps.

14,393. D. G. FITZGERALD. London. Improvements in voltaic batteries.

14,396. A. B. HUTCHINGS and R. J. CROWLEY. London. Improved means for telegraphing copies of writing, drawing and the like.

14,403. J. JAHNSSON. London. Improvements in or connected with electrical gas-igniting devices.

July 30, 1895.

14,446. T. CLARK. London. A combined astatic and dead-beat galvanometer, especially for use on board ship.

14,473. W. S. SCALES. London. Improvements in and relating to electric clocks.

14,476. H. W. LIBBEY. London. Improvements in transmitting and receiving attachments for telephones.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

11,211. GRIMES. Railway electrical signalling apparatus.

11,320. LAKE (Pupin). Telegraphic transmission.

13,636. WHAWELL. Transmitting telegraphic messages, &c.

14,340. SHARMAN. Electro-massage roller appliance.

15,985. AKESTER and PRICE. Arc lamps.

16,599. MILLER. Regulating electric currents.

16,857. DELANY. Telegraphy.

16,918. FOX. Electric conductors.

17,357. ALLIN and WOOD. Arc lamps.

17,369. EPSTEIN. Secondary voltaic batteries.

17,566. SCHÄFER AND HEINEMANN. Electrodes.

25,215. BAKER and OTHERS. Electrically-propelled vehicles.

1895.

5,798. BURRY. Telegraph, &c., instruments.

6,681. CRONIN. Electric switches.

7,548. SIEMENS BROS. AND CO., LIMITED (Siemens and Halske). Controlling electric currents.

8,011. HÜBENER. Electric battery plates.

9,513. SHEPPARD. Incandescent electric lamps.

9,703. PORTER. Electrically transmitting power to vehicles, &c.

9,704. PORTER. Electric rail or tram switches.

9,806. COMBOUL. Electrolytical apparatus.

10,836. PAYER. Storage batteries.

10,929. HERMITE and OTHERS. Electrolysing chloride solutions.

10,587. REED. Electric heaters.

10,930. HERMITE, E., and OTHERS. Electrolysing chloride solutions.

11,283. PETTINGER. Electric fuse heads.

11,375. RANDALL and SHALLCROSS. Covering for electric wires.

11,399. PARMLY. Arc lamp.

11,478. JOHNSON (Pelatan and another). Electrolytical separation of precious metals.

11,510. MORRIS TUBE AMMUNITION AND SAFETY RANGE COMPANY (LIMITED) and WYATT. Electric primer.

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COMPANIES' MEETINGS.

Crompton and Co. (Limited).

The seventh annual general meeting of the members of this Company was held on the 9th inst. at the Cannon-street Hotel, under the presidency of Viscount Emlyn.

The SECRETARY (Mr. Francis R. Reeves) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, there is a foot-note to the accounts in the auditors' report, which is as follows: "We have examined the foregoing balance sheet, with the accounts and vouchers relating thereto, and certify it to be in our opinion correct, with our letter of this date." I will ask the Secretary to read that letter, so that the shareholders may know what it is.

The SECRETARY read the letter, which was dated the 31st ult., and was addressed to the Chairman and Directors of the Company. It was as follows:—"Gentlemen, we beg to report having audited the accounts of your Company for the year ended March 31st last. The stock and work in progress have been certified to us as before by the Works Manager, and the additions to capital by Mr. Crompton, one of the Managing Directors. The depreciations have been taken at the same rates as previous years. The reduction in the capital by the surrender of £20,000 Ordinary shares by the vendors, and sanctioned by the Court of Chancery on June 25th last, has been given effect to in the accounts, and the amount written off the value of investments. With regard to the trade debtors and remaining investments, we are informed that in the judgment of the Board, arrived at after careful examination, the amount to be set aside to reserve fund will be a sufficient provision to meet any loss."

The CHAIRMAN: I have now to propose the first resolution, and in doing so would say a few words as to the report and accounts. With reference to the unfortunate reduction of profits, as shown by the Directors' report: while this result is much to be regretted, there is a satisfactory feature in connection with the business not mentioned in the report, which is, that although there have been considerable reductions in prices during the period covered by the report, still, probably, the principal reason for the falling off of profits is attributable more to the falling off in orders during the earlier period of the year under review than to the reduction of prices, for it is a fact that during the first six months of the year business was so slack that practically no profit at all was made in that period. That means that our standing charges, of course, were high, and we could not get sufficient profit by the work we had to do. The whole of the £7,000 profit shown in the balance sheet was practically earned during the latter half of the year, when the order book was well filled and the works were kept extremely busy. This satisfactory state of affairs still continues, and several good contracts have recently been taken at higher prices, which justify the Directors in looking forward to better results in the current year. There is no doubt that a healthier tone prevails in business generally, and particularly in the electrical branch. During the year the Directors effected several changes in the working of the Company with a view to future economies, and one of the most important of these was the removal of the accountants' department of the Company from Chelmsford to London, and the enforcement of a stricter system of departmental work, whereby the Directors are able more accurately to gauge the results of the working of the different departments, and so to retain a better control over them. This change entailed for a time some considerable delay in the keeping of the accounts, but happily this is now all at an end, and the Directors will be able in the future to be supplied earlier and more accurately with particulars of the working of the departments than they have hitherto been. From an examination of the statement of accounts accompanying the report, the shareholders will see that the Court of Chancery has sanctioned the resolutions passed last year for the reduction of capital, and this order was obtained without the usual corresponding order to add the words "and Reduced" to the title of the Company. The Directors had hoped that the debentures issued in January last would have been fully subscribed, but in this they were disappointed. The amount, as will be seen from the report, actually taken up by the public and the shareholders was £32,850. With this the Directors were able to reduce the loans from the bankers, and a small amount of additional working capital was brought into the business. On the other side of the balance sheet it will be seen that the stock-in-trade has been slightly reduced from the previous year, while the trade debtors have increased some £7,000; at the same time the work in progress on contracts is nearly £4,000 less than in the previous year, and consequently by that much the trade debtors have been proportionately increased. The investments in the subsidiary and other companies have been, of course, reduced by the sum of £20,000 written off in accordance with last year's resolution, but although this amount is written off the investments remain for what they are worth in the coffers of the Company, and some of them might hereafter improve in value. In turning to the profit and loss account it will be seen that the reduction in gross profits brought forward is about £5,000, while on the other side the trading and office expenses have been reduced by £730. The repairs and depreciation have naturally increased with the larger amount of the Company's property in plant, tools, &c., but there is one item in connection with this account which should be mentioned, viz., that a sum of nearly £600 which in former years had been debited to capital account as an expenditure on plant and tools has this year been debited to repairs account in profit and loss, and by this amount, of course, the profits are apparently reduced. The item in question is for the purchase of small tools, which the Directors feel should more properly be charged to revenue, since the amount of depreciation annually written off the plant and tools account, while more than sufficient to meet the proper depreciation on large tools, is practically not sufficient to provide for depreciation and loss on small tools, and they have thought it better, therefore, to charge the amount to profit and loss rather than to capital. There is one other item which may be mentioned as explaining somewhat the reduction of profits, and that is, that a loss was made on one of the contracts carried out during the year, a loss entirely arising through the misreading of a specification, from which it appeared afterwards it was intended to provide for more work than the manager of the department entrusted with the work had estimated for. The engineer for the contracting company insisted upon his reading of the specification, and the Company had to submit and carry out the work. These two items account for a substantial proportion of the deficiency in profit and loss account. In the previous year's report a statement was made that the Directors considered the cooking and heating department would be likely to prove a valuable addition to the Company's business, and this anticipation seems likely to be fulfilled, inasmuch as since the closing of the accounts the Directors have granted a licence to a firm in France to manufacture and sell the cooking appliances under which the licensees have to pay a substantial royalty on every article made and sold, and in addition—what is rather unusual in such cases—the Company has received the sum of £1,000 for granting the licence. The licensees have the option of purchasing the patents for France within two years for a substantial sum, and it is very likely that they will take advantage of this option. The Directors have also during the last week concluded arrangements for licences for Switzerland and Austria-Hungary, and in the latter case the licensees have the right of acquiring the patents within a fixed period. With a view to concentration and economy, the Directors have decided to close the works at Lillie-road, which were taken some years ago in consequence of the large London contracts, and in a short time the whole of the work now done at Lillie-road will be carried on at Chelmsford. There is no doubt this will effect a considerable saving, and the Directors hope either to let or sell the lease of the Lillie-road works. In my remarks last year mention was made of the satisfactory amount of the orders received from Sydney for the Australian Company, it having been apparent at that date that the Australian business would be likely to show a considerable improvement during the year: unfortunately, however, it subsequently transpired that the contracts which the manager of the Australian Company had made were of a most unsatisfactory character, in that they entailed upon the Company receiving payment by instalments deferred over several years, and in consequence the Australian Company very soon found itself in difficulties, and the debenture holders decided to take steps for the appointment of a Receiver. This Company being the largest creditor and debenture holder, the Directors were able to secure the appointment of the Secretary as Receiver, so that the work of realising the assets will be carried out under their immediate supervision. As to the shares held by this Company in the Australian Company, these were written off in the depreciation of assets last year, consequently the Company have only debentures and the balance of the trading account, for which they also hold debentures as security. It is hoped, although the realisation may take some considerable time, that the result will prove so far satisfactory that the debenture holders and secured creditors will be paid in full. There is undoubtedly a considerable amount of business to be done in Australia, and since the stoppage of the Australian Company, offers of contracts at good prices, and for cash payments, have been received by this Company, and in consequence it has been thought advisable that Mr. Albright, one of the Managing Directors, should proceed to Sydney with a view to investigating these contracts and making arrangements, if the result of his investigation should be satisfactory, for a continuance of the Company's business there. Mr. Albright sails to-morrow, and advantage will be taken of his presence in the Colony to assist in the realisation of the Australian Company's assets at the same time. Reference was made last year to the arc lamp department, which was then reported to be doing well; it is satisfactory to be able to state that this department continues to show very excellent results, and the lamps are sold practically as fast as they can be made. When the Company was first formed arrangements were made, as was natural and proper, that the two partners in the firm of R. E. Crompton and Co. should consent to give their services to this Company for a period of years as Managing Directors. This period having now expired, the Directors have made arrangements whereby the Company will continue to have the benefit of the services of Mr. Crompton and Mr. Albright, who, besides being by far the largest shareholders in the Company, Preferred and Ordinary, have had the building up of the Company's business, and presumably, therefore, should be the best able to continue its management. The Directors, while regretting that the last two years' reports should have been unsatisfactory reading, have reason to believe that the period of depression in the Company's business is passing away, and that the future promises considerable and satisfactory improvement, resulting, it is to be hoped, in better reports and a return to a dividend-paying position. I wish I had a better report to give you as far as the question of dividend is concerned, but I think there are a good many cheering signs in the future. We are full of work now. We are economising in all departments as far as we possibly can, and I hope that the next report of the Directors may be one of a satisfactory character. I have endeavoured to tell you the whole story, and you know all the facts that I could put before you. I now move—

"That the report and audited statement of accounts for the year ended March 31, 1895, be and the same are hereby received and adopted."

Mr. R. E. B. CROMPTON: I beg to second the Chairman's motion, and I do not propose to add many words. I will not prophesy as to the future for I think we have had enough of prophesying. We will do our level best to pull the thing round, and I think that that process commenced about six months ago, and that, as your Chairman has said, things are much more hopeful now. I can only assure you that, as far as the Managing

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Directors are concerned, they will do their utmost to improve the position of the Company, and I need hardly say that there is no shareholder among you who suffers so much as I do from the present state of affairs.

Mr. EVANS asked various questions respecting certain items in the accounts, and maintained that some of the assets ought to be written down—such as the goodwill and the patents, and in this was supported by Mr. KITCHIN, who urged that they must face the position which was shown by their assets, and if the Directors were not prepared to face it he urged the shareholders to appoint a committee of investigation, and see what the assets were worth.

Col. WOOD expressed a desire to hear more about the contract which had been entered into and which had not paid.

Mr. CROMPTON said it was a very small affair. In spite of all Mr. Kitchin had said it was very difficult for any firm to get profitable contracts unless they took financial risks; in all ordinary cases the profit was very small indeed. In the particular contract in question the wording in the specification was fairly clear, but a mistake was made, which wiped off just the possible profit that would have been made on the job.

The CHAIRMAN: I am glad to answer the other observations which have been made. In reference to Mr. Evans's remarks, I do not know in what way it is suggested that we could give further details. It is true that we might do so, but I do not know that it would be any advantage to the shareholders. With regard to the goodwill, I think it is placed at a fair figure, and it is justified. Our business has very largely increased since that figure began at £30,000. I am certainly not prepared to say that it should be written down by sixpence. As to the suspense account, Mr. Evans says that we ought to write off a part of it. We write off £1,000 this year, as mentioned in the report, from the £9,777. With regard to the patents, a remark was made that it was monstrous that we wrote nothing off them—but we write 10 per cent. off them. The amount against the item of patents is always increasing, but we write off from the total sum 10 per cent. I was asked why we had not got the £1,000 to which I referred from the French contract we have just made. The reason that sum is not in this year's account is that it does not belong to the present account, but it will come into the accounts next year. Then we are asked whether we are satisfied as to the doubtful debts account. That account stands at £277, but, as mentioned in the report, we are adding a further sum of £1,000 to it. Our experience in past years has shown that that is sufficient. The Chelmsford Electric Lighting Company is now beginning to pay its way, and is doing very good work. It has been of enormous value to the Company as a training ground for the staff, and we believe it has now become a paying concern, and that we are fully justified in keeping it at this figure. With respect to one other point, we have been told that the more business we do the worse our position is, but if Mr. Kitchin had arrived at the meeting earlier he would have heard me state that the reason for our loss this year was that in the first half of it we had not sufficient work to do, while our standing charges remained the same. Since then we have had a large amount of work, with the result that we are going on better. I believe that if a very large business came to us we should do very well. I do not think it is of any use my going into the question about Crompton and Co. being one of the worst of the "cutting" firms. I will merely say that I think any one concerned in this particular work would find it impossible to get any business unless he tendered at a very low price. If we had not had the business which we had in the last six months we should be in a far worse position now than we are.

After a few further questions had been put and answered, the motion for the adoption of the report was carried.

Resolutions were afterwards passed re-electing the retiring Director, Mr. Bernard Gibson, and the auditors, Messrs. J. H. Duncan and Co.

The CHAIRMAN then intimated that in the course of the last five weeks he had been appointed to the Chairmanship of the Great Western Railway Company, an office which he had held for just a month. He need hardly state that the duties of that position were not a sinecure, and he found, in fact, that the pressure of work in connection with it was so great that he did not think he could undertake any other business. The result, he feared, was that that would be the last time that he could be among them. It would not be fair for him to remain unless he could attend to the work, and he really found that all his time was now taken up with the business of the Great Western Railway Company.

This announcement was received with great regret, and a cordial vote of thanks was afterwards passed to the Chairman and Directors, after which the proceedings terminated.

Liverpool Overhead Railway Company (Limited).

The half-yearly meeting of this Company was held on Tuesday at Liverpool, Sir W. B. Forwood presiding.

The Directors' report for the year ended June 30th, which was given in our last issue, was taken as read.

The CHAIRMAN said the accounts were of a satisfactory and encouraging nature. Their traffic for the first six months had always in their experience been considerably less that that of the second half-year. Therefore they compared their figures with those for the corresponding period of last year. They would notice that their number of passengers had increased from 2,861,437 to 3,460,060 in the past half-year. There had been a very satisfactory increase in the number of first-class passengers from 277,653 to 400,260, and also in second-class passengers from 1,246,975 to 2,114,462. Some remark had been made as to the decrease in the number of workmen's special return tickets during the past half-year; the decrease had been from 1,336,809 to 945,338. This meant a decrease of 391,000. That was no indication of any less traffic by workmen, but it arose from the fact that they now did not issue workmen's tickets after eight o'clock in the morning, and were also charging 3d. for a workman's return ticket instead of 2d., which was their charge a year ago. Therefore, what they were losing in the cheap return tickets by workmen they were getting by the increase in the second-class traffic. There were 391,000 fewer workmen's tickets, but in second-class passengers alone there was an increase of 868,000. Their gross receipts amounted to £28,082, against £20,011 in the corresponding half of last year, an increase of £8,071. The gross expenditure had been £18,658, against £14,947, an increase of £3,711; they had therefore earned an increased revenue of £8,071, of which they had spent in earning it £3,711, part of the expense having gone in increased mileage. The increase in the running was 45,000 miles, and they had worked 16 stations instead of 14, consequently they had had the additional expense of two stations. He was glad to say their traffic had continued to progress since the accounts were made up. During the six weeks which had elapsed since June 30th they had increased their traffic by 55,000 passengers, and had taken £1,568 more money than they did during the corresponding six weeks of last year. The net available profit for dividend was £8,076, and they proposed to declare a 5 per cent. dividend upon their Preference capital, and a dividend at the rate of 2¼ per cent. on the Ordinary shares, leaving a balance of £1,302 to be carried forward. Their receipts for passengers had averaged 1·92d. per passenger, as against 1·65d. This increase, which meant nearly one-third of a penny per passenger, was due to the advance they had made in the workmen's tickets and to the increased first-class traffic upon the line. The ratio of expenditure to their revenue had been 66·43 per cent., as compared with 74·69 for same half of last year. The ratio of the cost of their locomotive expenditure to net revenue was 24·26d., as against 21·28d. That was an increase of nearly 3d. This was due to their having had more repairs to effect to their motors than they had at the similar period last year. The long frosty winter was particularly trying to the motors. The proportion of their travelling expenses to their revenue was 37·54d. against 41·99d. That was also a satisfactory feature, as showing that in proportion to their revenue their expenses had gone down. Their revenue per train mile had increased from 18·10d. to 21·65d, or 3·55d. per cent. The expenditure per train mile had gone up from 2·88 to 3·49, or 0·61 of a penny. With regard to punctuality, he found that during the past half-year 96·8 of their trains were up to time, against 95 per cent. in the previous half-year, and he believed that since they had closed the half-year they had touched a record, that was to say, last week every train on the line was up to time. In reference to the physical condition of their line, it had never been in a better condition than now. The permanent way was in a most excellent state, better in fact than it had been at any time since the line was opened. The contract for the Southern extension, from the Herculaneum Dock, the present terminus, to a point in Park-road near the Dingle, had been let at a figure within the estimate made by their engineers, and the contractors were already very busy at work. The Directors had every reason to anticipate that this new extension would be completed within the twelve months as stipulated by the contract. The thanks of the Directors were due to the shareholders for the way in which they had come forward and taken up all the Ordinary and Preference shares offered them for the purpose of defraying the cost of the extension. The subscription was considerably more than double the shares they had to allot, and they were glad to think they would be able to construct their extension without issuing any bonds whatever. There was every prospect of their traffic being considerably increased by that extension. They were very much indebted to Mr. S. B. Cottrell, their engineer and general manager, and also to his very efficient staff, for the excellent and very satisfactory manner in which they had done their work during the past half-year.

The report and accounts were then unanimously adopted, and a cordial vote of thanks to the Chairman terminated the proceedings.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1895, pages *304-332, &c. &c.*]

KEIGHLEY ELECTRICAL ENGINEERING COMPANY (LIMITED).—This Company was registered on August 12th with a capital of £5,000, in £1 shares, to take over the business carried on by the Keighley Electrical Engineering Company (Limited), at Keighley, Yorks, to undertake the liabilities of the old Company on certain terms and conditions, and to carry on the business of electrical and mechanical engineers, electricians, suppliers of electricity for the purposes of light, heat and power, and manufacturers of and dealers in every description of electrical apparatus. The subscribers, with one share each, are: Messrs. L., J., and J. C. Ickringill, A. D. Smith, J. S. Naylor, C. H. Seed, and C. J. Garnett, electrical engineer.

MACHINERY INSURANCE COMPANY (LIMITED).—This Company was registered on August 8th, with a capital of £200,000, in 195,000 Ordinary and 5,000 Deferred shares of £1 each, to purchase and take over the business of machinery insurance and maintenance now carried on by James R. Fawkner, and to carry on the business of insurers of machinery, ironfounders, mechanical and consulting engineers, manufacturers of agricultural implements and other machinery, tool makers, brassfounders, metal workers, boiler makers, millwrights, machinists, iron and steel converters, &c.

SMELTING COMPANY OF AUSTRALIA (LIMITED).—This Company has been registered with a capital of £500,000, in £1 shares. The Company

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recently acquired the benefit of an agreement to grant the sole licence to use in the colony of New South Wales the electrolytic process of Messrs. Siemens Brothers and Co. (Limited) for the production of metallic zinc, patents for which are to be obtained by Messrs. Siemens Brothers and Co.

ACME AND IMMISCH ELECTRIC WORKS (LIMITED).—The annual return to July 3rd has been filed. The nominal capital is £25,000, in 20,000 Ordinary and 5,000 Preference shares of £1 each. 19,042 Ordinary and 4,140 Preference shares have been taken up, and the former have been issued as fully paid. A call of 15s. per share has been made on the Preference shares.

CHESHIRE ELECTRIC AND STEAM YACHT COMPANY (LIMITED).—An agreement just made with J. L. Gordon, merchant and contractor, of Liverpool, provides for the sale to this Company of three launches propelled by electric power, fully equipped and furnished, and ready for immediate use for passenger and goods traffic.

DISTRICT MESSENGER SERVICE AND NEWS COMPANY (LIMITED).—The annual return to July 23rd is filed. The capital of £275,000 is divided into 39,800 Ordinary and 200 Founders' shares of £5 each, and 75,000 Preference shares of £1 each. 17,939 Ordinary, all the Founders' and 23,937 Preference shares have been allotted, and of these 12,653 Ordinary, all the Founders' and 182 Preference shares have been issued as fully paid, while 14,818 Preference shares have been issued with 13s. 4d. per share considered as paid. The full amount has been called on the remaining 5,286 Ordinary and 8,937 Preference shares, and 6s. 8d. per share has been called on the 14,818 Preference shares.

MILVER PORTABLE ELECTRIC BATTERY SYNDICATE (LIMITED).—An agreement recently made by this Company with H. Levetus, electro-plate manufacturer, of Birmingham, W. Rowbotham, electrician, of Manchester, and Mrs. Sarah J. Levetus, the vendors, provides for the acquisition of their rights to provisional specifications Nos. 106, 107, 231, and 2,394 of 1895 for "improvements in primary batteries," and No. 7,600 of 1895 for "improvements in and relating to primary batteries," in consideration of £750 in cash, and the allotment of 3,020 fully-paid £5 shares.

OSWESTRY ELECTRIC LIGHTING AND POWER COMPANY (LIMITED).—The annual return to April 9th has been filed. The nominal capital is £10,000, in £1 shares, and 2,021 shares have been allotted. On each of these 2s. 6d. has been paid.

RAND CENTRAL ELECTRIC WORKS (LIMITED).—An agreement recently made with Messrs. Siemens and Halske, of Markgrafenstrasse, Berlin, filed July 5th, provides for the acquisition by the Company of a certain licence or grant from the Transvaal Government, and the benefit of various arrangements with John H. Davies, who is to act as sole agent of the Company for supplying the material and apparatus and erecting the plant requisite for the equipment of the power installations at the various mining companies' works; with the Transvaal Trust Company, for the purchase of an electric generating station site at Brakpan, and with Edward Lippert. In consideration of such transfer the Rand Central Electric Works has agreed to pay £1,000 as a repayment of the deposit to the Transvaal Government, and to allot 19,000 fully-paid shares to Messrs. Siemens and Halske and 1,000 fully-paid shares to John H. Davies or his nominees.

CITY NOTES.

BELFAST STREET TRAMWAYS COMPANY (LIMITED).—At the meeting of this Company on Tuesday the Chairman (Mr. Wm. M. Murphy, J.P.), referred to the question of the adoption of a system of mechanical traction on their lines. He strongly favoured an electrical system, and predicted that in 20 years' time horse trams would be a curiosity. The Belfast Company had only a 12 years' lease, and it would therefore be impossible for them to convert their present system, but they were willing to discuss the matter with the Corporation at any time.

BRIGHTON AND ROTTINGDEAN SEASHORE ELECTRIC TRAMROAD COMPANY.—An extraordinary meeting of the shareholders of this Company will be held at the offices, Madeira-road, Brighton, on 30th instant, to consider the question of an issue of debentures.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended August 11th were £860, against £897 in the corresponding week of 1894, a decrease of £37. The total receipts for the half-year amount to £5,084, against £5,203 for the corresponding period of 1894, a decrease of £119.

GAS COMPANIES' ACCOUNTS.—The sanguine views taken by the chairmen at some gas shareholders' meetings are exhilarating. Mr. E. J. Phillips, who presided over the Newport Gas Company's meeting on Monday, did not think the proprietary had any cause to feel alarmed at the electric light, "as business premises can be better illuminated as a whole by the incandescent gaslight than by electricity." The Chairman of the Chester Company, Mr. J. Gamon, is perhaps not quite so sure that the incandescent gas will prove a saviour. He said the Directors of the Company had not felt justified in incurring expense in the direction of introducing incandescent gas burners, in view of the fact that it was the intention of the Town Council to undertake the lighting of the streets by electricity. If this intention were carried out it would throw on the Company's hands a quantity of valuable plant, and so render unremunerative considerable capital expended for the purpose of public lighting.

GREAT NORTHERN TELEGRAPH COMPANY.—The coupons falling due on September 1st on this Company's 1883 Debentures (Series B) should be presented for payment at Messrs. C. J. Hambro and Son's, 70, Old Broad-street, London, E.C., where lists may be obtained.

GUILDFORD ELECTRICITY SUPPLY COMPANY (LIMITED).—The prospectus is issued locally of this Company. The Board of Directors consists of gentlemen who have substantial interests in the borough, and have been prominently identified with its commercial enterprise. The total share capital of the Company is £20,000, of which £1,500 has been already subscribed by the Directors and their friends. There are 3,900 Ordinary shares of £5 each, and 500 Founders' shares of £1. The subscription list closes on the 19th inst. Figures are given showing an estimated profit available for dividend of about 9 per cent. on the present issue.

IMPERIAL TRAMWAYS COMPANY (LIMITED).—The half-yearly report of this Company, just issued, states that owing to various stoppages of traffic on certain sections of the Dublin Southern District Tramways Company's lines, in which the Imperial Company are greatly interested, and to the disorganisation naturally caused by the introduction of a system of electric traction, the past half-year's figures cannot be compared with those for any previous half-year. The contract for the electrical reconstruction of the tramways provided for the completion of the portion from Dublin to Kingstown by May 1st, and from Kingstown to Dalkey by July 1st, but the contractors have been unable to complete the works within the stipulated periods. The Company has, therefore, been debarred from securing the summer traffic, and the contractors have agreed to contribute a specified sum in satisfaction of the Company's claim to June 30th. The permanent way reconstruction and electrical equipment of the lines between Dublin and Kingstown are well advanced, and work on the Dalkey section will shortly be commenced.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended the 11th inst. amounted to £1,578. The amount for the corresponding week last year was £1,257; increase, £321.

MANCHESTER EDISON-SWAN COMPANY (LIMITED).—The Directors of this Company have declared a dividend at the rate of 5 per cent. per annum for the past year. The gross profit amounted to £5,877, and the net profit to £1,590. £591 has been placed to the credit of the depreciation account, and a sum of £287 carried forward.

MACHINERY INSURANCE COMPANY (LIMITED).—This Company has issued its prospectus inviting applications for 95,000 Ordinary and 5,000 Deferred shares of £1 each, payable 2s. on application, 2s. on allotment, and the balance in 2s. calls at intervals. The nominal capital is £200,000, divided into 195,000 Ordinary shares and 5,000 Deferred shares of £1 each. The Company has been formed for the purpose of developing a system of machinery insurance and maintenance. The Company's prospectus includes the machinery employed in the following branches of industry as coming within the sphere of its operations:—Electric lighting, engineering tools, brass finishing, metal working, chemical works, pumping, hoisting, &c. The Company's scheme does not include the insurance of boilers. The consulting engineer to the Company is Prof. A. B. W. Kennedy, and the general manager is Mr. J. R. Fawkner, whose original business forms the nucleus of the Company's undertaking. The secretary is Mr. W. E. Duncan, and the offices *pro tem.* are 19 and 21, Queen Victoria street, London, E.C. The subscription lists opened yesterday (Thursday), and will close on Monday for town and country. With careful management and a moderate scale of premiums there should be a useful and fairly profitable future before the Company.

MERSEY RAILWAY COMPANY.—At the half-yearly meeting of this Company last week the chairman (Mr. A. K. Kitching) stated that since the date of the last meeting the Directors had made inquiries as to the working of the railway by electricity or other motive power, and had decided to proceed with the Company's Bill in Parliament for the necessary powers. This Bill had passed the Committee of the House of Commons. What the Board originally proposed in the Bill in relation to the finances of the Company had been very materially modified owing to the action of the debenture-holders, and the Act only now asked that the Company should be allowed to work the line by electricity.

MORECAMBE ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—An extraordinary general meeting of the shareholders of this Company was held on Saturday last to receive and consider a statement of the Company's affairs. After this had been discussed it was unanimously resolved that the Directors be empowered to treat with and enter into an agreement with the District Council, or any other intending purchaser, for the purchase and transfer of the Company's undertaking and property.

NORTH STAFFORDSHIRE RAILWAY COMPANY.—At the meeting of the shareholders on Monday Mr. T. Salt, the Chairman, stated that the Directors had recently introduced the electric light at Stoke, their principal station. They had lighted up a large goods yard and warehouse, and the electric light had proved the very best light they could use, both for convenience and for the safety of the men who were employed at night. The light had been very successful, and the result was that they not only got a much better light, but also a cheaper light. He was not prepared with the exact figures of cost, but he was assured that these which were being prepared would prove convincing as to the wisdom of the course taken by the Directors.

SMELTING COMPANY OF AUSTRALIA (LIMITED).—Letters of allotment and regret in the recent issue of capital of this Company have, it is stated, been issued.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended 9th inst., after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,725.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Divi-dend.	Name	Previous Week's Price, August 7.		Price Wednesday, August 14.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending August 14. Highest	Lowest
			TELEGRAPHS					£ s. d.			
£1,012,880	Stock	11 0	Anglo-American	47	49	47	49	4 13 9	Jan., Apr., July, Oct.	48¾	48
£2,993,560	Stock	22 0	Do. Preferred	88½	89½	88	89	5 1 2	,, ,,	89¼	88¾
£2,993,560	Stock	5/0	Do. Deferred	8½	9	8½	9	..	..	..	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 16 4	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	13¾	14¼	13¾	14¼	4 7 2	Mar., June, Oct., Dec.	14¼	13⅞
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 7 6	June and December	..	..
10,000,000	$100	1¾%	Commercial Cable Capital Stock	160	165	160	165	4 4 10	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine xd	13	14	13	14	5 14 4	February and August	–	..
6,000	10	10%	Do. Preference 10 per Cent. xd	20	21	20	21	3 16 2	,, ,,	..	..
12,931	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 0 0	April and October	..	–
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10¼	9¾	10¼	4 7 7	..	..	–
£80,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	104%	4 4 11	,, ,,	..	–
60,710	20	2/0	Direct United States Cable, 1877 xd	9¼	9¾	9	9½	4 4 3	Jan., Apr., July, Oct.	9 7/16	9¼
400,000	10	5/6	Eastern	17	17½	17	17½	3 15 4	,, ,,	17½	17 1/16
70,000	10	6%	Do. 6 per Cent. Preference	17¾	18¼	17¾	18¼	3 5 9	,, ,,	18 3/16	18 1/16
£1,297,857	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	126	129	126	129	3 2 0	May and November	..	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105	108	105	108	4 12 10	February & August	..	..
250,000	10	2/6	Eastern Extension	17⅜	17⅝	17⅜	17⅝	3 19 4	Jan., Apr., July, Oct.	17⅞	17⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock xd	127	130	125	128	3 2 6	February & August	..	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	102	106	102	106	4 14 7	January and July	105½	101½
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	102	106	102	106	4 14 7	,, ,,	104	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.) xd	105	108	105	108	3 11 1	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	112%	115%	3 10 2	May and November	..	..
180,227	10	2/3	Globe Telegraph and Trust	10¼	10¾	10⅜	10⅝	3 19 6	Jan., Apr., July, Oct.	10 7/16	10 5/16
180,042	10	6%	Do. 6 per Cent. Preference xd	17½	17¾	16¾	17¼	3 10 1	,, ,,	17¼	17⅛
150,000	10	5/0	Great Northern	21¾	22¼	21¾	22¼	3 16 3	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	103¾	..
17,000	25	37/6	Indo-European	49	52	50	53	4 14 4	May and November	51¾	51
37,548	10	2/6	London Platino-Brazilian	5	7	5	7	..	,, ,,	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	107	111	107	111	5 10 7	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	107	110	107	110	3 12 11	..	–	..
11,839	8	4/0	Reuter's	3½	4½	3½	4½	..	April and October	..	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	126	131	126	131	4 13 0	,, ,,	..	..
15,609	10	2/0	West African Telegraph xd	5½	6½	5½	6½	..	January and July	..	–
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	104	107	104	107	4 15 6	March & September	106½	105½
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	104	99	104	7 13 10	June and December	..	..
88,321	10	6d.	West India and Panama	¾	1	¾	1	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10	10½	5 14 3	May and November	10⅜	10 5/16
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	6 13 4	,, ,,	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110	113	110	113	4 8 8	June and December	..	..
64,242	15	6/0	Western and Brazilian	10½	11	10½	10¾	3 4 4	May and November	..	..
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	–	6¾	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4¼	4¾	4¼	4¾	..	..	..	..
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5 14 3	February & August	..	..
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5 14 3	,, ,,	..	..
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	6 0 5	May and November	..	..
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 18 5	March & September	..	..
			TELEPHONES.								
44,000	5	2/6	Chili Telephone (fully paid) xd	3	4	3	4	..	..	–	–
224,850	10/0	1⅛d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	–	May and November	..	–
171,504	£1	5·2 5d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	..	..
484,597	5	2/6	National xd	6⅛	6⅜	5⅞	6⅛	4 0 0	June and December	6¼	6
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref. xd	16	18	16	18	3 6 8	,, ,,	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid) xd	15	16	15	16	3 15 0	,, ,,	16	15¾
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref. xd	5⅞	6⅛	6	6¼	4 0 0	–	6⅛	..
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	105	107	105	107	3 5 7	January and July	106¼	105½
58,000	5	3/0	United River Plate	2½	3	2½	3	..	,, ,,	..	..
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	92	97	92	97	5 3 1	,, ,,	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	14½	15	14½	15½	1 12 3	–	15¼	..
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid) xd	15½	16½	15½	16½	3 12 9	–	16 3/16	16
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	131	134	131	134	3 12 9	June and December	133½	133¼
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	5⅝	5¼
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	–	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	–		..		..	–	..	..
8,322	£5	..	House-to-House Electric	–		..		..	–	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	–		..		..	–	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	–	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7⅝	7¾	7⅞	8⅛	..	–	..	..
111,000	5	..	London Electric Supply	..		..		..	–	..	–
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	10¾	11¼	11	11½	2 12 2	..	11⅜	11 1/16
£150,000	Stock	4½%	* Do. 4½% Debs.	116	119	116	119	3 15 11	June and December	..	..
6,452	£10	2/0	Notting Hill Electric	8½	9	8½	9	..	–	..	..
19,980	£5	2/0	St. James and Pall Mall	8	8½	8	8½	..	–	8 7/16	8 1/16
20,000	£5	7%	Do. 7 per Cent. Preference xd	9	9½	9	10	3 10 0	–	..	..
59,900	5	2/6	Westminster Electric Supply (fully paid) xd	7¾	8¼	8¼	8¾	3 2 10	–	8⅜	7¾
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2	2¼	2	2¼	6 11 7	–	2 3/16	..
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2⅜	2	2¼	5 6 8	–	2¼	2 3/16
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	112	115	112	115	3 18 3	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1	2	1	2	..	January and July	..	–
12,139	5	1/8	Edison and Swan United xd	2	2½	2	2½	..	..	2⅛	2
£1[illegible],000	Stock	4½%	Do. 4% Mortgage Debenture Stock	104	107	104	107	4 4 1	..	104	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		–		..	..	–	..
120,000	2	..	Electric Construction	¾	1	¾	1	..	..	–	..
12,845	2	2/9¾	Do. 7 per Cent. Cumulative Pref.	2	2½	2	2½	..	..	–	..
91,195	2	10/0	Elmore's Patent Copper Depositing	⅞	1⅛	¾	1	..	..	⅞	–
20,000	5	..	Fowler-Waring Cables (fully paid)	¼	¾	¼	¾	..	..	..	..
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	19	21	19	21	4 15 3	February & August	20⅜	19¾
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 7 10	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..	–	..	..
16,000	£10	..	Do. 8 per Cent. Preference	..		–		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	⅜	⅝	¼	½	..	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	43	45	43	45	4 0 0	March and July	44½	44
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	4 13 6	January and July	..	..
37,514	£5	..	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£[illegible],000	10	6/0	W. T. Henley's Telegraph Works Ordinary	10½	11½	10½	11½	..	..	..	–
£30,000	10	7%	Do. 7 per Cent. Preference	15	15½	15	15½	4 10 4	..	15½	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock	104	107	104	107	4 4 1	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1¾%	City and South London Railway xd	41	43	41	43	2 18 2	May and November	..	..
7,000	10	5%	Do. 5% Perpetual Preference xd	14½	15½	14	15	3 4 6	..	15¼	14¾
£67,130	Stock	4%	Do. 4% Perpetual Debenture	133	135	133	135	2 19 3	May and November	..	..
87,500	£10	2%	Liverpool Overhead Railway	10 5/16	10½	10⅛	10¼	1 18 7	–	–	–
6,295	10	5%	Do. 5% Preference	15¼	15¾	15	15½	3 4 6	..	..	–
£1[illegible],000	Stock	4%	Do. 4% Debenture	111	113	111	113	..	January and July	–	..

*In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 901. [No. 17. Vol. XXXV.] FRIDAY, AUGUST 23, 1895. PRICE SIXPENCE.

NOTES.

"PRACTICIANS" who may have been sufficiently courageous to glance at and sufficiently persevering to master the contents of Dr. LODGE's Report to the Electrical Standards Committee, which we published in our issue of August 2nd, will, we think, agree with the opinions expressed by Prof. SILVANUS THOMPSON with characteristic lucidity and point, in his letter to be found this week in our "Correspondence" columns. Prof. THOMPSON's dictum that the adoption of units likely to be used by practical electrical engineers is more important than names, and a common agreement between theorists and "practicians" more important than a scientifically ideal system, is instinct, to use his own phrase, with "elementary common sense." To us, the hankering after names evinced by so many on either side of the Atlantic is somewhat of a puzzle. N = 1,000,000 conveys, one would have thought, quite as much as N = 1,000,000 "thoms"; and there is no need to remember which mutilated surname we ought to apply. However, be this as it may, we trust dynamo-designers and others will follow Prof. THOMPSON's advice, and either discuss the many *pros* and *cons* of this question in the columns of the technical journals, or put in an appearance next month at the British Association, and take part in the proposed discussion. Above all things let us hasten slowly, but adhere doggedly to whatever is once definitely decided on in the matter of magnetic symbols, nomenclature, units, and definitions. Practical men cannot be for ever discarding what is good enough for what is better still.

A NEAT and useful piece of work has been done by Prof. IHLE on the conditions governing the action of nitric acid as a depolariser in a cell of the Grove type. The method of experimenting and the conclusions arrived at will be found in another column, and it is sufficient to say here that the views put forward are consistent with what is known of the behaviour of nitric acid towards oxidisable metals when no question other than those purely chemical is raised. It is now recognised that the presence of nitrous acid is necessary for the attack of a metal such as copper by nitric acid, and the case has been duly covered by the blessed phrase "catalytic action." The voltage given by a Grove cell is reduced to that of a plain zinc-platinum couple without a depolariser (such as our venerable friend the Smee cell), when for any reason, the nitric acid in the platinum compartment is free from nitrous acid. This merely means that whereas the high voltage of a normally-working Grove cell is due to the oxidation of the hydrogen which would be liberated at the platinum plate were nitric acid absent, nitric acid free from nitrous acid is incapable of oxidising that hydrogen, and the voltage is, in consequence, diminished by a quantity represented by the non-oxidation of the hydrogen. The hydrogen acts precisely in the way characteristic of metals which resist nitric acid *per se*, but succumb when nitrous acid is also present. It would have been interesting if Prof. IHLE had recorded the appearance of hydrogen on the platinum plate whenever the voltage fell to the lower limit, but no direct observation appears to have been made.

IN another column will be found M. ANDREOLI's reply to Mr. STEPNEY RAWSON's letter on the subject of "Indirect Electrolysis," which we published last week. From M. ANDREOLI's account of his experiments we should not have supposed that any phenomena had occurred which could not be accounted for by the ordinary modern theories on the subject of electrolysis; but as no data as to the resistance of the bath, or the current density, or the E.M.F. employed are given, it is not possible to form any definite opinion. M. ANDREOLI accepts, we understand, the ionic hypothesis of the transfer of electricity through an electrolyte, and he is aware of the text-book statement that if a plate of metal is suspended in an electrolytic vessel when the current is passing, the current enters the plate on one side and leaves on the other. This being so, it is natural that the side facing the anode should act as a cathode. It would appear to us that this is just what happens in the case of the experiments described by M. ANDREOLI. As we have stated before, the data on which to form an opinion are incomplete, but as the process described forms the subject of Eng. Pat. 4,393, 1895, doubtless we shall hear more of the matter.

WHEN an electric supply station is situated in a residential district, and its chimney persistently belches forth injunction-raising smoke, it will be conceded that, for the time being, the suppression of the nuisance, in a manner which will not hamper the working of the station, is of more importance than mere economy. Either the smoke alone, or smoke and station altogether must be stopped. In such a predicament engineers have been put to the trouble of trying all manner of smoke-consuming apparatus; some, of these grossly uneconomica

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and unsatisfactory; some the former but not the latter; and and some which, with special coals, however, will not only remove the nuisance, but, happily also augment the dividends.

INVENTORS of smoke-consuming devices are not, as a class, content merely to whisper the merits of their wares; and it is not uncommon to hear one man proclaiming as his triumphant remedy the very thing which another will tell you is the chief cause of the trouble. With all this, we are still troubled with smoky chimneys; and, indeed, are likely to be to the end of the chapter, or as long as bituminous coal is burned in boiler furnaces. The latest remedy proposed consists in a device for removing solid matter from the products of combustion, by means of a cold water spray at the base of the chimney. The soot goes away in the water and is afterwards collected, while the gases are cooled to about 150°F. As this temperature is too low to give a natural draught, a fan is placed at the bottom of the chimney; and the water spray, directed on to the fan, serves to keep the apparatus comparatively cool and clean. Since, as we have already said, questions of economy are occasionally of secondary importance, it is perhaps hardly fair to ask what the working of all this is going to cost. We understand that the apparatus is the invention of Mr. J. PATERSON, of Glasgow; and we feel quite safe in saying that with a sufficiently copious spray of water all the soot will be taken out of the gases. But, for the rest, we await the results of the forthcoming tests.

OF the feats performed on American electric railways there is no hearing the end. The latest is the performance of the cars on the Nantasket Beach branch of the New York, New Haven and Hartford Railway. Accounts differ as to what the cars actually did do; some papers stating that a speed of 80 miles an hour was attained "with the juice not fully turned on," while others more moderately limited it to from 30 to 50 miles. Naturally we should expect to find this performance took place on a long length of good and fairly straight railway. But no; the entire length of the track was only 6·91 miles—the second place of decimals is convincing—and of this "there are 4·4 miles of curves in about 20 curves, the sharpest being one of 10 degrees." And the track was laid with mere 70lb. rails, about which nothing special is to be noticed, save the absence of anything special. Yet, we are assured, it has been calculated—for actual speed measurements do not seem to have been made—that during the tests single motor cars have been run at 80 miles an hour; while a train of 40 trailers drawn by one 4-motor car attained a speed of 40 miles an hour "past the visitors." We do not know if the visitors made the calculations, nor whether a slide rule was used in the process; but we humbly suggest that possibly there is something wrong with the decimal place.

Electric Traction in Genoa.—The necessary approval having been given to the plans, work is about to be commenced at Genoa on two lines of electric tramway.

Tory Island Cable.—It is stated that the Government have entered into negotiations for the purchase of the cable laid some years ago by Lloyd's Committee between Tory Island and the mainland.

Cable Interruptions and Repair:—

	Date of Interruption.	Date of Repair
Accra-Kotonou	August 9th.	August 17th
Accra-Lagos	August 12th.	—

Electric Light on German Lighthouses.—The authorities for lighthouses in the Bremerhafen district have resolved to provide the lighthouse on the island of Wangeroog with an electric light installation. It is also under consideration to run a submarine cable to the lighthouse of Rothensande, at the mouth of the river Weser, for the purpose of lighting the same electrically. A survey of the place is now being made by the steamship "Weser."

Lightning.—Yesterday morning a heavy thunderstorm passed over London. There were also severe storms in other parts of the country. At Hampton a man, sheltering beneath a tree, was killed, and two children appear to have been struck down, but without serious injury. Near Loughborough a man and horse were killed, the man having been driving the horse in a cart. On Saturday last lightning fired a haystack in a field near Dover.

Electric Traction in the Suburbs of Berlin.—According to the latest reports from Germany the Allgemeine Elektricitäts Gesellschaft is about to erect extensive electric plants for lighting and traction purposes in the districts of Teltow and Niederbarnim, in the vicinity of Berlin. It is intended to build a whole network of tram lines connecting about five villages with each other, and also with the German capital. The preparatory work has already commenced, and the completion is expected in 1896.

Utilisation of Water Power in Italy.—Plant is being established at Castellamontel (Ivrea) by Messrs. Siemens and Halske, of Berlin, for the utilisation of the water power of the Chinsella torrent. The plant, when completed, will include three turbines of 750 H.P., constructed by Messrs. Riva, Monneret and Co., of Milan, and three alternators. The electrical energy generated will be transmitted to Strambino, Ivrea, St. Georgio, Rivarolo, Canavese and Brellà, the latter town being 37 kilometres distant from the station, for lighting and power purposes. The plant has to be in operation by July 1, 1896.

Stellar Gaseous Elements.—Mr. Norman Lockyer has reported to the Académie des Sciences that upon heating minerals of various kinds in vacuum traces of gas are given off, which exhibit, upon spectroscopic examination, lines not hitherto observed in any of the terrestrial elements. He finds, for example, lines which have hitherto only been found in the spectrum of parts of Orion and of the chromosphere of the sun. Evolution of gas takes place in this way in every mineral yet experimented upon.

The Municipalisation of Tramways.—The accounts of the Tramways Committee of the Glasgow Corporation for the eleven months ending May 31st last showed a net profit enabling £8,260 to be transferred to the "common good." In *The Times* of Tuesday Mr. Joseph Ebbsmith points out in a letter of some length that on the figures submitted by the Tramways Committee themselves, the Glasgow experiment in Municipal Tramways must result in an average net loss of not less than £20,000 per annum. Here are some of the allegations:—

> Out of a stud of 3,694 horses purchased up to May 31, 1895, 250 had died or been sold during the 11 preceding months, and the loss upon them had been £6,427. The value of the stud stood at £117,337. The average life of a tram horse is five years. The provision for depreciation on horses made by the Tramway Committee was £4,145! Again, a reference to capital account shows that the expenses of preparing horses for work were more than £13,000, but no part of this sum—or, indeed, of the general preliminary charges, amounting to £38,992—was, so far as I can trace, charged against the revenue account.

The Salford Municipal Station.—The following particulars with regard to the electric light works of the Salford Corporation, which were formally opened on the 7th inst., may be of interest. The Council have spent, or shortly will have spent, a grand total of £34,338 on the works, acting on the advice of Messrs. Kincaid, Waller and Manville. The high-pressure alternating system has been adopted, the current being supplied, at a pressure of 3,000 volts, through concentric cables laid in cast-iron pipes to house transformers. There are three sets of

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engines and dynamos at the generating station, each set capable of supplying 2,500 8 c.p. lamps. The engines are of the slow-speed horizontal compound-condensing type, working at 160lb. pressure, and running at 85 revolutions. These engines drive Mather and Platt alternators by means of cotton ropes. There are three Lancashire steel boilers, fitted with mechanical stoking appliances, economisers, &c. The fuel to be used in them is coke from the Corporation gas works. From trials that have been made it has been found that not only has gas coke the great advantage of being a clean, smokeless fuel, but it is a very economical one for steam boilers. At the present time the Corporation have 19 customers, who have altogether about 1,000 lamps, and there are applications from others for a supply for about 500 additional lamps. The charge for current is at present 7d. per unit.

Self-Propelled Road Carriages.—The following important notice appeared in the editorial column of the *Engineer* of the 16th inst.:—

"We have offered for competition prizes to the value of one thousand guineas for self-propelled road carriages, believing, as we do, that the construction of such carriages may very well constitute a new branch of manufacture at least as important as that of cycles, which in a very few years has attained to enormous proportions. But it is obvious that unless the use of vehicles propelled by steam, oil, gas, or electricity is sanctioned by the Legislature, no progress can be made in this direction. It will be remembered that an alteration in the existing Highways (Locomotives) Act was prepared and met with favour in the late Parliament, and would probably have become law but for the dissolution. It is most desirable that the existence of a demand for such a change should be brought to the notice of the new Government, and to that end we have prepared the subjoined memorial, a copy of which lies at our office for signatures. We may add that those of our readers in the country who are interested can have a copy of the memorial forwarded to them for signature on application to our publisher. Energetic action at the present moment will be of far more value than at a subsequent period when Parliament becomes engrossed with matters which, however important for the nation in general, have scant interest by comparison for engineers."

Then follows the text of the petition, which is addressed to the President of the Local Government Board, and which requests that the Bill introduced to Parliament under the late Government, or some similar Bill, "may be presented to Parliament with the least possible delay."

Magnetic Units.—Commenting upon the Report by Dr. Oliver Lodge on "Magnetic Units," published in *The Electrician* of August 2nd, our contemporary the *Electrical World* of New York says:—

"Though the question of scientific units is essentially an international one, the English writer proceeds to consider it as if its geographical boundaries were those of the British isles and that, perforce, all other countries would, willy nilly, have to accept the English solution. Notwithstanding the adoption and definition by the Chicago International Electrical Congress of the henry as the unit of inductance, and its legalisation by act of Congress in this country, the Paper merely states that 'It has been practically decided in America that this unit shall be named after Prof. Henry, of Washington, but the precise definition has not yet been agreed upon.' This is the only reference in the Paper to any non-English action on the question of units, and 'Prof. Henry, of Washington,' is the only non-English name mentioned. Though recognising the name 'henry,' the Paper suggests as a value for unit inductance, 10^9 times the C.G.S. unit, the present value of the henry being 10^8 C.G.S. units. It very fortunately happens that the suggestions of Prof. Lodge will have to stand criticism before the B.A., and, still more fortunately, that final action in the question of units will rest with Kelvin, Rayleigh, J. J. Thomson, Ewing and others, who will be inclined to take the liberal view of the subject which its nature demands. Prof. Lodge in his Paper states that, 'It need hardly be said that in the last resort it rests with practical men to employ or decline any suggested system of units.' What fate, at the hands of the 'practical men' of the United States, France and Germany, would be met by a system of units devised in a spirit of insular 'jingoism' and promulgated as by a lordly estate to an inferior order?"

Electricity in Parliament.—According to an American technical journal, the present system of voting in the House of Representatives will be abolished before long, and electricity will take its place. The first step toward such a plan already has been taken in the abolition of the old method of calling pages in the House. Hitherto the member who wanted a page had to clap his hands until a boy came. This kept some 10 or 15 boys always waiting on the edge of the speaker's dais. This had proved to be a nuisance long enough, and it has been done away with. Each congressman's desk is now provided with an electric button which communicates with an ordinary hotel annunciator in the lobby. As it was impracticable to attach the wires to the desk permanently, an improvement has been made which permits of the removal of every desk in the place without trouble. Brass plates have been let into the floor, and upon these the legs of the desk stand, being provided with metal contacts. Connection is made through the plates. The new plan will keep the boys out of the House and insure better service than under the old plan. It will also act as the entering wedge for the idea of voting by electricity. It would be easy enough to put buttons upon the desk of each member which would electrically record his vote. Those who favour the plan say that the recording board could be in full view, and that fraudulent voting would be impossible.

The British Association.—The arrangements for the meeting of the British Association at Ipswich are, says *Nature*, making rapid progress. The reception room will be located in the Town Hall, the council chamber being the room actually set apart for the purpose, whilst the library will be the writing room. The President's address and the evening discourses will be delivered in the public hall, as will also the lecture to working men. In the matter of Section rooms, there are fortunately a number of suitable rooms and halls in the town within a very short distance of each other, and all are close to the reception room. The two halls at the Girls' High School, which were formerly the New Assembly Rooms, will be allotted to Section A and Section B. About 200 yards distant is the Co-operative Hall, in which Section G will meet. The proceedings will commence on the evening of Wednesday, Sept. 11th, when the Marquis of Salisbury will retire from the presidential chair, and Sir Douglas Galton will take his place. The new President will then proceed to deliver his address. On Friday evening Prof. Silvanus Thompson will deliver a lecture on "Magnetism in Rotation." The lecture to working men will be given on the Saturday evening by Dr. Alfred H. Fison, who takes "Colour" for his subject. The hon. local secretaries for the meeting are Messrs. S. A. Notcutt, G. H. Hewetson, and E. P. Ridley. All communications to them should be addressed to the Museum, Ipswich.

Magnetic Observations.—The results of some observations on declination made by M. Ch. Lagrange, which, if unaffected by some unsuspected error, are most unexpected, are, says *Nature*, given in a recent number of the *Comptes Rendus* (June 17, 1895). During the last three years the author has been making observations of declination at the Uccle Observatory at Brussels, using for this purpose magnets having very different magnetic moments. He finds that systematic differences occur in the values obtained; but what is most astonishing is that diminution, within certain limits, of the magnetic moment of the magnet causes an amplification of the observed changes in declination. In one set of observations, lasting for six months, one of the magnets consisted of the almost astatic magnetic system taken from a galvanometer. By comparing the readings obtained with this system of magnets with those obtained on the self-registering magnetometers, it was found that the amplitude of the movements of the galvanometer needle was from 15 to 25 times as great as that of the magnetometer needle. Another set of observations has been made with a large steel magnet, only feebly magnetised, however, so that its magnetic moment was only about $\frac{1}{10}$th of that of the magnet of the magnetograph. This magnet was suspended by a fine platinum wire, and here again the amplitude of movement of the feebly magnetised bar was greater than that of the more strongly magnetised one.

The Ohm Statue at Munich.—On July 5th, during the third annual meeting of the Verband Deutscher Elektrotechniker at Munich, a statue of Ohm was unveiled in presence of a large number of members of the Verband. The statue is of white marble, and stands in the square in front of the Technical High School. Around the pedestal there are figures in relief. There is also an inscription to the effect that the statue has been "erected by his admirers and disciples." Funds were raised by subscriptions, the first appeal for which was made six years ago, on the occasion of the 100th anniversary of Ohm's birthday, to which England, France and America liberally responded. In all £2,000 was subscribed. The statue was designed and cut by Profs. von Thiersch and von Ruemann after an old photograph and a painting of Ohm

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in the possession of the Academy of Science, and from description furnished by still living friends. Ohm was born at Erlangen on March 16, 1789. He was the son of a master locksmith, who was able to teach his sons mathematics. Ohm's first post was that of teacher of mathematics and physics in Gottstadt and Neuenburg in Switzerland. Thence he returned to his native town and acted as *privat-docent* at the university there for a short time. From there he went to Bamberg, and later to Cologne, where he published his chief work, "The Galvanic Circuit Mathematically Elaborated." Later on he became a professor at, and ultimately rector of, the Polytechnic at Nuremberg. He was 60 years of age when he came as professor to Munich, where he worked until his death on July 6, 1854.

The Hodgkins Fund Prizes.—*Nature* publishes the reports of the committee appointed by the Smithsonian Institution to award the Hodgkins Fund Prizes. The report states that 218 Papers were submitted in competition. The first prize, of £2,000, for a treatise embodying some new and important discoveries in regard to the nature or properties of atmospheric air, is awarded to Lord Rayleigh and Prof. William Ramsay for the discovery of argon. The second prize, of £400, is not awarded, owing to the failure of any contestant to comply strictly with the terms of the offer. The third prize of £200 is awarded to Dr. Henry de Varigny, of Paris, for the best popular treatise upon atmospheric air, its properties and relationships. The following receive honourable mention, with silver medal, for their Papers:—Mr. A. L. Herrera and Dr. Vergara Lopez, of the city of Mexico—"La Atmosfera de las Altitudes y el Bienestar del Hombre"; Mr. C. L. Madsen, ("Geo") Helsigór, near Copenhagen, Denmark; Mr. F. A. R. Russell, of London, vice-president of the Royal Meteorological Society of Great Britain—"The Atmosphere in Relation to Human Life and 'Health.'" Among the other awards Mr. Hiram S. Maxim receives honourable mention, with bronze medal, for his Paper, "Natural and Artificial Flight"; and Mr. E. C. C. Baly, University College, London, is awarded honourable mention for his Paper, "The Decomposition of the Two Constituents of the Atmosphere by means of the Passage of the Electric Spark."

Electrolytic "Parting" of Gold and Silver.—The German Gold and Silver Separation Works at Frankfort are using an electrolytic method of "parting." According to ordinary modern practice, the separation or "parting" of gold and silver is effected by boiling the granulated alloy with strong sulphuric acid, in which silver is soluble, while gold is unattacked. This method has almost entirely displaced the time-honoured process of parting with nitric acid, its smaller cost being a tangible advantage, even when dealing with raw materials as valuable as the precious metals. It has now a competitor, actually working on a commercial scale, in the electrolytic process about to be described. The auriferous silver to be parted is cast into plates, which are enclosed in linen bags and made the anodes in a weak solution of silver nitrate made acid with nitric acid. The cathodes, which are thin plates of fine silver, are suspended, without covering, in the bath, and below them is a tray, the bottom of which is of linen. Seeing that there is no difficulty in melting finely-divided silver into an ingot without loss, there is no need to endeavour to precipitate the metal upon the cathodes in a coherent form; thus it happens that a high current-density can be used and the silver deposited pell-mell, scrapers being employed to sweep it down from the cathodes into the tray at the bottom of the bath, and prevent the occurrence of a short circuit. The linen bags containing the anodes are emptied of their residual gold once or twice a week, according to the richness of the alloy treated. Copper which may be present in the original alloy, remains in solution as nitrate, provided a little fresh nitric acid be added to the electrolyte from time to time.

Electric Power in a Hungarian Mine.—At the Kremnitz Mine, belonging to the Hungarian Government, a plant, says the *Engineering and Mining Journal*, has been put down for the electrical transmission of power to be utilised for the operation of a winding engine and a stone-breaking machine. A turbine is used to furnish motive power, and some difficulty was experienced owing to the variation of the load on the turbine. The winding engine had to lift a net load of 15cwt. at a speed ranging from 3ft. to 5ft. 6in. per second, and it was required to drive this engine by means of an electric motor having a normal performance of 45 H.P., and to simultaneously actuate the stone-breaker by a second electric motor. The greatest demand for power is at the moment of taking up the load, and the power required attains various values according to the relative positions of the two ropes, ceasing the instant the cage reaches the surface. After the cage has been brought to rest after the lift has taken place, it has to be lowered a few centimetres upon a given signal. Then, before lowering the empty cage, it has to be raised the same distance, be stopped, and then, on the signal being given, it is allowed to descend. Therefore, within a comparatively short space of time, very wide changes in the load upon the electric motor take place, and these variations were very noticeable in the generating station. The turbine runs at 150 revolutions a minute, under a head of 67ft. water, and it drives a countershaft, from which a dynamo is belt-driven at 500 revolutions. The dynamo has an output of 150 amperes at 350 volts. The turbine was regulated by a centrifugal regulator. It was found when there was no load upon the generating dynamo the turbine raced, the regulator only coming into action when the demand for power reached 12 H.P., and then was not sufficiently precise. An artificial load was therefore inserted so as to keep the speed of the turbine practically constant under variable loads. The idea was that the dynamo should be loaded artificially in such a manner that this artificial load would diminish as the useful load came on and increased, and that it would be entirely taken off when the useful load reached or exceeded the value of the artificial load. For the latter a liquid resistance was selected on the ground of cheapness and sparklessness. The whole arrangement is automatic.

An Electrolytic Forge.—A recent number of the *Electrical Engineer* of New York contains an account of an electric forge, worked on the principle first utilised by Messrs. Lagrange and Hoho, which has recently been put into operation at a blacksmith's shop at Niagara Falls. The principle referred to consists in the heating of the metal to be worked, by immersing it in acidulated or salted water while forming part of the circuit of a powerful continuous current dynamo. It is found that it takes from eight seconds for a piece of iron one quarter of an inch square cross-section, to one minute for a piece one inch square; the latter required 26 amperes at 220 volts, which costs, it is claimed, less than a quarter of a cent. for current. The cost of preparing a horseshoe with a coal forge, with coal at £1 per ton, is 5·58 cents; with the electric forge, and current at 15 cents per unit, it is 2·32 cents. The forge consists of a rectangular wooden tank, with a float controlled by a handle and rack-work for raising or lowering the surface of the liquid. The positive wire is attached to the lead plate suspended from the edge of the tank. The negative wire is connected to three work rests; two of these are used for heating articles held by tongs, such as horseshoes, bolts, rivets, &c., and the other for heating particular points on a long bar of iron. This last is accomplished by laying it in a trough on two pieces of movable firebrick, which can be separated to any required distance. The space between the two bricks determines the length of the part of the rod that will be heated, and can be regulated so as to heat a space on the rod from one-fourth of an inch in length up to the full width of the tank. When the piece of iron is in position, and the bricks are adjusted, the clamps are brought in contact with the iron; on depression of the float the solution is brought in contact with the iron; electrolysis takes place, and the heat due to the high resistance is imparted to the iron. By moving the float up and down, the circuit can be made and broken at will, and in an irregular-shaped piece of iron this gives the heat a chance to distribute itself throughout its mass. The solution used in this forge consists of washing soda 10lb.) borax 1½lb., in 45 gallons of water. The burning hydrogen has the colour of burning sodium, indicating that some of the constituents of the electrolyte are gradually consumed; these must be replaced, and cost about 10 cents per month.

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PHASE DIFFERENCE IN ALTERNATE-CURRENT ELECTROLYSIS.

BY W. R. COOPER, M.A.

Theories of electrolysis by alternating currents have from time to time been put forward by Mengarini and others, who have shown that a difference of phase between current and E.M.F. should result by the introduction of a voltameter into an alternating-current circuit, and certain experimental evidence has been brought forward in favour of this view. In the *Elektrotechnische Zeitschrift* for June 6, 1895, Herr Peukert describes some experiments carried out with the object of directly investigating whether any such phase difference does exist.

For this purpose a current of 3·3 amperes was passed through a voltameter, containing acidulated water, in series with a hot-wire ammeter and a carbon resistance, free from self-induction. The current was supplied by a Siemens alternator, separately excited, and was maintained of the same strength throughout the experiments by varying the excitation. A constant speed was also obtained, with a frequency of 96 ∿, by employing an electromotor to drive the alternator. The values of the potential difference at the terminals of the voltameter and the current at any time were found by the well-known method of a Joubert disc revolving with the shaft of the alternator. The potential difference was measured directly, and the current by the fall of potential along a non-inductive resistance. The deflections of the Wiedemann galvanometer employed for the purpose were plotted without further reduction.

Platinum electrodes, each 5·5 x 9cm. were first employed. In order to determine the effect of varying the current density, a platinum strip 11 x 9cm. was used as one electrode, whilst a platinum wire 1mm. in diameter, of which 9cm. were immersed in the electrolyte, was used as the other. Carbon electrodes, in the form of arc-light carbons, one being cored and the other uncored, were also made use of.

From the curves which are given in illustration of the results, it appears that practically no difference of phase was introduced in any of the three cases.

That the experiments are insufficient to disprove the existence of phase difference under all conditions is pointed out in the *Elektrotechnische Zeitschrift* for June 20th by Herr Dolivo-Dobrowolsky, who contributes an article dealing somewhat fully with the matter, which we will here briefly reproduce. It may be shown in a simple manner that a phase difference must theoretically exist where polarisation takes place. If a current, in traversing a circuit, creates an E.M.F., a certain amount of energy is absorbed, apart from that due to ohmic resistance; and, if the current is changed in strength or is reversed, a part of this energy is restored. Thus in the case of an alternating current a definite amount of energy becomes oscillatory. The smaller the resistance the more nearly will the energy given to the circuit be equal to that which is returned; and, in the limiting case, when the resistance is zero, there will be no loss of energy: the current will be wattless, and therefore in quarter phase with the potential difference. If, in the usual manner, the potential difference is resolved into two components, viz., the watt component due to the ohmic resistance and the wattless component due to the E.M.F. created by the current, these components being at right angles, the phase difference ϕ will be given by the relation

$$\tan \phi = \frac{\text{wattless component}}{\text{watt component}}.$$

This formula is known to hold good for coils and condensers, provided we deal with simple sine functions.

In the case of a voltameter, polarisation sets in as soon as a current passes; energy is absorbed, the cell acting as a condenser or a coil, and the potential difference may again be resolved into a watt component due to ohmic resistance, and, at right angles to this, a wattless component, due to the E.M.F. of polarisation. The latter has a limiting value, which for platinum electrodes in acidulated water amounts to about 2·5 volts. To obtain the pure phenomenon it is therefore necessary to keep below this limit, just as it would be necessary to keep below the saturation limit of iron in a corresponding experiment with the self-induction of a cored coil.

In his experiments Herr Peukert mentions the strength of current employed; but he gives no information about the value of the potential difference, or the resistance of the cell—data of far greater importance, since the phase difference directly depends upon them, and may have a very small value unless the conditions are suitable. For example, suppose the impressed potential difference at the electrodes amounted to 50 volts, and that due to polarisation had a mean value of 1·5 volts, then $\sin \phi = \frac{1\cdot5}{50} = 0\cdot03$. This corresponds to so small an angle that it would not be observed by direct curve measurements. In order that a large phase difference should result, the potential difference loss due to ohmic resistance must be small compared to the E.M.F. of polarisation. Now, to produce a certain value of the polarisation, a definite mean-current density in the electrodes is necessary. The resistance must not, therefore, be diminished by increasing the size of the plates, since the current would then require to be increased to obtain the same polarisation, and the ratio of the two potential-difference components would remain unchanged. Any diminution of the resistance must be effected by bringing the electrodes nearer to one another.

Having regard to these precautions, Herr Dobrowolsky mentions, in conclusion, that he has obtained a phase difference of over 80deg. with batteries of iron plates in solutions of soda, and has also reproduced the capacity phenomenon of the Lauffen-Frankfort conductor with low-voltage currents. For example, if a weakly-excited alternator is put in circuit with a polarisation battery, a rise of potential difference takes place of from 50 to 100 per cent. Self-induction has also been balanced against polarisation by Stanley; and Brown has employed a polarisation cell for the production of a phase difference required in starting his alternate-current motors. Thus both theory and practical experience indicate that a phase difference is always produced.

It is scarcely necessary to remark that such investigations have a practical bearing upon the testing of alternators, for which purpose a water resistance is often made use of on the assumption that it is equivalent to a non-inductive resistance. Barrels and sheet lead are generally at hand, so that such a method is particularly convenient for a trial run after the erection of an alternator. But does the product of volts and amperes give the power expended as accurately as may be required? In certain cases it evidently does so, and indeed it does not appear probable that serious error would arise in practice, provided the electrodes are so placed that the loss of potential difference through ohmic resistance is large compared to the polarisation. In other words, the number of tubs in series should be as small as possible, and the electrodes should be far apart with a high current density.

Alternate-current electrolysis presents a field for experimental research, which, under favourable conditions, should yield results of considerable interest, though perhaps not of much commercial value. Mengarini placed polarisation in the same category as self-induction, but there seems very little doubt that it acts in a way analogous to capacity, as pointed out by Herr Dobrowolsky, though in a less simple manner. A good deal must depend upon the magnitude of the impressed potential difference. If that is below what is required to effect decomposition, then a voltameter would be expected to act simply as a condenser. If it rises above this critical value, but does not exceed the limiting value of the E.M.F. of polarisation, there would be a condenser effect followed by a polarisation effect every alternation, giving rise to a potential difference in quarter phase with that due to ohmic resistance. Lastly, if it exceeds the E.M.F. of polarisation, the changes in the last case are followed at the end of each alternation by a period during which the products of decomposition are readily evolved, if gaseous; but in this case the resulting potential difference is not simply in quarter phase with the other component. Disregarding, for the moment, capacity and the critical value of the potential difference necessary to break up the electrolyte, let us suppose that a current, represented by the curve A in the usual manner, is flowing through the voltameter. If the impressed E.M.F. does not exceed the limit of polarisation, the latter gives rise to an opposing E.M.F. which may be represented by the curve P, in quarter phase with A and with

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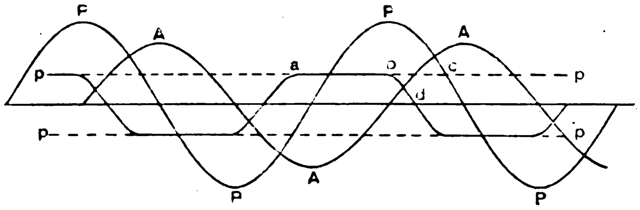
the component due to ohmic resistance. Now let the impressed E.M.F. be greater than the limit of polarisation, which limit we will suppose to be given by the lines *p p*. The curve *p* in this case cannot rise above *p p* on either side of the axis of time. There are therefore periods during which the polarisation has a steady value, as indicated by the continuous parts of *p p*, such as *a b*. But this does not continue to the point *c*, where *p p* cuts the curve *p*. As soon as the current falls to a zero value the polarisation will begin to diminish. It will become zero when the quantity of electricity passing, since the reversal of the current, is equivalent to the products of decomposition upon the electrodes; and the polarisation curve will cut the



axis at a point *d*, after which it will pass on to a steady maximum of opposite sign. Thus a wave is produced which is displaced from the position of *p*, the extent of the displacement increasing as the current density in the electrodes increases. The resulting component of the potential difference is no longer in quarter phase with that due to ohmic resistance, and, in the limit, when the current density is very high, the phase difference between current and impressed potential difference vanishes, the two components being in opposition.

THE ACTION OF NITROUS ACID IN A GROVE CELL.

A Paper on this subject was recently read before the German Electrochemical Society by Prof. Ihle, who touched upon the following interesting points:—

A Grove cell having in the platinum compartment nitric acid of a strength corresponding with a content of 38 per cent. of HNO_3 possesses a voltage which is that characteristic of a nitric acid cell (about 1·8 volt), and is sensibly constant. If the nitric acid be further diluted, the cell exhibits, if only for a very short time, a voltage proper to a cell of the Smee type, viz., 0·7 volt. As the strength of the nitric acid is decreased, the time during which the cell retains the lower voltage increases, until at a strength of 27-28 per cent. HNO_3 the lower voltage is permanent.

The observation of this alteration of voltage may be conveniently made by filling a battery glass with dilute nitric acid, and placing two small porous cells therein, the one containing an amalgamated zinc rod in a solution of zinc sulphate, and the other a platinum plate in nitric acid of the required strength. Working with an arrangement of this kind it can quickly be demonstrated that the voltage of the cell depends upon the nitrous acid originally present in the nitric acid or formed during the action of the cell while the circuit is closed. For example, using nitric acid of a strength below that represented by 28 per cent. HNO_3, so that the cell gives the voltage proper to a Smee, the addition of a small quantity of potassium nitrite to the compartment containing the platinum plate, at once causes the development of the higher voltage characteristic of a nitric acid cell. On removing the nitrous acid thus introduced, by the addition of potassium permanganate, hydrogen peroxide or urea, the voltage drops again to the lower limit. In performing this experiment with potassium permanganate, a voltage still higher than that of an ordinary Grove cell is noticed for a moment, on account of the presence of permanganic acid acting as a depolariser. This, however, is quickly reduced, and the aforesaid drop takes place. On adopting the reverse method of experimenting, and removing nitrous acid (by treatment with urea or potassium permanganate) from nitric acid of a strength (38 per cent. HNO_3) such that it is capable of acting as a depolariser, the voltage proper to a Grove cell is diminished to that characteristic of a Smee, in spite of the fact that the acid is of adequate strength to act in its customary manner under normal conditions. It appears, therefore, that nitrous acid, rather than nitric acid, is the true depolariser in a Grove cell, or, to be more precise, that nitric acid is capable of oxidising the hydrogen which would otherwise be liberated at the platinum plate only in the presence of nitrous acid. The function of the nitrous acid is precisely similar to that which it assumes in the action of nitric acid on metals, the presence of the former being frequently essential for the activity of the latter.

ELECTRIC FURNACES AND THEIR APPLICATION TO THE TRANSFORMATION OF CARBON INTO GRAPHITE.*

BY CH. STREET.

Gentlemen, the honour of reading this Paper belonged of right to my colleague M. Charles Girard, and I have to thank him for having allowed me to give you an account of our labours.

Before describing our methods of transforming carbon into graphite, methods which are founded upon the employment of special electric furnaces, we thought it would be a good thing to review for your benefit the interesting attempts that have been made in the direction of applying electricity to metallurgy, by making use of the extremely high temperatures placed at our disposal by the electric current. We thought it appropriate for the Société Internationale des Electriciens to record the results obtained, in order that it might assist progress towards the distant goal which we shall certainly reach in the future. The limited scope of this communication and the fear of tiring you by a too detailed *exposé* obliged me to limit the number of inventions to which I shall call your attention.

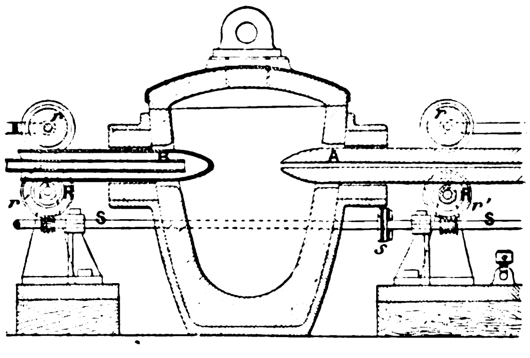


FIG. 1.—Siemens Furnace exhibited at the International Electrical Exhibition of 1881.

Apparatus in which heat is produced by means of electricity may be divided, like electric lighting apparatus, into two large classes; some furnaces are based on the incandescence of a resisting portion of the circuit, the others on the use of the electric arc. The latter are those which enable us to obtain the most powerful effects and which it would seem are destined to yield the most valuable results.

The International Electrical Exhibition of 1881 acquainted us with the two first electric furnaces which may be regarded as the starting point of all apparatus of the kind. The apparatus exhibited by Messrs. Siemens consisted of a carbon crucible heated by an electric arc in the interior (*see* Fig. 1). The carbon crucible containing the substance to be heated had two apertures through which the electrodes passed. A carbon lid enclosed the contents. The electrodes were either both of carbon or the positive was of carbon and the negative was of metal and kept cool by circulating water. The electrodes were fed forward automatically as they were consumed by means of a device which I will not stop to describe. The Siemens electric furnace could be arranged in another way when the material in the crucible was a good conductor of electricity. The current was brought to the bottom of the crucible by a platinum screw *a* (Fig. 2) and transmitted to the conducting substance A, which was thus placed in connection with the positive pole. An arc was established between A and the negative pole B, which was cooled by circulating water.

The second piece of apparatus to which I will allude is that of our colleague M. Louis Clerc. This consisted of a block of magnesia or carbonate of lime (Fig. 3), in which a cavity was hollowed out where the arc played. The electrodes consisted of two 20mm. carbons. In this furnace its inventor volatilised silica and lime. If my memory serves me aright M. Clerc, who publicly

* Paper read before the Société Internationale des Electriciens.

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repeated his experiments every evening before the visitors to the Exhibition, sent M. Daubrée some very curious specimens of crystalline lime, products of the condensation of the substances volatised in his furnace.

In 1885 Messrs. Eugene and Alfred Cowles took out a patent for an electric furnace which was the starting point of their interesting work on the production of aluminium. In this furnace the heat was produced by bringing the material to be treated to incandescence by means of the electric current, the charge being

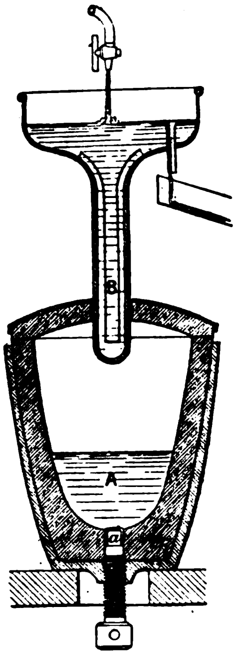

FIG. 2.—Siemens Furnace: Another form.

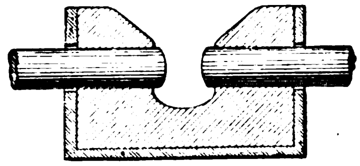

FIG. 3.—Clerc Furnace.

previously pulverised and mixed with powdered retort carbon (Fig. 4). The first apparatus which was made was intended for the reduction of zinc ores, and its use was extended to the reduction and fusion of other ores, especially aluminium, silicium, magnesium, and boron ores. This furnace consisted of a cylinder A, made of silica or any other non-conductor of electricity. This cylinder was surrounded with powdered charcoal B, or any other bad conductor of heat. One end of the retort was closed by a plate of carbon

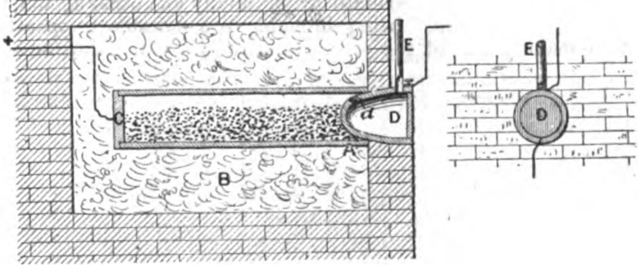

FIG. 4.—Cowles Furnace (1885).

C, which formed the positive electrode. The other end was closed by a graphite crucible D, which formed the negative electrode. This crucible, at the same time as it served as a negative electrode, formed a gas-tight plug for the retort and a condenser for the zinc vapour. The charge, a mixture of ore and carbon, was introduced through the aperture closed by the crucible.

In 1886 Messrs. Cowles patented a furnace (Fig. 5) in which the material to be treated was packed around two carbon electrodes, in close proximity at first, but gradually separated as the electric resistance of the furnace fell. At the start the electrodes were 25mm. apart; at the end of the operation they were 1·2 metres apart. This pattern of furnace shows considerable similarity to that which later on was made use of by Mr. Acheson for the production of carborundum, with the difference that the carbons in the latter furnace were maintained permanently in contact. The difficulties encountered by Messrs. Cowles in following the progress of the process going on inside their furnace, and estimating the separation to give to their electrodes, led them in the same year (1886) to take out a patent in which they claimed the simultaneous use of an ammeter and a resistance interposed in the circuit of an electric furnace with a view to the control of the process (Fig. 6).

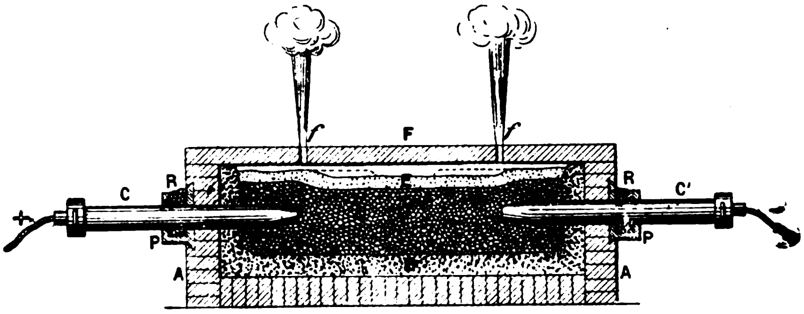

FIG. 5.—Cowles Furnace (1886).

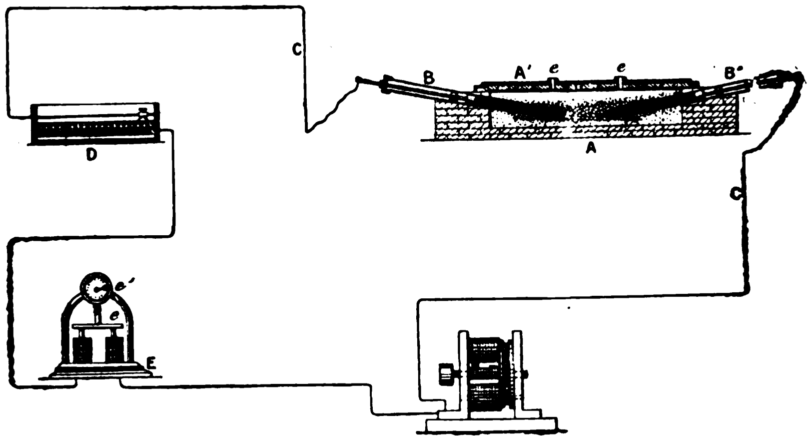

FIG. 6.—Cowles Patent 2403 of 1886.

In 1886 Messrs. Rogerson-Statter and Stevenson took out a patent, the object of which was the utilisation of electromagnetic attraction and repulsion to control the path of the electric arc when employed to produce the heat of a furnace. There is often an advantage in keeping the arc in a fixed position, either at a distance from or close to the material to be heated. In this patent the desired attraction or repulsion was produced by means of a permanent magnet, an electromagnet, or a solenoid. One of the arrangements employed is shown is Fig. 7. A is the body of the furnace, B and C are the two electrodes. On either side of the furnace are the two poles D of the electro-magnet. The polar

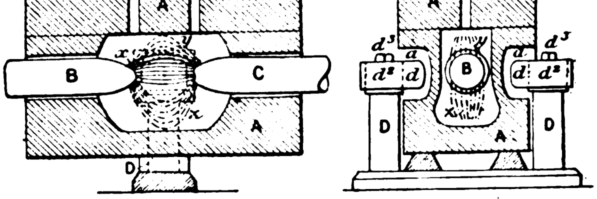

FIG. 7.—Rogerson-Statter and Stevenson Electromagnetic Device for Deflecting the Arc (1886).

expansions are movable in order to permit of the air-gap being varied. The effect of the electro-magnet is to deflect the arc towards the top or bottom of the furnace, according to the direction of the current circulating around the electro-magnet coils.

In 1887, MM. Bernard Frères patented the furnace shown in Fig. 8. Inside the furnace there was a carbon crucible, C, containing the substance to be treated. This crucible was inside a second crucible, C′, made of refractory material, and resting on a carbon support, p, connected to the positive pole of the source of electricity. The carbon electrode a was connected to the negative

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pole. The crucibles C and C′ were first heated by fuel burnt on the bars G, and when the charge had attained a suitable temperature the heating was completed by an electric current, which at the same time electrolysed the substance contained in the crucible.

In 1887, M. Héroult patented a furnace intended for the production of aluminium. The crucible *a* (Fig. 9) contained the bath of cryolite (double fluoride of aluminium and sodium). This crucible was placed in a second crucible, *b*, made of graphite or plumbago, and resting on stand *c*, which was interposed between it and the fire bars. The electrodes *e* and *e′* were of carbon. The anode was

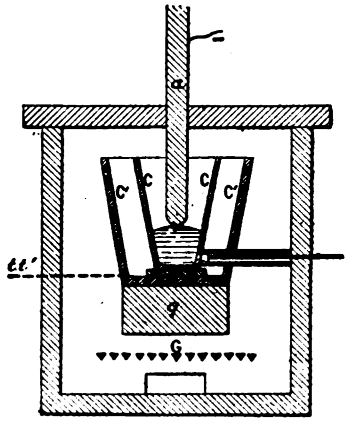

Fig. 8.—Bernard Compound Furnace (1887).

placed in the axis of the crucible, and the cathode was formed by the crucible itself, which was closed by the lid *g*.

In 1887, Messrs. Cowles took out a patent, the subject of which was an electric furnace in which the charge was introduced in a continuous manner. The positive electrode A (Fig. 10) is formed by a carbon tube. B is a feed-hopper, having its lower end fixed to the top of the electrode A. C is the negative tubular carbon electrode, fixed to the plate D arranged at the bottom of the furnace. The containing walls E are of refractory and silica bricks. A packing F of charcoal, or of lime and retort carbon mixed, surrounds the negative electrode C, and insulates it electrically and

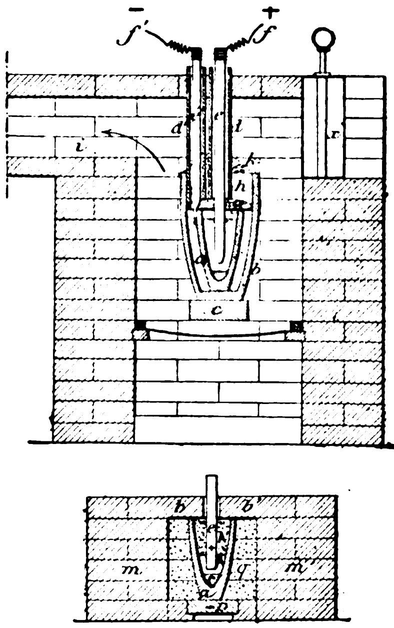

Fig. 9.—Héroult Furnace.

thermally. A packing, G, similar to the above, surrounds the zone of fusion between the two electrodes. The grain of this packing is, however, coarser, in order to allow the gases which result from the reactions of furnace to escape by the tube T which leads them to the condenser *t*. The upper part of the furnace is closed by the plate H, provided with an aperture *h*, through which the positive electrode slides freely. An arm, I, pivoted at *i*, enables the electrode A to be raised or lowered by means of a screw, in order to increase or diminish the zone of fusion or compensate for the consumption of the electrodes.

In 1888 Mr. Readman took out a patent for a furnace (Fig. 11) intended for the production of phosphorus. The furnace A consisted of refractory material, the heating chamber receiving two electrodes, K, which brought an arc to bear either above or in the vicinity of the material from which the phosphorus was to be extracted. In 1888 M. Reuleaux took out a patent for an electric cupola. This consisted of a piece of circular masonry (Fig. 12),

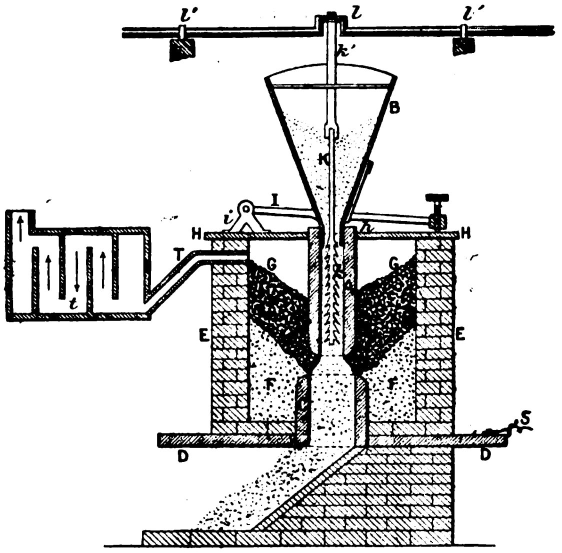

Fig. 10.—Cowles Continuous-Feed Furnace (1887).

divided at the upper end into three compartments, F F′ F″. These three compartments terminated in a common heating chamber, in which were a series of electrodes, E E′. Tubes C and T allowed of the material being heated before it reached the region of the arc. In 1888 Mr. Crompton patented a mixed furnace (Fig. 13),

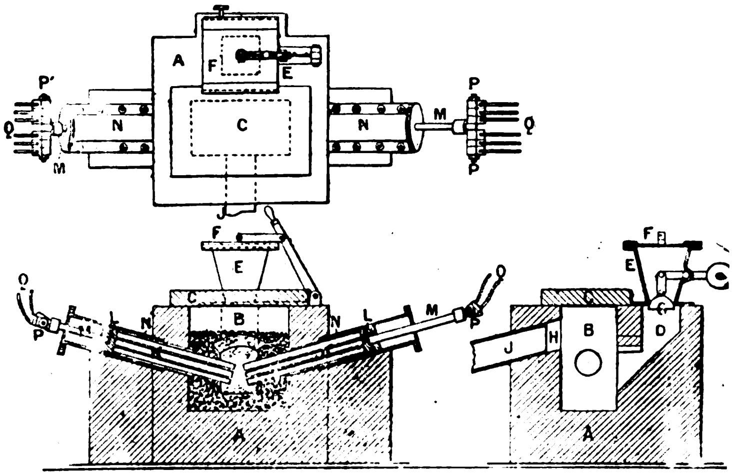

Fig. 11.—Readman Furnace for Phosphorus Reduction (1888).

in which the heat was produced by electrictiy and other agents, the material to be treated being brought to a suitable temperature before making use of the electric current; *a a* are the burners,

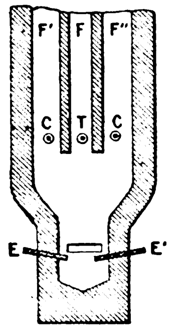

Fig. 12.—Reuleaux Cupola.

through which the combustible gases were introduced into the interior of the furnace; D and D′ are the electrodes, consisting of a bundle of carbons secured in a holder. In 1889 M. Kiliani patented a device whereby an oscillatory or circular motion was

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given to the anode with a view to avoid the formation of solid crusts at the surface of the molten bath, crusts which prevent the

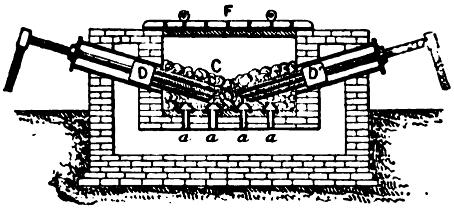

FIG. 13.—Crompton Compound Furnace.

introduction of fresh matter into the furnace (Fig. 14). In 1889 Mr. Thomas Parker devised the furnace depicted in Fig. 15, in

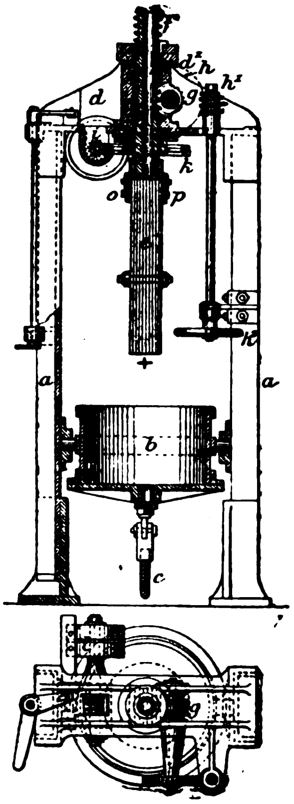

FIG. 14.—Kiliani Furnace with Oscillating Anode (1889).

which the heating was due to two rows of electrodes placed opposite each other. At the commencement the electrodes are brought

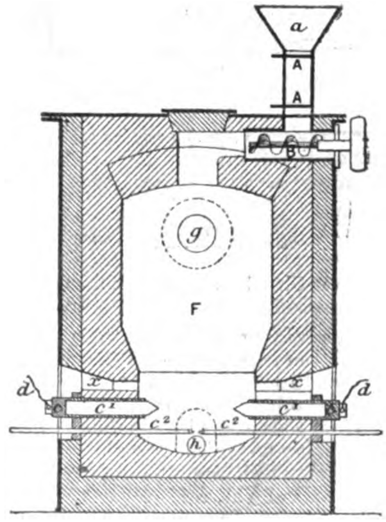

FIG. 15.—Parker Furnace.

into contact, and the charge is then introduced. The electrodes are next separated and afterwards brought together as fast as they burn away.

In 1890 Mr. Willson patented a device, the object of which was to reduce the consumption of the anode in mixed electric furnaces; that is to say, in furnaces which are calorific as well as electrolytic.

To this end the anode (Fig. 16) was a tube of carbon through which hydrogen, illuminating gas, or some other hydrocarbon gas was passed. This arrangement was used mainly to make aluminium-bronze by means of copper and corundum.

In 1890 Herrn Schneller and Astfalck patented the aluminium furnace shown in Fig. 17. The necessary heat is obtained by means of high voltage currents supplied by secondary generators. The high voltage is employed to overcome the high resistance of the substances to be reduced, and also to take advantage of having

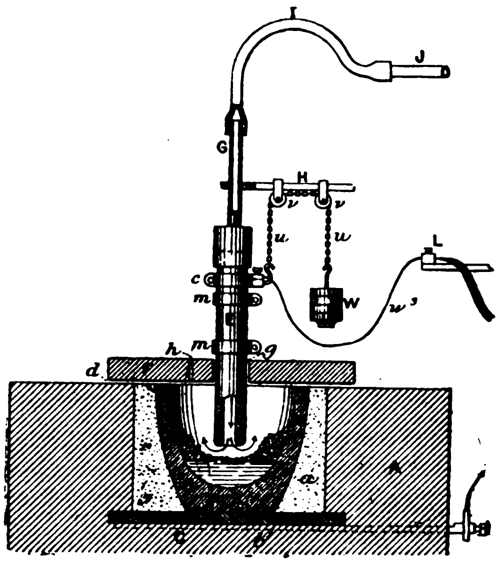

FIG. 16.—Willson Furnace with Tubular Carbon Electrode, through which hydrogen or a hydrocarbon gas is passed (1890).

a large surface presented to the gases which are to effect the reduction. This reduction is effected by hydrogen or a suitable hydrocarbon introduced into the interior of the furnace. The charge consists either of alumina, or of sulphide, chloride, or fluoride of aluminium. The fall of potential across the furnace terminals is some 20,000 volts.

In 1892 M. de Laval patented a furnace for the fusion of metals. The method employed consists in producing the heat necessary to effect the fusion by passing the current through a layer of molten matter of low conductivity, which is by that fact brought to a very high temperature. The current employed is alternating, to avoid electrolytic phenomena. Two arrangements are used, according as

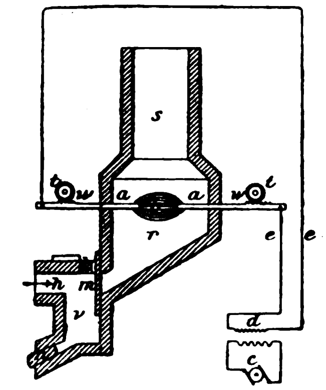

FIG. 17.—Schneller-Astfalck High Voltage Furnace (1890).

the metal is more dense or less dense than the electrolyte. Fig. 18 shows the apparatus used in the former case. The interior of the furnace is divided throughout its length into two parts by a bridge, C, of refractory material. The electrodes D and E are at the bottom of the furnace, and the circuit is completed by passing over the ridge C through the electrolyte. The metal to be melted is introduced through the opening B, and flows out through the pipes F and G. The excess of electrolyte gets away by the overflow pipe H.

On May 25, 1893, my colleague, M. Girard, and I took out a patent, the subject of which is a continuous electric furnace, which enables us to heat or treat any kind of material by electricity

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by causing it to circulate or pass in a continuous manner through the furnace. I lay stress from the beginning on the essential feature, which lies in passing the substance to be treated through the furnace. In the electric furnace the high temperatures are extremely local, and when substances are put into the furnace in the ordinary way they are heated in a very irregular manner, particularly when we have to deal with moderately good conductors of heat. To overcome this, we may increase the number of electric "burners," but by this means we reach a current consumption quite out of proportion to the result obtained. On the other hand, the circulation of the material through the furnaces permits of the establishment of continuously producing furnaces. Fig. 19 shows, partly in section, partly in elevation, a furnace applicable to the heating of solid materials in the shape of rods, bars, or wires. The apparatus consists of a block of refractory material *a* in one or more parts

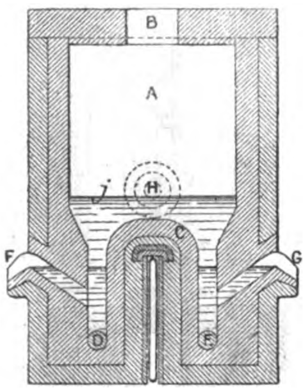

Fig. 18.—De Laval Furnace (1892).

secured by an external metal frame *b*. In the centre of the block there is a metal cavity *c*, which is, properly speaking, the heating chamber. In this cavity there is an orifice, by which the carbon *d* penetrates into it, and a tunnel traversing the walls of the furnace from one end to the other and into which the bar *e*, which is to be treated, is introduced. This bar *e* is given a motion of translation which should take it through the furnace and the heating chamber at a rate depending on its mass, and the temperature to which it is desired to raise it. The actual heating chamber is composed of a block of carbon in one or more pieces according to the size of the apparatus. In the model shown in the illustration the circuit is between the piece *e* to be heated and the carbon *d*. The arc is struck between the two electrodes, keeps itself in a fixed position, notwithstanding the motion of *e*, and successively springs from

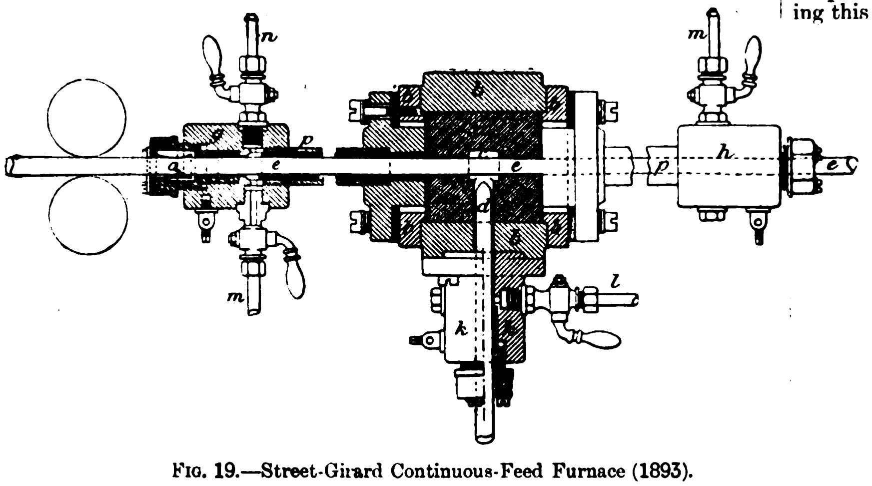

Fig. 19.—Street-Girard Continuous-Feed Furnace (1893).

every point along a generatrix of the piece to be heated, raising these points to a very high temperature. It is easy to see that the speed with which the piece moves determines the average temperature of each element. When the heating is required to take place in any particular gas the piece *e* passes through stuffing boxes *g* and *h*, and the carbon *d* through the stuffing box *k*. The gases enter and leave at *l* and *m*, and at *n* a manometer is fixed. The current is brought to *e* by a rubbing contact at *o*. The length of the arc between the carbon *d* and the piece *e* can be kept constant by means of one of the arrangements usually employed in arc lamps. The piece *e* traverses, before entering and after leaving the furnace, propersuitable tubes *p*, in which it is prepared on the one hand for the action of the furnace by passage through the special gas therein contained, and on the other cooled before passing through the stuffing-box by which it leaves. The working of the apparatus is absolutely continuous, since a constant succession of bars or rods may be passed through it. In the figure the object to be heated is shown undergoing the action of a single arc, but generally the object to be heated serves as a common electrode to two arcs in succession. The movement of translation is given to the piece of work by means of rollers actuated by an electric motor.

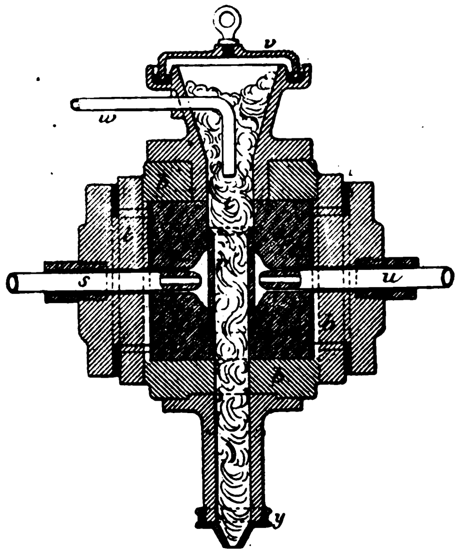

Fig. 20.—Street-Girard Furnace with Fixed Tubular Recipient.

When it is desired to pass pulverulent material capable or not of being fused, the piece *e* may consist of a tube, closed at either end and containing the material to be treated. The cylinder moves across the furnace in the manner already described, and is made of some material capable of withstanding the temperature it is called upon to resist. Instead of circulating with its recipient or crucible the substance to be treated may instead be set in motion inside the containing vessel, which may then be kept fixed. In this case we employ the arrangement shown in Fig. 20, where the heating chamber consists of a carbon tube *r*, which is at the same time a crucible and an electrode for the arc. The heat is then obtained from two arcs in series or from several groups of arcs two in series. When the material, after its passage through the heating chamber or crucible *r*, is capable of fusion, the pattern shown in Fig. 21 is adopted, in which there is an outlet *z* so arranged that, notwithstanding this orifice, the special gases can be kept in the furnace.

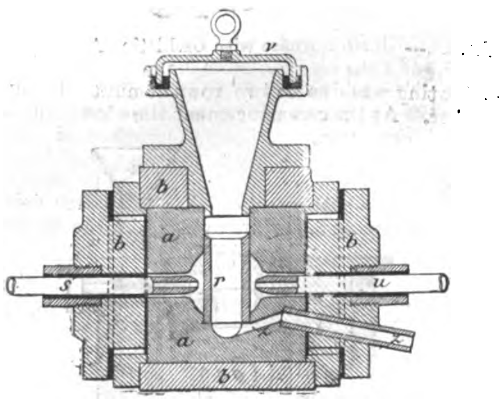

Fig. 21.—Street-Girard Furnace for Molten Substances.

It is sometimes an advantage to spread the action of the electric arc more evenly over the material to be treated. To attain this end we cause the arc to rotate within the furnace by bringing a suitable magnetic field to bear upon it. Let us take, for instance, the treatment of bars, rods and wires just described. The rod or bar *e* (Fig. 22) undergoing treatment passes through a succession of carbons *s*, the ends of which are pierced, as shown, with holes concentric with the axis of the rod or bar *e*. The arc is struck between *e* and the carbons *s* at a certain point by drawing the carbons through their stuffing boxes until they come into contact with *e*. Upon this element of current we bring a perpendicular magnetic field to bear by winding the outside of the furnace with coils traversed by an electric current, the metal cover *b* being in this case of non-magnetic material. Under the influence of this

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field the arc rotates in a plane at right angles to the bar *e*, and thus touches it at every point on its circumference. The speed of rotation of the arc is a function of the magnetic field in which it is placed and the strength of the current passing through the arc. The principle of the rotating arc is applicable to the different patterns of furnace we have devised. The combination of the rotary movement of the arc with the translatory movement of the bar to be heated results in the arc touching every point of the surface of the piece, and there is consequently a perfectly symmetrical distribution of heat.

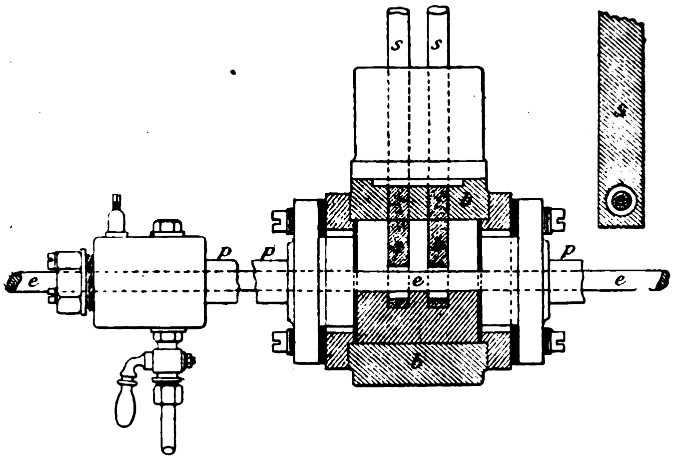

FIG. 22.—Street-Girard Furnace with Rotating Arc.

On August 1, 1893, M. Chaplet took out a patent for an electric furnace based on the researches of M. Moissan. These furnaces (Figs. 23 and 24) are those with which M. Moissan carried out those interesting investigations with which he has entertained the scientific world. I will not stop to describe the apparatus, which is well known to all.

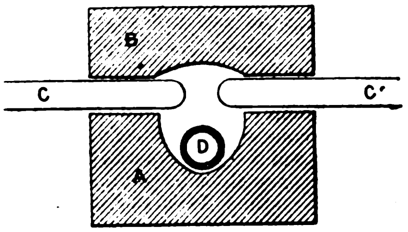

FIG. 23.—Chaplet-Moissan Furnace (1893).

Continuing our researches on the rotating arc we devised, in 1894, a type of crucible based on this principle. In this piece of apparatus the arc is influenced by a suitable magnetic field, and rotates more or less rapidly around the surface of the crucible and of the electrode. By this means we have succeeded in making the maximum use of the heat generated, and in effecting a uniform distribution of the heat so generated; this latter point is of considerable importance so far as the duration of the crucibles is concerned.

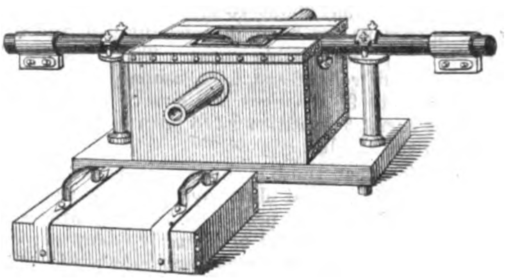

FIG. 24.—Chaplet-Moissan Furnace (1893).

The arc can be made to rotate either around the external or internal surface of the crucible, or around two independent electrodes, between which the crucible is situated.

In Fig. 25 is shown an arrangement which allows us to heat a crucible by an externally-rotating arc, the arc revolving round the axis of the crucible in a horizontal plane. *v* is the carbon crucible, supported at the centre of the furnace by its rim, which rests on a ledge cut in the carbon block *a*, which is itself placed within another block of refractory material *g* of silica, magnesia, or some other suitable substance, this block in its turn resting on a slab of refractory material *f*, a similar slab *h* resting on the top of *a* and *g*. Finally, two blocks of carbon, *c* and *b*, complete the interior of the furnace. All these parts are contained within a metal tube, closed top and bottom by the covers *j* and *j'* by the intermediary of an insulating joint. The blocks *c* and *f* are pierced by a channel through which the carbon electrode *e* is passed, the shape of the electrode being such that it envelops the lower end of the crucible without touching it. The crucible *v* is kept pressed down on its seat *a* by means of a carbon plug *d* carried in the holder *l*, the latter being contained in the tube *k*, together with the spring *r* and the abutment ring *q*.

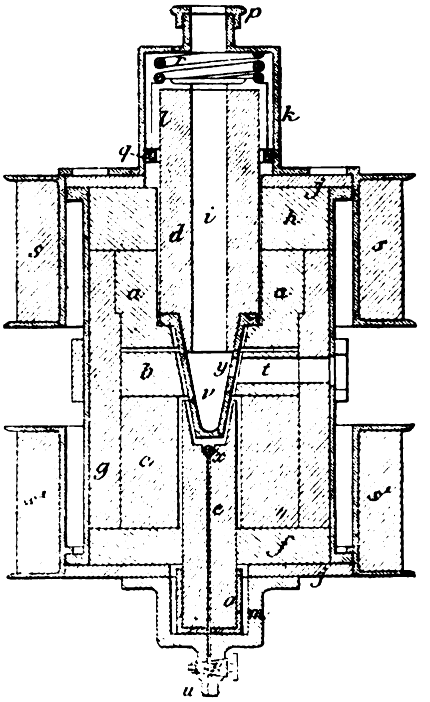

FIG. 25.—Street-Girard Furnace with Rotating Arc (1894).

The tube *k* is mounted on the upper cover *j'* by a bayonet joint, and is stopped at the top by a screw plug *p*, which tightly secures a sheet of mica. The carbon stopper *d* may be pierced at the centre by a hole *i*, through this hole and the mica the reactions going on may be followed. In attaching *k* to the top plate *j'* the stopper *d* presses upon the crucible *v* with a pressure proportional to the strength of the spring *r*. If the top and bottom plates *j'* and *j* are connected to the two poles of the source of electricity, an arc will start between the crucible *v* and the carbon *e*. To cause this arc to revolve round the outside of the crucible we place outside the metal frame two solenoids, *s* and *s'*, traversed by an electric current which obliges the arc to rotate in a plane perpendicular to the axis of the crucible and around the axis of the crucible as its axis of rotation. The crucible *v* is pierced at a certain height by a hole *y*, which is opposite a tunnel *t*, which is run through the blocks *b* and *g* and the metal frame. When the material introduced into the furnace *v* is capable of being fused by the high temperature attainable in it, the whole system is tilted round an horizontal axis, and the molten material flows away and is collected without interrupting the work of the furnace.

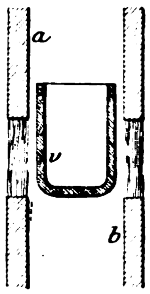

FIG. 26.—Street-Girard Furnace. Crucible between ends of two tubes.

In Fig. 26 is shown an arrangement by which a crucible *v* placed inside two tubes *a* and *b* is heated. The arc is stuck between the ends of the two tubes, and runs round under the action of a two-

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phase current. A crucible of this type has enabled us to effect in a few minutes the fusion of a 25 gramme nugget of platinum, and to reduce the oxides of manganese, uranium, and vanadium and also tungstic acid. The current employed was 80 amperes at 110 volts.

When the crucible is connected to the negative pole the metals obtained are highly carburised, and when the crucible is connected to the positive pole one obtains, if the operation is carried out with certain precautions, metals containing only a trace of carbon.

The electric furnaces devised by us have been made chiefly with a view to raising artificial carbons, such as they are now made, to an extremely high temperature. One of the most important factors in this process is the baking of the raw materials. The higher the temperature to which they are raised the more valuable do they become; their conductivity and general qualities increase with this temperature, and are a function of the point to which the baking was carried. Fom the experiments we had made in this direction we foresaw that by raising the carbons to the highest temperature available we should obtain new and interesting results. To realise this programme we thought that the best way, and the one that would be the most efficient, would be that in which the arc was made to play actually on the surface of the carbon to be treated; a method which we were able to make use of by means of our furnace. When two arcs are used in series on either side of a carbon rod or strip to which a translatory motion has been given, the arcs, if the current is relatively small, trace two generatrixes on the carbon, which are graphitic in character. The width of the line traced out by the arc is about 2mm., with a 14mm. carbon and a current of 40 amperes, and the depth of the graphite is about 1·5mm. In proportion as the internal temperature of the furnace increases the region of change widens and deepens. At the end of a certain time the carbon treated, which presents excrescences and hollows at the spot touched by the arc, still retains its shape absolutely unaltered, though it is entirely transformed into graphite, or rather the extent to which the transformation is carried becomes uniform throughout its mass. From this moment the arc no longer has its customary filiform appearance. When an alternate current is employed the carbon electrodes and the carbon under treatment appear to be the seat of a volatilisation of carbon over their entire surface, as is shown by the appearance of the ends of the electrodes and of the surface of the carbon that has been transformed.

When rotating-arc furnaces are used, then at the beginning of the experiment, and when the rate of translation of the pieces undergoing treatment in the furnace is exaggerated, the pieces exhibit on their surfaces the marks of a helix of graphitic carbon. The pitch of the helix varies for the same current with the speed of the carbon, and with a suitable speed the entire surface becomes graphitic. The wear of the carbons in these furnaces is extremely small.

In the case of rotating arcs the currents used are continuous, the piece undergoing treatment forming the positive pole. This arrangement has the advantage of placing the fixed electrode in the best condition for continuous work without the necessity of any mechanism for adjusting the length of arc.

In the case of furnaces in which the pieces to be treated pass between two fixed electrodes we employ preferably alternate currents. Owing to the small wear of the electrodes it is only necessary to adjust them by hand every hour. This consumption is 5mm. for a 300 ampere current and 40mm. electrodes. When the furnace has settled down to its work it is perfectly regular in its action; the ammeter placed in circuit remains absolutely steady, and the voltmeter across its terminals enables the length of the arc to be regulated with the greatest possible nicety.

Given the same current and rate of translation, the rate of transformation of any carbon into graphite varies with the mixture of which it is made. A carbon made with gas retort coke and tar is not converted into graphite to such an extent as one containing 2 per cent. of silica or 2 per cent. of boric acid. A similar result is obtained with powdered iron mixed with gas retort coke in the same proportion.

The nature of the medium appears to have but little influence on the tendency to transformation. Carbonic oxide, nitrogen, bisulphide of carbon, give similar results. Hydrogen alone would appear to slightly aid the change.

When carbons are subjected to this baking process the foreign matter they contain is volatilised or transformed into carbide, having a very high percentage of carbon and very difficult to attack with acid. The carbons obtained by this process possess very interesting new properties. The electric conductivity is augmented in the ratio of 1 to 4; the thermal conductivity increases in the same ratio. Finally, the resistance to combustion, is considerably increased, as well as the resistance to fused alkali. The density of an ordinary 14mm. carbon was found, before treatment in the electric furnace, to be 1·98, and that of the same carbon after passage through the furnace was 2·6, the proportion of carbon transformed into graphite being 85 per cent. The density of a 25mm. carbon after passage through the furnace was found to be 2·36, the proportion of graphite being 80 per cent. These differences depend upon the strength of the current, the speed at which the carbon is passed through the furnace, and the amount of carbon concerned. The proportion of graphite was determined by analysis by Berthelot's method, the main features of which I may be permitted to sum up. The carbon to be investigated is reduced to an impalpable powder, and then mixed with five to six times its weight of separately pulverised chlorate of potash. The material is then thrown, in small amounts, into fuming nitric acid so as to obtain a sort of paste. After the material has been left for a few hours, it is heated gently in an open vessel at 50°C. or 60°C. for three or four days. The material is then washed in water to eliminate the potash salts. This series of operations is renewed five or six times in order to completely dissolve the amorphous carbon, and to transform the graphite into graphitic acid.

The peculiar properties of these new carbons enable us to employ them with advantage as carbons for arc lamps, as anodes in electrolytic operations, and as dynamo brushes. When used as the positive carbons of arc lamps they wear away half as quickly, other things being equal, as ordinary carbons. Used as anodes these carbons behave in an altogether extraordinary manner, whether for electrolysis by the wet way or by the way of fusion. The ordinary artificial carbons rapidly disintegrate, crumble, and render all industrial use of them impossible, owing to the necessity of having to unmount and remount the electrolysers at extremely short intervals. In the particular case of the electrolysis of the metallic chlorides the results obtained are perfect. Unfortunately we cannot give you many commercial results, the use of our carbons for this purpose being, as yet, in the experimental rather than in the commercial stage. Nevertheless, we can give you some figures which have been given to us by Mr. Greenwood, the inventor of the electrolyser exploited by the Caustic Soda and Chlorine Syndicate of London and intended for the production of caustic soda. Mr. Greenwood's electrolyser is composed of a series of vats arranged in cascade. Each vat is divided into five compartments, each compartment forming a unit electrolyser. Each of these units contains an iron cathode and a carbon anode constructed in a special manner, the electrodes being separated by a porous diaphragm, which is an important feature of the invention. This diaphragm consists of a rectangular frame supporting a series of V-shaped troughs arranged so that the lower point of the V enters into the groove of the one immediately below it. These channels are of glass or slate, and are filled with fine Canadian asbestos. This arrangement enables Mr. Greenwood to obtain a porous diaphragm of low resistance, and to effectually separate the chlorine liberated in the anode compartment from the product of the cathode compartment, since owing to the interlacing of the V-shaped elements of the porous partitions they present a path which it is impossible for the chlorine to take, owing to its density. The anode is constructed in the following manner. A certain number of carbon plates are coppered on one side, then tinned, and then placed side by side in a mould so as to form one large plate. In order to unite the constituents of the plate an alloy of lead and antimony is run into the mould, so that after solidification one obtains a set of carbon plates secured in a skeleton-like metallic frame. This skeleton, and the joints covering the plates, are covered with an insulating cement, unattackable by acids. Moreover, the carbons are dipped in paraffin wax in order to stop up the pores and prevent the electrolyte from getting into contact with the metal at the back. When these anodes are constructed with ordinary artificial carbons they become, after a few days in the vats, quite useless, the carbon crumbling into dust. Mr. Greenwood has fitted a certain number of his electrolysers with electro-graphitic carbons, and that about 15 months ago. From that date until now the apparatus has been in constant use, and the anodes do not exhibit any perceptible wear. The current densities employed have varied from 100 to 1,000 amperes per square metre of anode (9 amperes to 90 amperes per square foot). On several occasions greater current densities have been employed without in any way injuring the anodes.

We are of opinion that these carbons will contribute largely to the development of industrial electrolysis, seeing that they bring within the region of industrial practice numerous processes which up to the present have remained of a purely laboratory character. The high electric conductivity of these electro-graphitic carbons, and their perfectly homogeneous texture, which causes them to resemble cast material, should recommend them to the special attention of electricians with a view to their use as dynamo brushes. Ordinary carbon brushes possess, generally speaking, many advantages, some of which are: suppression of sparking, the possibility of allowing the machine to rotate in either direction without altering the position of the brushes, preservation of the commutator in a good state. The advent of electro-graphitic carbon brushes will permit of the extension of the employment of brushes of this type to machines, which by reason of their construction or conditions of working could not hitherto make use of other than metallic brushes.

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Moreover, the peculiar character of the carbon of these brushes results in an extremely small coefficient of friction, and they do not unduly foul the commutator; they further enable us to obtain high conductivity at the point of contact between the brushes and the commutator. MM. Sautter-Harlé have found that electro-graphitic brushes can stand a current twice as great, other things being equal, as that which has been found dangerous for ordinary carbon brushes.

We are endeavouring at the present moment to adapt our electrical furnace to the making of incandescent lamp filaments, and we shall hasten to inform you of the results obtained in this direction.

In concluding this communication, I have to thank, in the names of M. Girard and myself, Mr. Frederick Maquaire, who has superintended the construction of the various type of furnaces, and M. André Tonnard, head of the laboratory of the Société le Carbone, who has superintended with the greatest possible devotion experiments often delicate and sometimes dangerous.

List of Electric Furnace Patents.

Date.	Patentee.	Country.	Number.
1879 ...	Siemens.	England.	2,110
1880 ...	Clerc.	France.	...
1885 ...	Cowles.	England.	6,994
1886 ...	Menges.	France.	173,649
1886 ...	Cowles.	England.	1,160
1886 ...	Cowles.	England.	2,403
1886 ...	Grabau.	France.	179,801
1887 ...	Rogerson-Statter & Stevenson.	France.	183,987
1887 ..	Bernard.	France.	185,765
1887 ...	Ferranti.	England.	700
1887 ...	Cowles.	England.	4,664
1887 ...	Cross.	England.	9,017
1888 ...	Gérard-Lescuyer.	France.	194,673
1888 ...	Reuleaux.	France.	194,944
1888 ...	Hobbs.	England.	11,817
1888 ...	Crompton.	England.	13,687
1888 ...	Readman.	England.	14,962
1889 ...	Taussig.	France.	202,395
1889 ..	Kiliani.	England.	6,745
1889 ...	Parker.	England.	17,060
1890 ...	Colby.	England.	7,876
1890 ...	Willson.	England.	9,361
1890 ...	Taussig.	England.	12,475
1890 ...	Schneller and Astfalck.	England.	13,486
1890 ...	Dewey.	England.	14,604
1891 ...	Butterfield Mitchell.	France.	215,450
1891 ...	Willson.	England.	4,757
1891 ...	Taussig.	England.	6,323
1891 ...	Niewerth.	England.	9,219
1891 ...	Parker.	England.	13,114
1891 ...	Parker.	England.	18,974
1892 ...	Von Poschinger.	France.	223,010
1892 ...	Kreinsen.	France.	224,270
1892 ...	Zerener.	France.	226,495
1892 ...	De Laval.	England.	15,793
1892 ...	Willson.	England.	21,701
1892 ...	Niewerth.	England.	23,773
1893 ...	Electric Heating Company.	France.	229,129
1893 ...	Girard and Street.	France.	230,341
1893 ...	Chaplet.	France.	231,902
1893 ...	Crompton.	England.	259
1893 ...	Mitchell	England.	6,922
1893 ..	Kreinsen.	England.	14,516
1894 ...	Girard and Street.	France.	236,406

THE NEW WESTINGHOUSE WORKS AT EAST PITTSBURG.—III.*

New Types of Apparatus.

Generators.—For polyphase work the Westinghouse Company is building two distinct types of generators, which are distinguished by their form of armature winding. The older style, known as the "plus two" type, and used only for two-phase work, has a toothed armature with two more teeth on the core than there are poles in the field. The newer type of machine is available for the generation of either two-phase or three-phase currents, and has what is called a "distributed" winding; that is, the coils are laid in slots in the armature, and the winding is made continuous. This is the type of machine installed in the Westinghouse power plant. The distributed form of winding, shown in Fig. 1, gives a very effective E.M.F. wave, and avoids fluctuations in pole-face inductions, which are often the accompaniment of the toothed armature. The standard line of machines is designed to be belt-driven, but may be modified to suit direct connection when desired.

The following is a list of generators which at present are being regularly built:—

Two-Phase Generators.

3,600 periods, 1,000 or 2,000 volts.

Rating.—K.W.	Weight.—Lbs.	No. of Poles.	Speed.—R. P. M.
45	3,500	8	900
60	4,500	8	900
75	6,000	10	720
150	12,000	12	600
225	19,000	16	450
300	25,500	18	400

Polyphase Motors.—Fig. 2 shows very clearly one of the latest type of Westinghouse polyphase motors. As will be noticed, there

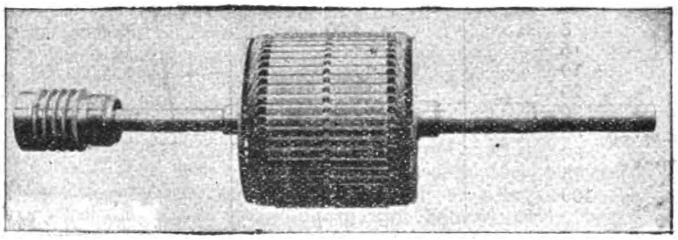

Fig. 1.—Two-phase Generator Armature with distributed winding.

is no external controller or rheostat. The revolving primary is wound very much the same as a direct-current armature, and is supplied with two-phase currents through three collecting rings, the four leads to the winding being taken off inside the rings. The stationary secondary is built up of laminated ring punchings held in position by a circular cast-iron yoke. Instead of distinct pole-pieces and exciting coils, the winding of the secondary element is "distributed," as it is thought that this type of field gives much better results than any other that can be used in a polyphase motor. The windings are connected together through small resistances which are short-circuited after the motor has got under way by throwing the handle of the short-circuiting switch projecting

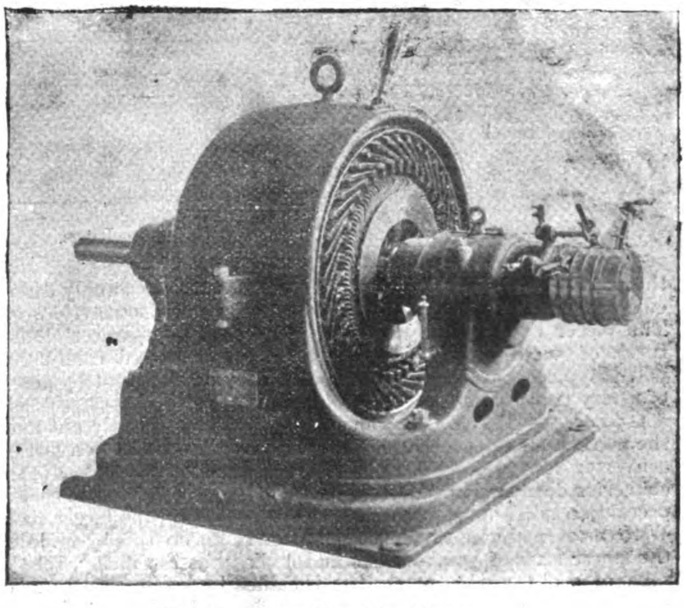

Fig. 2.—40-h.p. Two-phase Motor.

from the top of the yoke. The resistance is necessary in order to insure the large starting torque usually required, and to cut down to a minimum the starting current. Some motors of smaller size which do not require a starting resistance are built with a stationary primary and revolving secondary. In the motor illustrated in Fig. 3 there are no collecting rings on the shaft, the revolving secondary windings being short-circuited on themselves. The current is introduced through stationary windings to the stationary

* Abstract from the *Electrical World* of New York, to whom we are indebted for the blocks illustrating our abstract. Article I. appeared in our issue of July 5th, and Article II. in our issue of August 16th.

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primary. As these motors have no resistances in the secondary windings to be cut out of circuit after starting they are not equipped with any short-circuiting device.

The following is a list of the standard machines at present manufactured by the Westinghouse Company :—

Two-phase Motors.

1,500 periods. 200 or 400 volts.

Rating.—Brake H.P.	Weight.—Lbs.	Speed.—R. P. M.
3	600	750
5	800	750
10	1,000	750
20	1,500	750
25	2,000	750
30	2,500	750
40	4,000	750

Two-phase Motors.

3,600 periods. 200 or 400 volts.

Rating.—Brake H.P.	Weight.—Lbs.	Speed.—R. P. M.
3	600	1,800
5	800	1,200
10	1,000	1,200
20	1,500	1,200
30	2,000	1,200
40	2,500	1,200
50	4,000	900
75	6,000	900
100	8,000	720

Rotary Transformers.—These machines (*see* Figs. 4 and 5) are built like multipolar direct-current machines, except that they have collecting rings on the other end of the armature. A number of

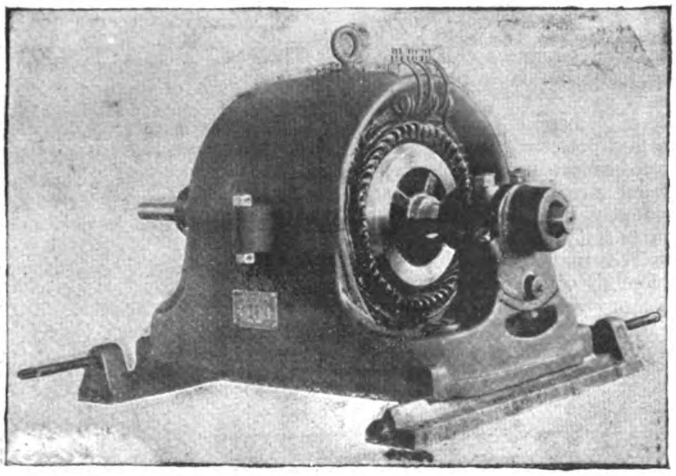

Fig. 3.—5-h.p. Two-phase Motor without Collecting Rings.

these machines are being installed at Niagara to supply direct-current, such as required for field excitation and electrolytic work. The power used by the Pittsburg Reduction Company, manufacturers of aluminium, at Niagara Falls, is transformed from 2,000-volt polyphase currents into low potential direct-current by means of rotary transformers.

Converters.—The Westinghouse Company has recently put upon the market a new type of converter. It is a well-known fact in converter design, that the ratio of radiating surface to the loss in the converter decreases rapidly as the size is increased, so that special precaution must be taken against undue heating in the larger sizes. With most manufacturers it is customary to do this by building the larger sizes of great weight and bulk, thus sacrificing, for the sake of cool running, much that is gained by an increased size of unit. A method for overcoming this difficulty has been devised by the Westinghouse Company. It consists in increasing the radiating surface of the converter, by spreading the coils, outside the iron, at the ends of the converter. The coils of a converter are shown in Fig. 6, and the spread of the coils is easily seen. Greater radiating surface, however, was not the only consideration which led to an increase in the number of coils, for other distinct advantages, both electrical and mechanical, are gained by this subdivision. Electrically, the chief feature consists in the fact that the magnetic leakage is so reduced that the inductive drop, which might otherwise be enormous, becomes practically negligible. The mechanical advantages are that the voltage on each coil is reduced in proportion to the number of coils, making it correspondingly easier to insulate each coil from the others; and the shape of the coils is such that the voltage between adjacent layers is reduced to a minimum, reducing in like proportion the chances or a short-circuit within a coil. All converters of the standard line are provided with a combination block, so arranged that any converter may be

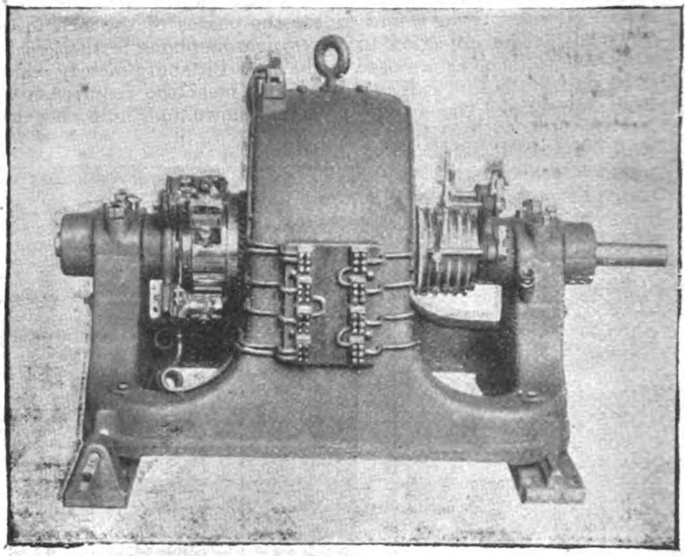

Fig. 4.—10-h.p. Rotary Transformer.

connected for a primary voltage of either 1,000 or 2,000, and for a secondary voltage of either 50 or 100. Fig. 7 illustrates a 100-kilowatt converter built for the Cataract Construction Company at Niagara Falls. The converter is designed to run in oil and is kept cool by the circulation of water through a coiled pipe immersed in the oil. By regulating the flow of water the temperature may be kept down to almost any desired value.

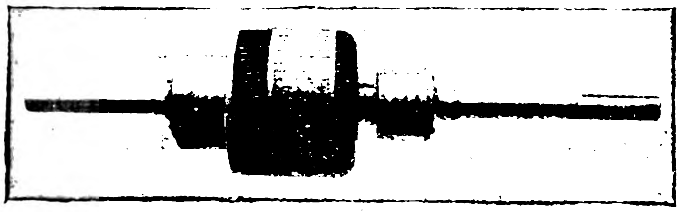

Fig. 5.—Rotary Transformer Armature.

Shallenberger Wattmeter.—The new Shallenberger alternating-current measuring instruments were described in *The Electrician* of January 25th, when the patents were first issued. Since that time a number of instruments have been built for the Niagara installation, and some slight modifications and improvements have been introduced.

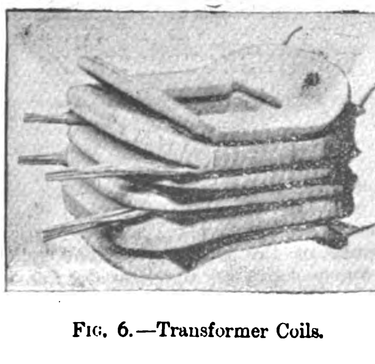

Fig. 6.—Transformer Coils.

Synchronoscope.—When throwing alternating-current machines into parallel it is necessary that the maxima and minima of the E.M.F. waves of the different machines shall be in unison, otherwise the difference of potential will result in an abnormal rush of current and consequent liability to injury to the machines or the

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windings. For the purpose of determining whether the generators are in multiple, before closing the switch which throws the machines together it has been customary to use incandescent lamps. The objection to lamps has been that the carbon remains incandescent for a short time after the flow of current has ceased, and thus, if the operator waits until the lamps are extinguished, he throws the switch a little too late for perfectly synchronising the machines. In order to know the exact instant at which the generators should be thrown in parallel, the Westinghouse Company some time ago brought out a synchronophone or phase indicator, an instrument which gives a buzzing sound unless the phases of the machine are the same. The objection to the synchronophone is that, on low alternations, such as are used at the East Pittsburg factory and the Niagara installation, it is inaudible. To meet the requirements of low alternations the synchronoscope, shown in Fig. 8, has been developed. It consists of a high resistance coil about a laminated horseshoe magnet, between the poles of which is a small Z-shaped piece of iron normally held by a spring in such a position as to be least effectively magnetised. When there is no current flowing between the machines the needle stands at zero; when there is a difference in phase between the alternators the difference in E.M.F. causes a slight flow of current around the magnet, which deflects the needle. When two machines are connected in multiple through the synchronoscope, the needle will vibrate back and forth, having a periodicity of greater and greater duration, as the machines come more nearly in step. By watching the swinging of the needle the switch may be closed and the machines thus thrown in multiple when the needle is exactly at zero, thereby avoiding even the slightest disturbance of the ammeters. The synchronoscope is designed for use on the secondary of a transformer.

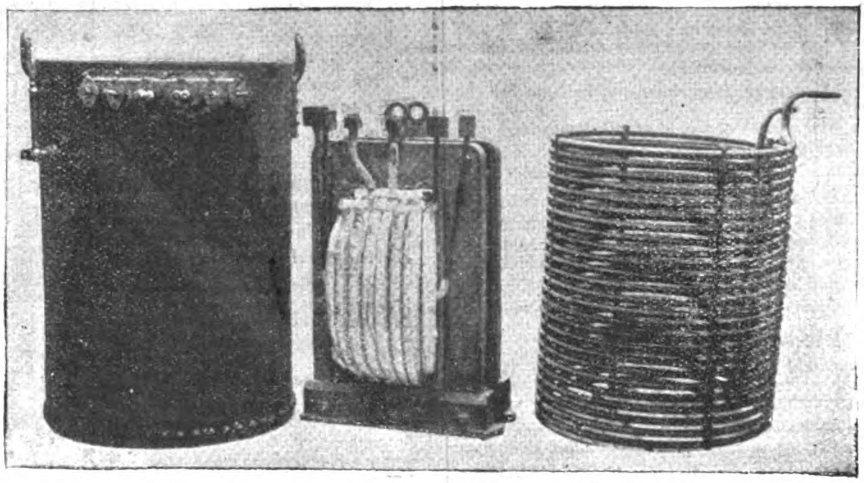

FIG. 7.—100-K.W. Oil Transformer (Niagara).

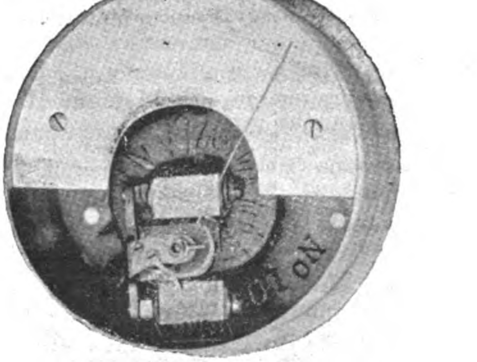

FIG. 8.—Synchronoscope.

New Railway Motor.—A new single reduction series motor of 50 H.P. has just been brought out by the Westinghouse Company to meet the requirements of greater speed or heavier work. It is the same motor that is being used by the Pennsylvania Railroad at Mount Holly, N.J., in its experiments with high-speed electric cars. The novel features are the use of a cast-steel yoke with laminated pole-pieces and a ventilated armature. The motor is entirely encased, and thus made water and dust-proof. It is intended to be used with any one of three sets of gears having a ratio of 1 to 4·86, 1 to 3·44 and 1 to 2·3, and intended respectively for slow-speed freight and snow-sweeper work, city passenger traffic or suburban high-speed service. The very symmetrical and simple form of ventilated armature winding is clearly shown in Fig. 9. The use of air passages parallel to the shaft, in the core, results in an efficient and at the same time very cool running armature. The motor is designed to be suspended by a single spring under the "nose" or lug projecting from the circular yoke, or, as the Westinghouse people prefer, by bars which pass through supports on each side of the motor and have their ends supported on springs.

Economy Coils.—Recent improvements in the construction and regulation of constant-potential arc lamps have wrought considerable change in the methods of arc lighting. The advantages gained in an arc lamp which may be operated from either lighting or power circuits, which may be turned off and on independently of other lamps, and which operates at low potential, make clearly apparent the reasons for the popularity and widespread use of constant and potential arc lamps. On direct-current constant-potential circuits, arc lamps are usually operated in a series of two or more in connection with a small resistance. On alternating-current circuits it is customary to operate each arc lamp independently, by the use of some type of transformer. This method insures complete and unrestricted control of every individual lamp. The Westinghouse Company has brought out what they call an "economy coil" to take the place of the comparatively expensive and more complicated arc lamp transformer. Each coil consists of an iron core having a winding of copper wire, the terminals of which are connected to the constant-potential circuit. At different points in the winding connections are brought out and form terminals, to which the arc lamps are attached. When all the lamps are turned off the coil acts as the primary of a converter, which has its secondary open-circuited, and no current flows. When one lamp is turned on the choke coil effect is reduced by one-third the total amount, and some current flows through the lamp circuit. When a second lamp is turned on the choke coil effect is still further reduced, and when three lamps are in curcuit the economy coil may be considered as practically cut out, and the potential as being applied directly to the three lamps in series. Thus, it will be seen that complete and independent control is secured as satisfactorily and more economically than if a separate converter were installed for each lamp.

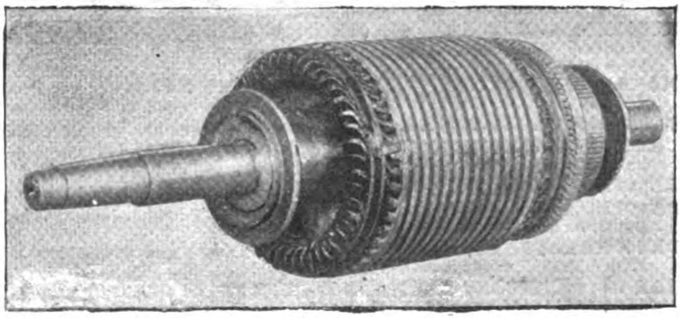

FIG. 9.—Railway Motor Ventilator Armature.

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The Electrician.

The Oldest Electrical Journal, 1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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THE DEVELOPMENT AND UTILISATION OF THE ELECTRIC FURNACE.

The energy manifest in an ordinary arc light is of such a character and disposition as to suggest to the least thoughtful mind the possibility of its utilisation as an instrument of research and as a weapon of industrial advancement. Such is its simplicity that a casual observer might indeed assume that the application of the electric arc as a means of heating, in all cases where the game is not too trivial to be worth a costly candle, is only a matter of the merest detail. The fallacy of this assumption is, however, sufficiently indicated by the admirable collection of facts concerning early and recent types of electric furnace which we publish in another column. A reference to the translation referred to will show that, although the fundamental idea of boxing up an arc to check loss of heat by radiation, convection, and conduction is common to most of the forms of furnace which have attained even the modest honour of a place in a patent specification, yet the ways in which this common idea is carried out are, to speak metaphorically, as the sands of the sea shore. For a detailed description of the various forms of furnace which have been favoured by inventors, reference to the article in question must serve, but there are several points upon which it may be profitable to enlarge.

In the case of the well-known Cowles furnace — that standard refuge of the destitute illustrator—the original idea occupying the minds of its inventors appears to have been the fascinating notion of reducing zinc by internal heating of the retort charge. In the manufacture of zinc, as now conducted chemically, a mixture of zinc oxide and carbon is heated to a high temperature in a horizontal retort of refractory fire-clay and moderate dimensions. Seeing that the reduction of zinc oxide by carbon involves an endothermic reaction, large quantities of heat must perforce be transmitted through the walls of the refractory retort at the cost of much consumption of fuel and considerable wear and tear. The early COWLES' attempt (it dates from 1885) therefore exhibits a complete grasp of the inherent advantage of electric heating

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as distinct from older and clumsier methods. The whole subject from this aspect has been amply dealt with in these columns within the last few years, and it is unnecessary now to do more than cite the example afforded by the Cowles patent as an indication of the direction in which the better class of inventor will prefer to work. It is needful for clearness of thought to preserve a sharp distinction between furnaces which are heated by electrical energy, but in which electrolysis is not intentionally performed, and those in which the execution of electrolysis is the primary object of the apparatus, and the heating of the contents of the vessel, into which the electrodes protrude a secondary and almost accidental concomitant. Cowles' furnace for the production of aluminium-copper alloys is a type of the electric furnace proper, and the Héroult apparatus is an example of an electrolytic cell having an electrolyte maintained in a state of fusion by a portion of the current passing through it. A practical and satisfactory method of discrimination consists in considering whether any given furnace the title of which is debatable can be fed with an alternating current. In 1888 and succeeding years there was a sudden activity in the application of the electric furnace proper to the performance of many chemical reactions which needed either much heat or a high temperature for their occurrence, and were normally conducted in closed vessels. Such were the methods of making phosphorus and carbon disulphide devised by Messrs. Readman, Parker and Robinson. Little has been heard of any of these hopeful attempts, save that which had phosphorus as its intended product. With regard to this it has been currently, though not formally, stated that the process proved entirely satisfactory, was bought for a substantial sum, and was forthwith relegated to limbo, those manufacturers who had a practical monopoly of the trade considering apparently that phosphorus was quite as cheap as is good for us. Until the year before last, no serious attempt seems to have been made to control the distribution of heat in an electric furnace in such a manner as to cause it to be uniform throughout the object or charge to be heated. Messrs. Street and Girard, by taking advantage of the dirigibility of the electric arc by a magnet, succeeded in presenting the arc which performed the heating, successively and rapidly to the object under treatment. The details of the arrangements contrived by these inventors will be found duly described in the Paper already adverted to. The command thus achieved over what is, under common conditions, a somewhat violent and spasmodic heating agent, has done much to render possible the application of the electric furnace to uses of a kind differing widely from those for which it has hitherto shown a limited adaptability. To turn a current into a firebrick box and subsequently empty that receptacle with the comfortable certainty that at least something will have happened to its contents if enough energy has been spent in its interior, is one thing. To carry out the delicate operation of baking carbon for use as electrodes, is quite another. The latter operation can only be successfully performed when the current can be controlled and the temperature of the furnace kept uniform throughout.

The development of the electric furnace has now reached a stage in no way sensational, but giving excellent promise of industrial utility. As yet, electrical heating is too costly to be indiscriminately used. Its applications are of necessity confined to those cases to which it does something that can be performed in no other way, or at least can only be accomplished with an inferior result. For arc lighting or for electrolysis the increased value of carbon, which has been baked at an exceedingly high temperature, is generally recognised. Much mystery has been maintained concerning the manufacture of carbon electrodes, but it is tolerably safe to say that no good product can be obtained without prolonged and vigorous heating. Of all forms of carbon, graphite is that which tends to persist as the temperature is raised; the diamond and charcoal are equally transformed into it. A half-recognition of this fact, coupled with a well-founded belief in the comparatively good conducting power of graphite, has led to the incorporation of this material into the carbonaceous masses destined to be moulded and burnt for electrodes of all classes. But graphite in its commercial form consists largely of clay, and its purification is somewhat tedious and costly. Indeed, it is pleasing to speculate whether most carbon makers have been alive to this necessity; regard being had to the amount of ash in some carbon electrodes, it seems possible that such drawbacks may have been overlooked. As an addendum to our knowledge of the tendency of carbon to assume the graphitic state on exposure to high temperatures, it has been recently shown that at the highest temperature attainable in an electric furnace, all substances other than carbon are dissipated and removed, with the result that the ends of the electrodes are not only graphitic but are also sensibly pure. It follows that a carbon plate or rod, of dense graphitic structure, good conductivity and unusual freedom from impurity, should be producible by exposing the ordinary moulded article to the temperature of the electric furnace. This is precisely the direction in which Messrs. Street and Girard have been working. They claim to have succeeded in producing a form of carbon, the conductivity of which is fourfold that of the untreated material, while its resistance to chemical action is also much enhanced. Taking the density of an ordinary carbon before heating as 1·98, they find that after treatment it has attained a density of 2·6. Should this figure be corroborated, it must be considered remarkable, inasmuch as the density of graphite obtained by ordinary means is not higher than 2·3, while the same figure has been observed as a maximum for hard gas carbon. Analysis of the carbons thus made indicated that the percentage of carbon transformed into graphite was about 80 to 85 per cent. The method of analysis is, however, by no means beyond criticism, depending, as it does, on the conversion of the graphite into the highly indefinite body known on the *lucus a non lucendo* principle as graphitic acid, which in no way resembles graphite, or comports itself as an acid. This point, however, may safely be left for future settlement. The precise percentage of graphite is not of moment provided a product has been obtained possessing many of the properties that would be exhibited by a sound coherent block of that form of carbon. When once criticism is allayed by the appearance, in a marketable form, of carbon which is nearly free from other elements than C and neither oxidises easily nor irregularly, nor breaks up when used as an anode for aqueous or igneous electrolysis, an ample field of application will at once be open. To take one of the most pressing cases alone: it is notorious that next to the want of a good diaphragm the most urgent need of those interested in commercial electrolysis has been a reliable unattackable anode. Hitherto the makers of moulded carbons have conspicuously failed to meet this want, and who shall say that it is not to the steady demand for retort carbon that the grossly inflated dividends of the gas companies are mainly due? In all seriousness, this latest application of the electric furnace marks, in virtue of its soundness of aim and seeming success, a hopeful epoch in a particular branch of electrical enterprise, which has until now suffered from over sanguine expectations rather than from indifference and neglect.

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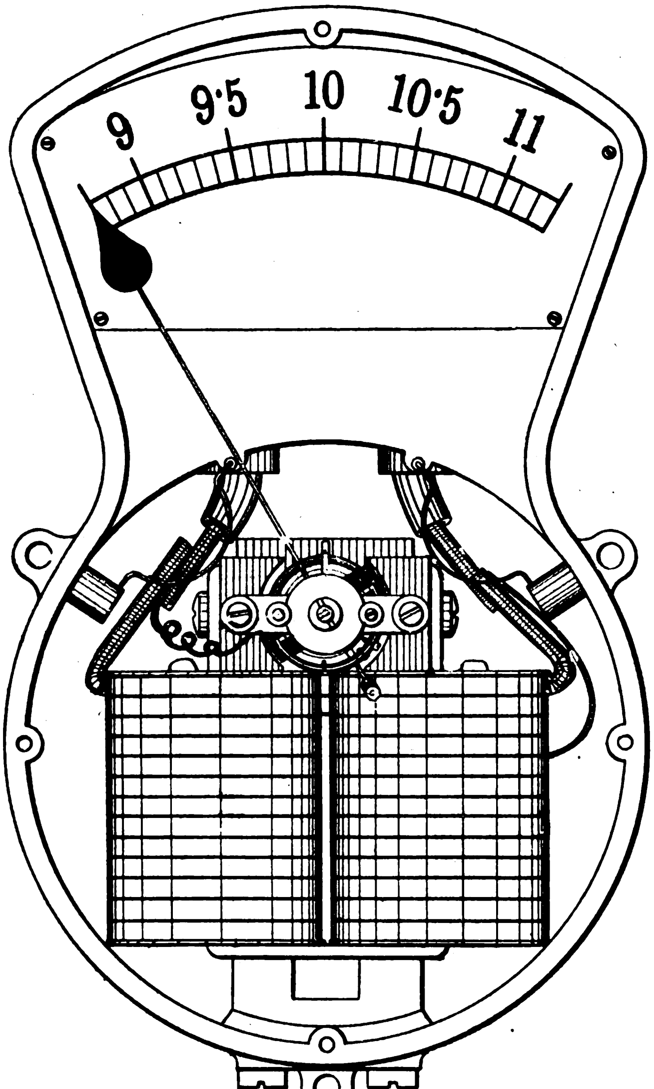
WESTON ARC-LIGHT CIRCUIT AMMETER.

The accompanying illustration represents a Weston arc-lamp ammeter, intended for use on constant-current continuous-current arc-lamp circuits. In the United States the extent to which this type of instrument is used is shown by the fact that one single American arc-lamp station has recently been supplied with 115 current gauges of this make.

The instrument consists of a moving coil carrying a pointer, which is lightly pivoted and kept at the starting end of the scale by means of two oppositely-wound spiral springs, through which the current leading to the suspended coil is passed. The permanent magnet of the ordinary pattern Weston instrument is, in the case of these instruments, replaced by an electromagnet, through the coils of which the main current of



View of Weston Arc-Light Circuit Ammeter with case removed.

the circuit is passed. The core of this electromagnet is of small section, so that it is practically saturated from the start. The moving coil is connected as a shunt across the terminals of this electromagnet coil, so as only to carry a very small proportion of the total current. By setting back the zero of the instrument, as it were, so as to be far beyond the left-hand side of the scale, and by employing a fairly weak spring, put under considerable initial stress, the needle is not moved from rest until a current of a very few per cent. lower than that necessary to bring the pointer to the centre of the scale passes through the instrument; hence a very small variation from the standard current, whatever it may be, is readily noticeable. A small polarised indicator shows a red or white disc behind a small circular window in the front of the case, and this serves to show whether the circuit has been connected up in the right direction, which is often of considerable use when connecting up a new arc-lamp circuit.

This ammeter, together with other instruments on the Weston principle, is being placed on the market by Messrs. Elliott Bros.

THE NANTASKET BEACH BRANCH OF THE NEW YORK, NEW HAVEN AND HARTFORD RAILWAY.

The first application of electric traction to a standard steam road was made on this line, and as it embodies some novel features, we give in the following a short description of it, the details of which we quote from the *Street Railway Review* of New York. The Nantasket beach railroad extends along a narrow peninsula, one side of which is known as Nantasket Beach. The length of the road is 6·91 miles, and of this there are 4·4 miles of curves in about 20 curves, the sharpest being one of 10deg. The line is almost level, the only grade being one of about 34ft. to the mile. The track is laid with 70lb. rails, with 15ft. space between the track centres, and the ballast is of stone. Each joint is bonded with a flexible bond of stranded copper, 7in. long, riveted into the flange of the rail. There are at present 10 stations, but others will be built to allow of stops about every quarter of a mile. The overhead trolley line is carried upon wooden poles set between the tracks. These poles are 30ft. long, 12in. by 14in. at the butt, and 10in. by 10in. at the head; and are set at intervals of 60ft. and 70ft. on the curves, and 90ft. on the straight track. At the cross-overs the posts are 180ft. apart, and side posts are used carrying a light iron truss over the track. The top of each pole is fitted with a cast-iron grooved cap, the grooves of which carry the six bare copper feeder cables. The poles are set in wooden boxes filled with concrete. The trolley wire is of unusual shape, being something like a figure 8 in section, and weighs 1lb. per foot. The lower surface is almost flat, and provides a large contact surface for the trolley wheel. This form has been given to the wire to permit of a more perfect attachment to the hangers, and to prevent the trolley from jumping when passing them. The brackets of two angle irons are bolted across the centre poles, and bent and bolted together at the ends. They are kept in position by an iron truss running through the cap. Each hanger is a double hanger, and gives an excellent support for the wire. The power plant is similar to other large modern direct-connected stations. The two generators are direct-driven General Electric 10-pole machines, having the armature spider keyed to the engine shafts. They are wound for a pressure of 600 volts at no load and 700 volts at full load, and are rated at 500 kilowatts at 100 revolutions per minute. The fields are of cast steel, and the armatures are of the "iron-clad" type, each winding being insulated, and then embedded in an insulated slot in the laminated iron armature body. The motor cars are of two types, the closed and the open. The closed cars are heavy baggage cars, and four are already equipped for service. The open cars resemble the familiar city trolley car, but have a flight of three continuous steps or foot boards. The closed motor cars are 42ft. long over all, and are built extra heavy, weighing each when fully equipped over 30 tons. Two of the four will have two motors on one truck, while the two others will have four motors, two on each of the two trucks. The open motor cars will have two motors. The motors used are of the General Electric type, especially designed for heavy work, and are similar to those in use on the Metropolitan Elevated Railroad in Chicago. The motors are 100 H.P. each, or 2,000lb. horizontal drawbar pull through a 33in. wheel. The current is brought from the trolley wires by a trolley wheel having an extra deep channel.

There are two controlling gears on each car. Immediately to the left of the controller is the air-brake handle. The compressed air for the brakes and whistle is furnished by an oscillating cylinder air compressor operated by an electric motor, which is controlled by a special automatic rheostat which regulates the action of the motor in accordance with the pressure in the tanks. A magnetic cut-out is also provided for the air-compressor motor. In the case of the closed cars the air pump is set just within the door. In the open cars it stands on the platform to the extreme left of the motorman. Behind the motorman and just under the hood is the car cut-out, which in this case is an automatic circuit breaker. A feature of the line construction is the system of interlocking switches, by means of which the overhead switch is thrown at the same time as the track switch. The line was opened for traffic on June 30th, and it is claimed that during the tests motor cars alone have been run as high as 80 miles an hour. A party of officers visited the road just before opening, and J. C. Sanborn, division superintendent, surprised the party by sending a train of 40 loaded gravel cars hauled by one four-motor car 40 miles an hour past the visitors.

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SNAEFELL ELECTRIC TRAMWAY.

A little over a year ago an electric tramway between Douglas and Laxey was opened and has since proved a success in every way. Almost before this undertaking was completed an electric line to the summit of Snaefell was contemplated, and this line is now an accomplished fact. On Friday last the line itself was inspected by Col. Rich, R.E., and the electrical equipment by Major Cardew, R.E., both of whom expressed complete satisfaction with what they had seen. Snaefell is the highest peak on the Isle of Man, its summit being over 2,000ft. above the sea. A survey of the route was made by Mr. Fell, the engineer to the Company, which showed that a road could be run to the top of the peak with an average gradient of 1 in 12. A rack railway was possible, but the Company preferred to that system one proposed by Mr. Fell. Between the bearing rails a centre rail of greater strength has been laid down, this third rail being raised somewhat above the level of the outer ones; runners are placed on the bogies which clutch this rail horizontally. A gripper brake is also added, which, when necessary, seizes the central rail firmly and comes to the aid of the ordinary brakes. The contractors for the line were Messrs. Mather and Platt, of Manchester, the work being generally superintended by Dr. Edward Hopkinson, and on the spot by Mr. Willis. Mr. Herd, of Douglas, had the contract for laying the road; Messrs. Cammell and Co., of Sheffield, supplied the rails, the bearing rails being steel and 50lb. to the yard, and the central rail 65lb. to the yard. The gauge of the line is 3ft. 6in.

The generating station is situated midway between the two terminuses, and contains four Lancashire boilers and five horizontal compound engines of 100 H.P. each, each driving five 55-kilowatt shunt dynamos at a speed of 800 revolutions. These dynamos generate current at 550 volts pressure, and have magnet limbs of well-annealed cast steel. The generating plant is sufficient to run four or more cars, each loaded with 48 passengers, simultaneously up the line at a speed of 8 to 8½ miles per hour under normal conditions. In addition to the dynamo station there is an accumulator station at Laxey, which is equipped with a battery of 240 "chloride" accumulators. The overhead conductor consists of No. 0 B.W.G. hard-drawn copper wire, the wire being carried upon insulators supported in clips attached to cross-arms from steel poles; the return is by the rails, which are copper bonded. The Company has at present six cars of the open-air type, similar to those used on the Douglas-Laxey line. In addition to powerful brakes these cars are fitted with sanding arrangements. On each car there are four No. 5A Manchester motors, one being fitted upon the axle of each bogie. The motors are geared with single reduction steel gearing with pinion and wheel, and fitted with carbon brushes, the working parts being suitably boxed and protected. In the driver's cabin at either end of the car there is an emergency switch and ammeter with a suitable resistance for regulating speed and for use in stopping and starting; these are so arranged that the driver can always stand in the front cabin. Current is collected by means of two bar collectors.

AN ELECTROMAGNETIC EFFECT.*

BY F. W. BOWDEN.

Some time ago, under the direction of Prof. Perry, I was making some experiments suggested by Dr. Larmor. The following curious observations were made, and as Dr. Larmor thinks them distinct from his own object, I beg leave to bring them before the notice of the Physical Society. In Fig. 1, N and S are nearly cubical blocks of iron whose edges are about 6cm. long, forming the poles of an electromagnet. The field between N and S near the middle was about 1,100 C.G.S. A is the end view of a glass tube, 4mm. internal diameter and about 30cm. long, containing mercury and connecting two large mercury troughs, and a current of about 40 amperes was sent through it. A standpipe, B, 2mm. diameter, indicated the pressure of the mercury. When the current passes in one direction (out from the paper) the mercury rises 15mm. in B. When the current is reversed, the mercury falls 15mm. Reversing the magnetic field produces the same effect as reversing the current.

With the tube in the position shown in Fig. 2, the effects were of the same kind, but not so marked, the rise and depression being about 10mm. As the tube was lifted more and more out of the field, the effects became less and less.

The field being vertical, as in Fig. 3, the mercury *rose* in the standpipe when the current passed, and in whatever direction the current passed; reversing the current did not reverse the pressure-effect produced. Also reversing the field did not reverse the pressure-effect produced.

* Communicated by the Physical Society to the *Phil. Mag.*, August, 1895. A brief abstract appeared in our issue of July 19th, p. 397.

I again used a horizontal field, as in Fig. 4, the standpipe showing now the side pressure in the tube parallel to the field. It was my intention to let Fig. 4 really represent Fig. 3 turned through a right angle, and again the mercury always rose in the standpipe, whatever the direction of the current or field.

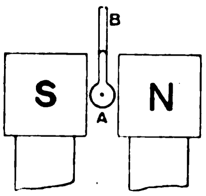


FIG. 1.

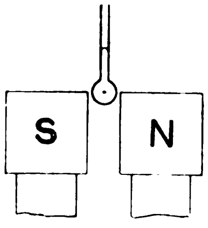


FIG. 2.

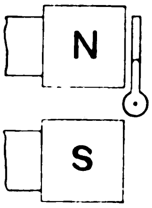


FIG. 3.

Lastly, I let four standpipes communicate with the middle of the tube. The current passing in one direction, the mercury in B rose, in C fell, and in A and D rose only momentarily during the starting of the current. When the current was reversed, the mercury in B fell and in C rose, and rose momentarily in A and D.

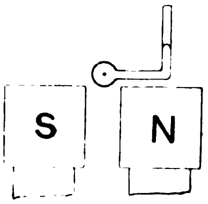


FIG. 4.

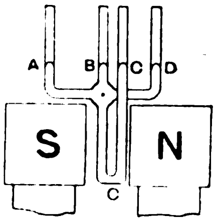
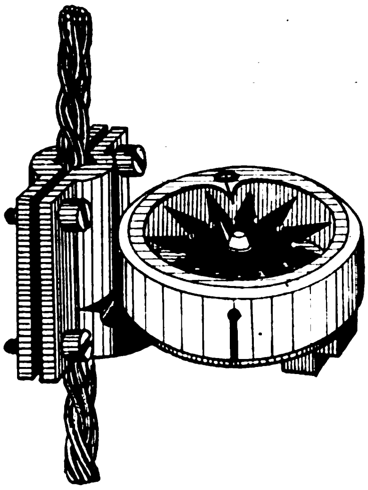


FIG. 5.

The non-reversible effects of Figs. 3, 4, and in the tubes A and D of Fig. 5, are probably due to curious motions of the mercury, but it seems difficult to understand how. They do not occur when the tube is far away from the magnetic field.

A LIGHTNING INDICATOR.

The accompanying illustration represents an instrument for the indication of lightning, and was invented by Herr Zielinski, of Berlin. It has, according to the German technical papers, been thoroughly tested by the German Imperial Post Office, and is now



employed at different post offices in Berlin, Munich, &c. The new House of Parliament at Berlin is also provided with several of these instruments. The arrangement of the instrument is very simple. In a glass-covered brass case a star-shaped compass needle swings on a steel point. The case itself is fixed to a bracket, which has a clamping arrangement at one end to allow of the whole apparatus being clamped to the lightning conductor. The magnetic star will set itself in the direction of the magnetic meridian, and when first erecting the instrument the red mark of the needle, or the point of the star opposite, should point towards the lightning conductor. The cover should so be put on that the pointer thereon occupies the same centre line as the red mark of the needle. If lightning

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strikes the conductor, the magnetism of the needle is disturbed, and the needle becomes newly magnetised in the direction of the lines of force of the discharge. Under the influence of the earth's magnetism, or of that of the conductor itself, should this be of iron, the star magnet will settle down in a new position. A deflection of the needle is taken as evidence that lightning has struck the conductor. The pointer on the cover should afterwards be readjusted—that is to say, made again to cover the red mark of the needle. The instrument is then ready to indicate another discharge. It is interesting to note that this instrument, it is claimed, is only affected by lightning, heavy continuous or alternating currents passed through the conductor failing to influence it.

ELECTRICAL SUPPLY AT 230 VOLTS.*

To drive a coach-and-four through an Act of Parliament is generally an attractive performance, and a sporting metaphor is well applied to a feat which in itself is a deed of daring. From the small boy who darts between a policeman's legs on Lord Mayor's day, to some European Power who cleverly evades a treaty, the successful defiance of constituted authority has ever a peculiar interest. An active imagination, however, is needed to detect any sporting element in the recent achievement of the late electrical engineer to the Corporation of Bradford. Electrical supply in this borough was originally laid out, as our readers may remember, on extremely conservative lines. A simple two-wire system of conductors was used, and the only originality about the design was the use of 115-volt lamps. The five volts addition to the 110 volts, which was then the highest in ordinary use, did but little to extend the very inextensible system of distribution; but probably the inconvenience of a voltage peculiar to this town was hardly felt by the purchasers of incandescent lamps, since, of course, the local agents and dealers kept this kind of lamp in stock for the use of Bradfordians. The designer of the Bradford electric supply always argued that, so far from being utterly antediluvian, the system could be indefinitely extended, though whether by battery stations or by connecting districts in series or by dynamotor transformers was not disclosed. When at last something had to be done to meet the increased demand for electric supply, a five-wire system of mains was suggested. This was not carried out; but a three-wire system was constructed, the consumers, of course, enjoying their 115 volts as before. In the original system the dynamos, generating a trifle more than 115 volts, maintained this pressure between the two conductors. When the third was laid, electrically, if not actually between the first two, a difference of potential of 115 volts was maintained between each of the old outer conductors and the new middle one, one of them being 115 volts higher and the other 115 volts lower than the third or middle wire. The same dynamos, of course, sufficed, and were in effect coupled in pairs in series, the middle conductor being joined to the point between them. The consumers were all connected to one or other of the outer conductors and to the middle one. This constitutes what is known as the three-wire system. But so excellent is the service, so cheap the rate, so economical the management of the station, that the mains soon became overloaded again. To step from three-wire to four-wire would give but little relief compared with the great expense of laying another main, and altering the service connections, and something more had to be done, not only for the outlying districts, but for the very heart of the town.

In the meantime the art of lamp making, once sacred to Ponder's End, had been thrown open, and for every new manufacturer there sprang up half-a-dozen agents, mostly German, who sell unbranded lamps under various names. It was at one time thought that it would be a wise policy—though we are not aware that it was ever carried out—for a lamp maker to confine his attention and concentrate his skill upon 8 candle and 16 candle 100-volt lamps, but it now appears that Continental makers are ready to attempt to make almost anything that is asked of them, if only they can effect sales. The 8-candle 100-volt lamp was a long time in making its appearance. The monopolist company was no doubt right in declining to sell an untrustworthy lamp, lest it might spoil the reputation for good work which it was carefully building up, against the time when its patents should be valueless and its goodwill its best asset. But the art has slowly developed, and 4 c.p. or 5 c.p. lamps for 100 volts are possible. Multiple filament lamps have been used for very large candle-power, the filaments being in parallel, and being, in fact, merely a bunch of lamps in one globe. Double filament lamps have also been made for alternative use as 8 c.p. or 16 c.p., and, of course, when the manipulative skill in making such lamps has been acquired, it is just as easy to couple the two filaments in series. Take two 8 c.p. 100-volt filaments, mount them in series in a bulb, and you have a 200-volt lamp. We have observed that the fashion at Bradford, as dictated by the consulting engineer, is 115 volts. To make a good 8 c.p. 115-volt lamp is more than 15 per cent. harder than to make an 8 c.p. 100-volt lamp; but it can be done, though 8 c.p. lamps are not encouraged at Bradford. In short, within the past few months practicable 230-volt lamps have been made. Some have been sad failures, and we understand that the Edison-Swan Company declines to recommend them.

* From the *Engineer.*

To change from 115 volts to 230 would be a grand step, but the present consumers would not make the change to suit the convenience of their highly-respected Corporation. New customers who continue to apply for current can be dictated to; but it is not worth while to lay another set of mains for them, and any interference with the existing mains seems impossible, for what saith the Provisional Order? "The 'standard pressure' shall be fixed by the undertakers for every main, and shall not be altered except after notice to the Board of Trade, and upon such terms and conditions as the Board of Trade may impose, and after public notice has been given during a period of one month in such manner as the Board of Trade may require of the intention of the undertakers to alter the same." The coach-and-four feat is generally preceded by a careful scrutiny, resulting in the discovery of a minute crack, or, as it is sometimes called, a loop-hole. Turning back to the definition of a "main," we find that "The expression 'main' shall mean any continuous metallic conductor which may be laid down by the undertakers," &c. Let us leave electricity for a moment, and consider an analogy. Suppose the Board of Trade, wishing to define the gauge of a railway line, had ordered, "The 'standard gauge' shall be fixed for every line, and shall not be altered except after notice," &c. Somebody declares his "standard gauge" shall be 4ft. 8½in., and he will have two lines with a 6ft. way. The Board of Trade never mentions lamps in Provisional Orders, and we will imagine that in these railway regulations they never mention carriages. Suppose our friend wants to run a really comfortable saloon-palace car, and would like to use a gauge of about 16ft. Is there anything to prevent him? Certainly not. He builds a car to run on the two outer rails. Somebody looks up the definition of a "line," and finds that "The expression 'line' shall mean any continuous metallic rail which," &c. The late electrical engineer to the Bradford Corporation has hit on precisely the same device, which he will no doubt shortly introduce in his new sphere at St. Pancras. With the fear of a daily penalty of £10 before him, he has not altered the electrical pressure between any of the conductors, two of which, by the way, go to make up a main. The definition of the Board of Trade took it for granted that there must be two conductors, and it is to be noticed that when the third wire was laid at Bradford—a thing not contemplated in this Provisional Order—no regulation was infringed, no pressure was altered; everybody continued to use 115 volts, and to-day the old consumers continue to do so. But the new consumers, including all those who have been connected during the past few months, have no choice but to take 230 volts. They are not permitted to make use of the negative and the middle conductor at 115, or the positive and the middle conductor at the same pressure, but are connected on to the "outers," and now, without laying a yard of new main or raising the voltage in the station or elsewhere by so much as a steel knife and silver fork will generate when plunged into a beefsteak, Bradford can point to anything but an antediluvian system of continuous-current supply at 230 volts. Had the Provisional Order spoken of a standard pressure between the two conductors which constitute any given main, there might have been a little difficulty. There is nothing in the Parliamentary powers of the Corporation to prevent the use of this high pressure. The Bradford Order of 1883 permitted 200 volts, and the regulations issued in 1890 varied this to 300 volts, but did not allude to the three-wire system or to 115 volts. A new main with two conductors, having a difference of potential of 300 volts between them, might be laid any day; indeed, in the definitions of the regulations, "a low-pressure conductor shall mean any conductor in which the pressure between that conductor and the earth cannot at any time, if continuous, exceed 300 volts." So, if earthing the middle wire were practicable, there might be a difference of 600 volts between the "outers." The feat has been to use for service purposes a higher pressure, and yet to avoid making any change of the "standard pressure" on any main.

And what is the outcome of this achievement? We have only to turn to the advocates of alternating currents to learn the great economy of copper when high pressure is used. At Bradford the time is already talked of when a 230-volt three-wire system is to be general, that is, 460 volts between the "outers." Before that day, no doubt, the Board of Trade will be approached; for even if the whole generation of 115-volt consumers perish, their heirs, executors and assigns will want light; and unless the pendulum swings again, and the Board of Trade is swept away with other excrescences of a decayed Constitution, the Provisional Order confirmed by 46 and 47 Vict., Cap. CCXX., will remain in force. But to-day the Bradford Corporation relieve the congested current density in their mains. The new consumers who insist

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on enjoying the municipal electric supply—as should all good ratepayers—must be connected, and in thus connecting them, they add only half the current burden to the conductors, and the £26,388 worth of mains, which, according to the analysis of our contemporary, *The Electrician,* constitutes 40·1 per cent. of the whole capital expenditure, becomes twice as valuable, or will so become when the change is completed. In so far as it is possible to continue business, and perhaps indirectly, through increased business to lower the price, the consumers may benefit by the change. Fortunately the fundamental laws of electricity are so arranged that the use of 230 volts is possible with existing appliances, excepting, of course, the lamp. A pressure of 230 volts will not jump an ordinary fuse, it will not even arc across the narrow gap of a tumbler switch. It will tingle if touched, a little more than 100 volts, but, as a matter of fact, one hardly ever touches it. We are not aware that the Bradford Corporation demand any higher insulation than is specified in their old regulations, but it is possible that some insurance companies may not be so easily satisfied. Regulations which define the insulation resistance by the observed leakage current, throw additional trouble on the contractor where high pressure is used, and possibly additional expense on the consumer. The saving in copper in wiring a house is a mere nothing, and would be completely absorbed by the better quality of dielectric.

The most serious result to the consumer is the withholding from him of the benefit of 8 c.p. lamps. It has been said of amateur photography that the expense of the amusement lies in the cheapness of the materials; conversely it may be said of domestic electric lighting that its cheapness lies in the expense of the supply. Economies that were never dreamed of when paraffin lamps or gas were used are regularly and readily practised by consumers of electric light, and not the least of these economies is the use of 8 c.p. lamps, especially for passages, staircases, bedrooms, and lamps for occasional use. The 8 c.p., or even a smaller lamp, is a most important factor in popularising electric light in small households, though for shops and offices a good distribution of light can generally be managed with 16 c.p., or even larger lamps. We understand that 8 c.p. lamps are not common in Bradford. The extra 15 volts may be the cause, or they may not be in fashion. Many a manager of a London supply company would sooner connect 100 8 c.p. lamps spread over three houses than the same number of 16 c.p. lamps in one house. The big house will be shut up for half the year, and the bulk of the lights will only be used when guests are being entertained. The small houses, on the other hand, will use a steady number of lamps nearly all the year round, and will not haggle for rebates. These are the consumers to encourage, and the economical lighting of small houses is made possible by the use of 8 c.p. lamps. We have before us an account which, we observe with regret, is not yet paid, for the quarter ending June 24, 1895, for a house in the west end of London. The house is, we understand, rated at £100, and has four 16 c.p. and nine 8 c.p. lamps, gas being used in the passages and basement. The account stands, amount due for supply of electricity, 12s. 3d.; rent of meter for one quarter, 5s. The accounts for the previous quarter were, we are informed, £2. 15s. 9d. and 18s. 9d. Is this the sort of house to be encouraged (supposing, of course, that the accounts are properly settled)? The inhabitants greatly value the advantages of electric supply, which is used for light and for other purposes. To afflict them with 16 c.p. lamps throughout would be either to raise the cost very considerably, or to push their already economical habits to very irksomeness. To compel a consumer to use double-filament 230-volt 16 c.p. lamps is to make him put up 8 c.p. lamps throughout, but with the inconvenience of being obliged to turn them on and off in pairs. Cooking and heating appliances, still rather expensive, will be more difficult to construct for 200 volts, for this is the pressure which will be generally employed if the fashion spreads. The step is very interesting; the use of higher voltage on the consumers' wires has long been contemplated, and the want of really good lamps has been the real obstacle; but until the Bradford Corporation compelled its new customers to experiment with such lamps as they can obtain, there was no inducement for lamp makers to attempt to manufacture a new article.

THE POSSIBILITIES OF ELECTRICAL PUMPING MACHINERY *

BY CHARLES A. HAGUE.

The convenience and controlability of electrical power, together with its simplicity of application to the work of pumping, commends it very strongly for use in isolated places, such as high-service systems in public water supply, wherein a comparatively small percentage of the total water supplied by the initial plant is needed for dwellings situated upon levels too high to be accommodated by the general pressure, and the question arises whether we shall put the entire system of the city under the highest required to force a supply to these higher levels, or whether we shall isolate the higher levels and handle the smaller percentage of water by itself.

This phase of water supply is not new. The portion of my subject relating to high service supply is a living question now perfectly practicable and applicable, destined without doubt to be largely employed in the near future. The application of electrical energy to the pumping of the main supply of a city of considerable size, although presenting many attractive features as far as the actual operation of the pump is concerned, is not yet within the possibilities on account of the absence of inexpensive methods for producing the necessary electric current, so that apparently in pumping large quantities for some time to come, compound, triple and quadruple steam pumping engines will hold sway. But the matter of transforming the energy of falling water by means of the turbine, and upon a large scale, with electrical energy at the end of a copper wire, is awakening interest far and wide to-day. It is beginning to offset very forcibly the proposition that it does not pay in the present state of perfection of the steam engine to go very far out of the way of regular commerce, to get the cheap power afforded by a falling stream.

How convenient it would be to generate an electric current at the main pumping station, with the boiler plant used for pumping the main water supply, then run the wires up to a point adapted to the high-service pumpage, and operate an electrically-driven pump. Of course, a high-service steam-pumping plant could be installed at the proper point, but that would mean expensive attendance, hauling of coal, ashes, supplies, &c.; and last, though by no means least, large quantities of smoke and dust spread over what are generally residence districts. There are cities where pumping plants are supplied with anthracite coal at double the cost of bituminous coal, to quiet the complaints of the owners of lawns and trees.

The method of switching on and off the electric current by means of the water level or pressure is one of the details that will occur to the hydro-electrical engineer. At the start the hydraulic engineer thought there was nothing to do but harness the electric dynamo and motor to a pump, and the task of pumping by electricity was accomplished. The electric engineer imagined there was nothing to do but harness a pump to his motor, and behold the result was obtained. But after a few attempts it was discovered that the pump holding such a stubborn and inelastic element as water, was subject to inertia, shock and variable power within short limits, quite at variance with the steady and uniform operation desirable for the best electrical results.

The point in the subject now reached is a very good one from which to view the future possibilities in using electrical energy upon a large scale for pumping water. The pump portion of the machine may be said to be in sight. Even now on short notice we can produce a pumping machine complete up to the binding posts for receiving the wires, and of as large capacity as has yet been produced in the steam machine. But who will step forward and furnish us with the current at a cost that will compete with the wasteful use of heat involved in the steam engine?

* Abstract of a Paper read before the American Waterworks Association.

The Influence of Gases Dissolved in the Electrolyte of a Silver Voltameter.—The June number of *Wiedemann's Annalen* contains, says *Nature*, a Paper by J. E. Myers on the influence of gases dissolved in the electrolyte of a silver voltameter on the weight of deposited silver. The author finds, as has previously been shown by Schuster and Crossley, that if the same current is sent through two voltameters containing neutral solutions of silver nitrate of the same strength and at the same temperature, one voltameter being in a vacuum and the other in air, then the weight of the silver deposited in the vacuum voltameter is, for a solution containing from 20 to 40 per cent. of silver nitrate, about 0·1 per cent. greater than that of the silver deposited in the other voltameter. For a 5 per cent. solution the difference is somewhat smaller. If the solution is saturated with carbon dioxide the deposit is about 0·055 per cent. lighter than when the solution is saturated with air. With nitrogen, however, the deposit is about 0·05 per cent. heavier than with air. The electrical resistance of a 5 per cent. solution saturated with air is practically the same as that of the same solution in a vacuum. With a current of more than 0·25 ampere, it is found than in vacuum an evolution of gas takes place at the anode. The author has also examined the grey deposit which is formed on the anode, and finds that it consists of pure silver oxide.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *August 9, 1895.*

A Westinghouse Combination.—The Westinghouse Electric and Manufacturing Company has entered into an arrangement with the Baldwin Locomotive Works of Philadelphia with respect to the construction of electric locomotives. The former Company will supply the electrical equipments and the latter the structure and other parts of the locomotives. The Baldwin Works are now busy upon plans for a new type of electric locomotive which the combination intends to produce. Two types of truck will be made, one for light work on elevated roads and the other for a heavier class of traffic and suitable for hauling from 12 to 15 cars. The design of the trucks is such that by fitting them with motors of the necessary power they may serve all the requirements of electric roads, from the lightest elevated at the maximum speed of 40 miles an hour, to the fastest suburban work of 90 miles an hour. The Baldwin plant has been the leading one in the United States during a long period for the manufacture of steam locomotives, and may be said to have originated most of the types now in use. The combination of two such great firms for the manufacture of electric locomotives will tend to accelerate their use, and furnishes a significant commentary on the present trend of electrical development.

Long Distance Electric Railways.—A contract for the building of an electric railway between Washington and Baltimore, a distance of forty miles, has been awarded. The cost of construction will be $3,000,000, and the road is to be completed with the year. Plans have been completed for another line between the same two cities, and it is expected that a contract for their execution will be signed within a few days, a syndicate of capitalists having offered to take $750,000 worth of the bonds. The former road is intended for an express service between the two cities in competition with the Pennsylvania and the Baltimore and Ohio steam railroads; the other line is intended to develop a section not now reached by steam roads.

The General Electric Manufacturing Plant.—It is beginning to be generally believed that there is something in the rumours which have been so persistently current during the past year with respect to the General Electric Company abandoning its present plant at Schenectady for a more favourable location. It is known that several advantageous offers have been made to the Company by capitalists interested in the development of manufacturing towns, and as the location of Schenectady is an unfavourable one for manufacturing purposes, it is not at all improbable that advantage will be taken of this opportunity to change the location of the plant. Several sites, it is said, have been offered, together with a large bonus for buildings and equipment, among which is one situated in a manufacturing town now being built up near Niagara Falls.

CORRESPONDENCE.

MAGNETIC UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It seems to me a much more important matter that electricians should understand clearly, and agree upon, the magnetic quantities for which units are to be chosen, than that they should try to settle names for units which may not be wanted. The need for names arises in order that the practical electricians may have convenient handles to denote things that they have to deal with, and are not specially wanted by abstract thinkers, to whom a symbol is more acceptable than a name. It would therefore seem to be a matter of elementary common sense that practical engineers should be asked what units they want to have defined.

Before trying to find or adapt any names, let us try to ascertain what units are wanted, and agree upon their definitions. As a beginning permit me to make the following suggestions:—

1. Most important of all, and first to claim attention and definition, is the quantity on which the operation of every dynamo, motor, and transformer depends—namely, the quantity variously called the *magnetic flux*, the *total number of magnetic lines*, or the *total induction*. It is that for which I consistently use the symbol **N**, and for which, in defiance of the recommendations of the Frankfort Conference (which decided that Greek letters should be reserved for angles, and for specific quantities like specific inductive capacity), M. Hospitalier uses the letter Φ. Who will suggest a definition for the unit of this quantity? The C.G.S. unit is *one line*. I know one accomplished designer of dynamos who regularly uses the terms *kilolines* and *megalines*, and finds them very handy.

2. The next thing that logically follows is the *density* of the first-defined quantity—namely, that which goes by the names of *flux-density*, or *number of lines per square centimetre*, also unfortunately sometimes miscalled *the induction* (as though induction were not the operation of inducing, and already so defined by Faraday). Happily, whatever dispute we may have about the definition or denomination of this quantity, we all agree in using (though we quarrel over the fount of type to be used) for it the symbol **B**, or **B**, or 𝔅, or 𝕭.

By proceeding in this order we avoid all academic fatuities as to whether we mean the flux in air or in iron or anywhere else, or that part of it which would remain if the iron were removed. We must define it as that, whether in iron or air, which, when cut by the moving conductor, induces therein electromotive force.

3. We then want a definition of that which, when applied to a given configuration of magnetic matter, produces in it what we have already defined in (1); in other words, we want a definition of, and unit for expressing, that which goes by the names of *the line-integral of the magnetising forces*, or of *the magnetomotive force*. Here we encounter the great four-pi difficulty. Unless we are prepared to take the heroic step of four-pi-by-tenning our ampere, and adopting a new unit of current, then we *must* either four-pi-by-ten our ampere-turns, or else shunt off the difficulty by one stage, namely, by declining to consider it until we pass to the next unit. *Magnetic potential* would not be a bad term were it not that some sticklers for precision—notably my friend Prof. Ayrton—have for years, and with utmost consistency, declined to let us use the word *potential* (in its electrical application) for the whole line-integral of the electric forces in a circuit, and have persistently used it only for that part of the line-integral that lies outside the battery or dynamo. It has been in vain to point out that the P.D. is only an E.M.F.; it has been almost fruitless to abstain from using either of these hateful symbols. We have no recognised or universally adopted symbol for the whole, or total, or nett circuital electromotive force: even the sacred "E.M.F." is not reserved for this clear and unmistakable quantity. Magneticians have, therefore, the opportunity of setting a good example by fixing upon a clear, good definition of a *circuital* quantity, the separate parts of which can be separately defined *pro re nata*.

4. Just as (2) follows from (1) by dividing it by an area, so the fourth quantity requiring definition can be defined as a sequence from (3), but in this case by dividing by a length. The fall of magnetic potential per unit of length along the path will give us a definition of the quantity variously called *magnetic intensity*, *magnetic field*, or *magnetic force at a point*, and symbolised by **H**, or **H**, or 𝔋, or H. If we have, however, evaded the four-pi difficulty, and taken ampere-turns for (3), then its fall per unit of length will not be **H**, but **H** ten-over-four-pied.

5. When (1) and (3) shall have been defined, we then want a definition of the quantity which intervenes in the relation between them as applied to any magnetic mass of given circuital configuration. In other words, we want a definition of *magnetic resistance*, or *reluctance*, or else of its reciprocal

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magnetic conductance or *permeance*. That such permeance or reluctance does in some kinds of magnetic media vary with the degree to which the flux-density has been pushed is quite immaterial to the need of definition and of a unit. One does not hesitate to define the specific refrangibility of a material because it depends upon the particular wave length of light that is being used. If we decide to define the *permeance* as the ratio of (1) to (3), or the *reluctance* as the ratio of (3) to (1), we shall still require tables giving statistical information as to the dependence of the specific permeance or specific reluctance upon the flux-density. Further, if we have shunted the four-pi difficulty from the preceding stages, we must finally face it now.

6. It will then only remain to define the specific quantity *permeability*, or *reluctivity*, as the case may be, by dividing (5) by a volume. Happily we are all agreed as to the symbol μ, in case *permeability* is chosen instead of *reluctivity*.

Will not some constructive engineers—Mr. Esson, Mr. Ravenshaw, Mr. Sydney Evershed, Mr. Mordey, or Mr. Andersen—tell us what things they think most important to be defined?—Yours, &c., SILVANUS P. THOMPSON.

UNIT FEVER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I see the scienticulists of the B. A. are at it again, and threaten us with a new series of units and names, while the original scienticulist (it is his own word) actually proposes to abolish 4π and leave us poor practicians to wallow in a sea of curling waves.

Lend me a little of your space to beg the B. A. folk, before going to work, to ask themselves what new units are wanted and who will use them? Let me tell them it is the practician who uses units with names to them, and at the present moment he wants a name for the unit of total magnetic induction and unit total magnetic force. He also needs—but not very badly—a name for unit self-induction, "henry" not having penetrated this side of the Atlantic.

Mr. Vignoles and I long ago suggested "thom" as a name for one "line of force" and "gauss" for one thom per square centimetre.

We very soon dropped the *gauss*, finding the *thom* alone was really useful in everyday work, and at Woodfield Works no one ever talks about lines of force. We think of the "*thom*" as a unit of squirming in the ether, and have consequently banished for ever all the paradoxical phenomena for which the line of force has been mainly responsible.

Now, I do not expect the B.A. to adopt the thom; it will not be easy to find a better word, but by all means let the B.A. endeavour to invent an equally good name itself. Only for Heaven's sake give us a word of one syllable. By the way, if it *must* be a dead and distinguished physicist, why not Thales—pronounced, of course, to rhyme with Wales?—Yours, &c., SYDNEY EVERSHED.

Hythe, Hants, August 17th.

INDIRECT ELECTROLYSIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The indirect electrolysis which I described in an article published on June 29, 1895, in the *Génie Civil*, and mentioned by you on p. 480 of your issue of August 9th, is certainly "something more than the well-known fact" alluded to by Mr. Stepney Rawson in his letter which appeared in the last issue of *The Electrician*. Moreover, it has nothing to do either with "the well-known copper refining or with the gold-amalgamating process of Prof. Crookes." Evidently Mr. Stepney Rawson did not understand the working of this new electrolysis, and altogether missed the point. I presume he has not read the text of my article, but only the abridgement. The phenomenon which I have observed, and which is very easy to explain, goes much beyond the remarks of Mr. Stepney Rawson, whom I can assure that there is not much "in the case of a carbon plate" which he mentions. I will try to make the thing clear to him.

If, in a vat divided into three compartments, by means of two porous partitions, I fill with a strong chloride of sodium solution the outside positive and negative compartments, each provided with its electrode, and if I fill the central compartment, which does not contain any electrode, with a bisulphite of sodium solution, or with any other solution, such as a cyanide of gold and potassium solution, there will be chlorine liberated in the "anolyte," and caustic soda formed in the "catholyte," but no change whatever will take place in the central compartment. But as soon as I dip in this central compartment some metallic or conducting plates not connected at all with the anode and cathode of the lateral compartments, an electrolytic action takes place, which is quite independent of the direct electrolysis which is going on in the true positive and negative compartments. This electrolysis, which is working between the chlorine and the caustic soda compartments, is what I call the indirect electrolysis, and this is what Mr. Stepney Rawson has not seen.

I will give two illustrations of this electrolytic decomposition of a solution, and of formation of products other than chlorine and caustic soda. The first will be the reduction of a bisulphite of sodium to the state of hydrosulphite of sodium, which is a very powerful bleaching agent; the second will be the reduction of gold from its solutions.

The electrolyte in the positive and negative compartments will be a chloride of sodium solution. The central compartment contains a bisulphite solution in which zinc or other suitable metallic plates are immersed. As soon as the electric current passes, the chloride of sodium solution is decomposed in the usual manner, but the transfer of the ions from one role to the other does not affect in the central compartment the bisulphite of sodium, which is instantaneously transformed into hydrosulphite of sodium. From a reservoir the sulphite of sodium solution flows into the central compartments of several electrolysers connected in series, and is pumped back to the reservoir, which may be used as a bleaching tank, and from which it passes again through the same central compartments, where it recovers its bleaching properties. The solution may be used several times before it requires an addition of fresh sulphite of sodium to maintain its strength.

Is this production of hydrosulphite of sodium a well-known fact, as suggested by Mr. Stepney Rawson? The phenomenon does not require explanation, but it is quite a new thing, and this indirect electrolysis differs entirely from the known methods in electro-chemistry.

Other liquids can be worked in the same manner, and there are several valuable applications of this indirect electrolysis.

I will show now that the process I have found for depositing gold or any other metal does not resemble the methods alluded to by Mr. Stepney Rawson. The electrolyte is the same, *i.e.*, a chloride of sodium solution in the positive and negative compartments. In the central compartment I have a cyanide of gold and potassium solution, which circulates and yields its metal to perforated sheets of zinc or lead which almost fill up the compartment, and are not connected with the positive and negative poles. Some secondary reactions take place next to the negative compartment, but it would take too long to explain them, and to show how to avoid them. I will only say that the gold solution may be strong or weak; the deposition of the metal will take place until the solution is practically exhausted, say to the extent of 99 per cent.

I do not say that this indirect electrolysis, as a practical process, is good or not. But there is novelty, originality and utility in this decomposition of a solution between positive and negative compartments where another electrolytic decomposition independently takes place, and in spite of exhaustive researches I have been unable to find any mention of a similar process.—Yours, &c., EMILE ANDREOLI.

ARMATURE REACTIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your leaderette referring to the Paper of Prof. Elihu Thomson in last week's issue, you suggest that an unwound but smaller pole than that used by Prof. Thomson might be used in conjunction with one of my armatures,

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This is very true, as I have proved by experience; several machines of my type being at work at different parts of the country and using a pole horn of this description. Some of those present may remember that I described such a pole in the course of my reply to the discussion on my Paper before the Institution of Electrical Engineers, although I think it does not appear in the printed report. The pole-piece will be found described in British Patent No. 10,298 (1893.) I may remark that I have lately been testing some 80-kilowatt machines which give a rising characteristic to the extent of 9 per cent. These machines have no series winding upon the magnets.—Yours, &c. W. B. SAYERS.

Glenwood, Bearsden.

THE BRIGHTON ACCOUNTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We beg to call your attention to the following slight errors into which you have fallen in your analysing our Revenue Account for 1894.

In Distribution Expenses you have included the sum of £399, the cost of work done for customers, which you will see by our statement of accounts is refunded, and has nothing to do with *repairs* or the *cost of distribution*.

In Rent, Rates and Taxes you have included the sum of £419, the cost of attendance and repairs to public lamps, which is also refunded, and have omitted to allow the sum of £63 for rents receivable. The total of these three amounts—£881—should be deducted from our total expenditure on *revenue account for the year*, thus bringing the expenditure down to £5,610, or 2·3d. per unit sold, now the second lowest figure obtained.—Yours, &c, ARTHUR WRIGHT,

August 16, 1895. Engineer and Manager.

[In the interests of accuracy and in view of the keenness of the competition for the position of premier "low costs" station, we are extremely sorry that the Brighton distribution expenses were inadvertently charged with some £399 they should not have been; at the same time, wiring work and lamp selling might well be placed under a special heading, if not done away with and left to those whose regular business it is. With regard to the inclusion of £419, the cost of attendance and repairs to public lamps, in the column headed "Rents, Rates, Taxes, &c.," Mr. Wright has omitted to state that we called attention to this fact in a special note, and also to observe that the column in question is intended, as is shown by the addition of the words *et cetera*, to include miscellaneous items not included under previous headings. It would be advantageous in cases where public lighting attains large proportions if *all* receipts and expenditure relating to it were kept entirely separate, as is so admirably done by the City of London Electric Lighting Company. Short of this measure it is impossible to ascertain exactly what the unit *sold by meter* actually costs to the seller—a feat, however, which we did not attempt to perform in our table.—ED. *E.*]

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices:—*

LABORATORY NOTES AND FORMS.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett *(now ready)*. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s.—each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

A SHEET TABLE showing Total Capital Outlay and Receipts and Expenditure for the year 1894 of the Statutory Electric Supply Undertakings of the Metropolis is now ready, printed on thick paper, price 6d. each.

A SHEET TABLE giving similar particulars in relation to Provincial Statutory Electric Supply Undertakings is now ready, printed on thick paper, price 6d. each.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. nett, is now ready.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d. post free (abroad 11s.).

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

TENDERS INVITED.—Tenders are invited by the Vestry of Hammersmith, London, W., for complete schemes for public and private lighting, and for the supply of motor power in the compulsory area of the Vestry's Provisional Order. Particulars can be obtained of Mr. H. Mair, Surveyor to the Vestry. Tenders have to be sent in by 6:30 p.m. of Wednesday, Sept. 4th.

——— The Vestry of St. Mary, Islington, London, N., invite tenders for the wiring of the Vestry Hall and municipal offices. Particulars can be obtained from the electrical engineer to the Vestry (Mr. Albert Gay), 50, Eden-grove, Holloway, N., to whom tenders must be sent by 12 noon *on Tuesday next*, 27th instant.

——— The Commissioners for the Control of Lunatic Asylums, Dublin, invite tenders for wiring the Killarney District Lunatic Asylum for the electric light. Plans and specification may be seen at the Asylum or at the Office of the Engineer, Mr. W. Leake, 30, Victoria-buildings, Manchester, and tenders, addressed to the Secretary, Board of Control, Custom House, Dublin, must be in by 10 a.m. on the 30th instant.

——— The Electric Lighting Committee of the Wakefield Corporation invite tenders for the supply and erection of (*a*) boiler and fittings, mechanical stokers and engine, economiser, feed pump, injector, &c.; (*b*) steam alternators, condensers, oil filter, fittings, &c., steam, exhaust, feed, blow-off and sundry pipes, valves and water tank, &c.; (*c*) main switchboard and instruments; (*d*) cables, junction boxes, culverts, and trenching, &c.; (*e*) transformers and switchboard, &c.; (*f*) arc lamps and posts; (*g*) meters, and (*h*) overhead crane. Tenders, addressed to the Town Clerk, must be in by 2 p.m. *to-morrow*, August 24th.

——— The Portsmouth Town Council invite tenders for wiring the police stations at Buckland, Southsea, Portsmouth and Portsea, for the electric light. Tenders by the 27th inst. to the Town Clerk (Mr. A. Hellard), Town Hall, Portsmouth.

——— The Municipal Authorities of Braila, Roumania, invite tenders for the concession for (*a*) lighting about 64 kilometres of public streets by both electricity and gas, and (*b*) 64 kilometres of public streets by electricity alone, and also for the concession for the construction and operation of a network of electric tramways in the principal thoroughfares. Tenders to the Maire, Hôtel de Ville, Braila, by October 2nd.

——— The Urban Sanitary Authority of Chepping Wycombe (Bucks.) invite tenders for working their Provisional Electric Lighting Order. Tenders, by noon of October 14th next, to the Town Clerk, High Wycombe. Some additional information appears in our advertisement columns.

——— Tenders are invited for the erection of the superstructure of a machine shop, foundry and testing department, at Rugby, for Messrs. Willans and Robinson (Limited). Plans and specifications may be seen at the offices of the architect (Mr. T. W. Willard), St. Andrew's-chambers, Rugby, and tenders addressed to the Secretary, Messrs. Willans and Robinson (Limited), Picton House, Thames Ditton, Surrey, must be in by September 5th.

——— The General Direction of the French Posts and Telegraphs require tenders for the supply of 40 kilometres of double-conductor paper-insulated telephone cable. Tenders to the Direction Générale des Postes et des Télégraphes, 103, Rue de Grenelle, Paris.

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TENDERS INVITED.—The Urban Sanitary Authority of the Borough of Bedford requires tenders for the supply of vulcanised rubber cables, in accordance with specification, which can be obtained from Mr. T. S. Porter, Clerk to the Authority, Town Hall, Bedford, to whom tenders have to be sent in by September 4th. Some further particulars appear in our advertisement columns.

——— Tenders are required for the establishment of a small central station for the electric lighting of the De Ruyter Fort at Willemstad. Tenders to the Café Het Schipperstuis, Willemstad, Holland.

——— The Queenstown Town Commissioners require tenders for the erection of works and the necessary plant for generating electric current for the public and private lighting of the town. Further particulars may be had from Mr. James Ahern, Town Clerk, to whom tenders must be sent by September 26th.

——— Tenders are required for lighting that part of the town of Thorne (Yorks.) included in the lighting area, from September 1st next to April 30, 1896. Tenders to Mr. C. Waller (Clerk to the Parish Council), by the 27th inst.

——— The Parish Council of Cheadle (Staffs) invite tenders for lighting the town quarter of the parish by electricity, gas or oil for a period of seven years. Tenders must be sent in to the Clerk to the Council (Mr. John Hulme) by Monday next, the 26th instant.

TENDERS ACCEPTED.—The Brighton Town Council have received the following tenders for the supply and erection of evaporative brass tube surface condensers, electrically-driven air pumps, exhaust and condenser piping for the electricity station :—

Wright's Patent Heater Condenser Company (*accepted*)	£2,476
E. Lar en	2,900
J. Fraser and Son	3,460

(All of London.)

The Town Council have also received the following tenders for the supply and erection of exhaust pipes, valves, &c , at their electricity generating station :—

H. North (Brighton) (*accepted*)	£489	0
J. Fraser and Son (London)	594	0
Reed and Son (Brighton)	540	0
J. Every (Lewes)	494	10

——— The Portsmouth Town Council have decided to accept the tenders of Messrs. W. T. Glover and Co. and the British Insulated Wire Company for cables for their electric light extensions. Subjoined is a complete list of the tenders received :—

For Conduits and India-rubber covered Electric Mains.

W. T. Glover and Co. (*accepted*)	£12,357	0	0
British Insulated Wire Company	13,812	0	0
Telegraph Manufacturing Company	13,026	0	0
Reid Bros	12,772	0	0
Fowler-Waring Cables Company	12,534	0	0
Johnson and Phillips	12,481	16	9
W. T. Henley's Telegraph Works Company	12,362	10	0
Siemen's Bros. and Co.	11,889	0	0

Messrs. Siemens Bros'. lowest tender was not accepted owing to the length of time required to complete the work. The tendering, it will be seen, was unusually close, due, in the main, to the clearness of the specification.

For "Compound" covered High-Tension Mains.

British Insulated Wire Company (*accepted*)	£490	£486
Siemens Bros. and Co.	634	623
Callender's Company	504	522
Fowler-Waring Cables Company	486	604
Reid Bros	459	565
W. T. Henley's Telegraph Works Company	437	538
W. T. Glover and Co.	400	486

These high-tension cables are required for the extensions in the St. Mary's and Milton-roads.

——— The Bolton Town Council have accepted the tender of Mr. W. Pollitt for excavation work in connection with the extension of their electric light mains to Saville Mill, Shifnall-street; that of Messrs. Hick, Hargreaves and Co. for clutch gear for the motor alternators, and of Mr. F. C. Jackson for the supply of stands for accumulators.

——— The Ashton-under-Lyne Town Council have accepted the tender of the London and Lancashire Electric and General Engineering Company for wiring and fitting up the Town Hall for the electric light.

APPOINTMENTS VACANT.—From our advertisement columns it will be seen that a thoroughly qualified lecturer in electrical engineering, telegraphy and telephony is required by the Croydon County Polytechnic. All further particulars may be obtained from Mr. J. W. Helps, the Chairman of the Committee.

——— The Municipal Commissioners of Singapore are prepared to receive applications for the position of municipal engineer. The engagement is for three years, with option of renewal, and the salary will be $500 per month, with certain allowances. Candidates who must be between 30 and 45 years of age), residing in Asia, must send in their applications to Mr. J. Polglase, municipal secretary, Singapore, by November 15th, but candidates residing in Europe or elsewhere may send in their applications to Mr. C. C. Lindsay, 167, St. Vincent-street, Glasgow, by October 15th next.

APPOINTMENTS VACANT.—The Governing Body of the Northampton Institute, Clerkenwell, E.C., are prepared to receive applications for the appointment of a principal. The salary attached to the office has been fixed at £600 per annum. Applications must be sent in by September 4th to Mr. J. J. Lambert, 8, Dowgate-hill, Cannon-street, London, E.C.

LIQUIDATIONS.—At a meeting on July 30th last it was resolved to wind up the Albert Lighting Company (Limited), of 110, Cannon-st, London, E.C., voluntarily. This resolution was confirmed on August 14th, and Mr. G. B. Gates, 12, Jerningham-road, New Cross, London, S.E , was appointed liquidator.

——— It has been resolved to wind up the Engineering Supply Company (Limited), Stockton Forge Works, Stockton, voluntarily. Mr. F. Brown, Finkle-chambers, Stockton-on-Tees, is liquidator.

——— All claims against the estate of Sir James Farmer and Sons (Limited) (in liquidation), mechanical and electrical engineers, must be sent in to the liquidator (Mr. A. Tongue), 86, King-street, Manchester, by September 14th.

DISSOLUTIONS OF PARTNERSHIP.—Messrs. J. Fleming, W. McFarlane, D. Leggatt and J. Heron, trading as electrical and mechanical engineers, Middleton, Lancs., have dissolved partnership. Debts by Messrs. J. Fleming and J. Heron, who continue the business.

——— Messrs. Gates and Hornibrook, mica merchants, Victoria Mills, Fairclough-street, and Backchurch-lane, Commercial-road, London, E., have dissolved partnership.

REMOVAL.—Messrs. Crompton and Co. have taken offices at Cornwall Buildings, 35, Queen Victoria-street, E.C., where their electric heating department will now be situate, the Brompton-road premises being kept open by the Kensington and Knightsbridge Company for the benefit of customers who may wish to see the various applications of electricity. The removal of Messrs. Crompton and Co.'s electric heating department to Queen Victoria-street is necessitated by increase of business, and the desirability of being in more central and accessible premises for inquirers, who come from all parts of the country and abroad to see these latest applications of electricity. Mr. H. J. Dowsing, who for the past three years has been in charge at Brompton-road, has taken over the new offices, and will be pleased to give any information in regard to this department.

OBITUARY.—We regret to announce the death of Mr. Peter Denny, of Messrs. W. Denny and Bros., electrical engineers and shipbuilders, which took place yesterday at Dumbarton.

ALSAGER (STOKE-ON-TRENT).—The Surveyor has just presented his report to the District Council on the lighting of this town by electricity. The report states that the Surveyor made a canvass of a number of houses in the district, with the result that 45 persons (who would require a total of 639 lights) were in favour of the introduction of the electric light, while 18 others favoured the introduction, but could not specify the number of lights they would require. Ten householders were neutral, eight against, and ten had not replied. The Chairman, in commenting on the report, said the promises were so encouraging that he thought the matter should be brought before the ratepayers. It was ultimately decided to ascertain the opinion of the ratepayers on the matter.

BATH.—A meeting of the City Council will be held on September 17th for the purpose of considering the question of an application to the Board of Trade for a Provisional Electric Lighting Order for the City.

BERLIN.—An Industrial Exhibition, to celebrate the jubilee of the recognition of Berlin as the Imperial capital, is to be held next year from May to October, in the Treptow Park, near Berlin. The ostensible object of the Exhibition is to demonstrate the progress and development of the various trades and industries of the city, and to exhibit its importance as a centre of commerce and industry. The exhibits will be divided into 24 groups, and there will be sections devoted to applied electricity, machine construction, shipbuilding and transport, building and engineering, textile, chemical, metal and india-rubber industries.

BOLTON.—At the last meeting of the Town Council it was stated that the receipts from the sale of current during the past month amounted to £180, making a total of £994 since the end of March. Seventy consumers are now connected to the mains, representing 5,800 lamps, and there are several other customers waiting to be connected up.

BRECHIN.—The Caledonian Electric Light Supply Company, and the Town and Village Electric Light and Power Company, recently notified the Town Council of their intention of applying for Provisional Electric Lighting Orders for this town. Some correspondence

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has passed between the Town Clerk and the Caledonian Company as to the terms to be offered, but Mr. Murray has given notice that at the next meeting of the Town Council he will move that they should not entertain any proposition on the subject, the time not having arrived for the matter to be considered.

British Museum.—A considerable extension of the electric lighting of the reading room is in hand, the object being chiefly to assist the deciphering of the titles of books on the highest shelves, to which the public have direct access. These shelves are darkened by the gallery projecting forwards from the walls of the reading room. A new system of radiating these shelves has been devised, and the bulbs of the 40 incandescents which are to be used for this purpose are partially darkened so as to throw the light only upon the bindings of the books.

Canterbury.—At the last meeting of the Town Council a motion by Mr. Alderman Mason, empowering the Electric Light Committee to take such steps as they thought fit for carrying out the provisions of the Council's Provisional Electric Lighting Order, was adopted. The Committee are to report as to the best means of lighting the city by electricity.

Cablisto.—Reginald Bolton, an old cablist, contributes a chatty article on "The Pleasures of an Operator's Existence at Home and Abroad," to the columns of *Answers* for August 24th. The same writer was responsible for an article on a similar subject in the "Windsor Magazine" for July.

Dover.—Last week a meeting of the ratepayers of Snargate-street was held to protest against the postponement of the introduction of the electric light into this street, and, after the use of some vigorous and expressive language, a motion "That this meeting asks the Town Council to adhere to their resolution for lighting Snargate-street by electricity, and to carry it out at once," was unanimously passed.

Electric Lighting in Brazil.—The municipality of Itaparicá (San Paulo) proposes to light that town by electricity, and has invited Dr. O'Connell Jersey, engineer, to submit plans and estimates. The work of equipping the electricity station at Petropolis is making rapid progress, and it is anticipated that this town will be lighted electrically by the end of next month.

Electric Traction in Egypt.—Electric traction is making considerable progress in Egypt. It will be remembered that a company (Société anonyme des Tramways du Caire) was recently formed in Paris for the purpose of constructing and equipping about twelve miles of electric tramways on the Thomson-Houston overhead system in Cairo; and it is thought that Alexandria is likely to shortly follow. For the concession for the electric tramways from Cairo to the Pyramids, a distance of about ten miles, there were several bidders, a Belgian firm proving successful. An offer by a Frenchman to erect a funicular railway to the top of the Great Pyramid has been rejected by the authorities.

Electric Traction Statistics.—Interesting figures are to hand showing the important part played by electricity in the tramway systems of the United States. On a total number of roads amounting to 976, with a total mileage of 13,588, 10,363 miles are worked electrically, the next highest total being 1,914 by horses. The amount of capital stock of the tramways in the States is $784,014,206, the funded debt $552,125,505, and the debt per mile $40,600. The total number of cars is 44,745.

Empire of India Exhibition.—Messrs. Spagnoletti and Crookes have recently installed fire alarms on the Single-Wire Multiple Telephone Signal Company's (Saunders and Brown) system at the Empire of India Exhibition at Earl's Court. These alarms consist of three posts and two wall boxes so arranged that anyone can give an alarm of fire by breaking the glass and pulling a handle which rings a bell at the fire station, and also one of any required degree of loudness at the call point to assist in the detection of persons giving a wilful false call. The fire department at the Exhibition is under the charge of Mr. Harman, who has had great experience in the Metropolitan Fire Brigade, for which the same Company has supplied over 650 street call points. The same system is in use at Newcastle and many other towns. Local authorities throughout the country are gradually awakening to the necessity of providing effective means of promptly communicating with the municipal fire stations.

Great Yarmouth.—The report of the Electric Lighting Committee on the working of the Corporation Electricity Works for the past half-year shows a total loss of £164, or a net loss of £130, plus amount to be set aside for repayment of capital and interest. It has been decided to light the Fish Wharf electrically during the ensuing season at a cost of £50. The total number of lamps now connected to the mains is 5,122.

Harrogate.—A discussion on the report of the Electric Lighting Sub-Committee took place at the last meeting of the Town Council, and recommendations to the effect that the British Insulated Wire Company supply cables for the low-tension system, in addition to the tender already accepted; that a slow-speed flywheel alternator plant be adopted; that two Lancashire boilers, 30ft. by 8ft., be purchased; that a site on the north side of Oakbeck be utilised for the electricity works; that a small day-time plant be put down; and that, in the first instance, £800 be spent in providing junction-boxes and meters to 100 customers, were approved.

Hospital Lighting.—As stated in our issue of the 9th instant, the Governors of the Brompton Consumption Hospital, recognising the purer surroundings of the electric light, decided to light the whole of the hospital by electricity, and we understand that the work of installation has been entrusted to Messrs. Laing, Wharton and Down. The plant, which is to be fixed in the rear of the new extension buildings, will comprise a 145-volt dynamo, a large battery of accumulators and a Crossley gas engine. 1,209 incandescents will be used, and it is anticipated that the work will be finished by the beginning of November. The *City Press*, in commenting on this action of the Consumption Hospital authorities, says: "If not the first it is one of the first of the great London hospitals to adopt the electric lighting system, and there cannot be the least doubt that the change will conduce to the general welfare of the patients, who number upwards of 300. The hospital chapel has for some years past been lighted with electricity. There are 70 wards to be lighted, together with the nurses' dormitories, the doctors' bedrooms, an entertainment hall, and the administrative and other offices. The hospital is the largest of its kind in the kingdom."

Infirmary Lighting.—The contract for the electric lighting, supplying and fitting telephones, electric cooking apparatus, medical switchboards, electric bells and speaking tubes for the Lancaster Infirmary has been placed with Messrs. Drake and Gorham. The number of lights will be about 250.

Japan.—The British Consul at Yokohama, in his annual report, states the value of the imports of machinery from Great Britain during the year was £100,000. He also adds that it would be greatly to the interest of British manufacturers who supply electric light plant and apparatus if they had expert agents on the spot. In conclusion, the Consul remarks that electric light material is principally supplied from Germany and America, while telegraphic apparatus comes from Great Britain. Japan now makes dynamos for herself, the raw material for which is imported from England. The telephones employed in the country are all of home make, while the supply of galvanised iron wire is chiefly in the hands of German manufacturers.

Johannesburg.—The Berea Barnato Park, which is being laid out by the Johannesburg Waterworks Company, is to be lighted throughout by electricity, and a mansion to be built by Mr. Barnato, at a cost of between £30,000 and £50,000, is to be similarly lighted.

Lagos.—A Reuter's telegram states that a mass meeting, attended by 10,000 persons, was held on Saturday evening last in Tinubu-square, Lagos, to protest against the Electric Lighting Bill submitted by the Government.

Leytonstone (Essex).—A meeting of the Wanstead Slip Ratepayers' Association was held on Monday last to protest against the introduction of the electric light into the district by the District-Council. It was decided to appoint a deputation to wait upon the Council and lay the views of the Association before that body.

Liverpool.—No notice of opposition has been given to the Bill confirming the Provisional Order for extending the boundaries of this city. It will be remembered that the purchase of the Liverpool Electric Supply Company's undertaking by the Corporation was contingent upon the passing of this Bill in the present session of Parliament.

Llandudno.—The District Council at their meeting on Wednesday last discussed a report prepared by the Borough Engineer on his visit to Lytham to inspect the Hermite system of electrical sanitation which has been adopted by that town. The engineer in his report states that in view of the Council providing their own electric lighting plant very shortly, it would be unwise to lay down special plant at present for the purposes of this system, and recommends the Council to wait until more was known as to the results obtained at Lytham and elsewhere. The Council decided to adopt this course.

New Cable Steamer.—It is stated that Messrs. Lobnitz and Co., of Renfrew, have just received an order from the Japanese Government for a twin-screw steamer, which is to be completely equipped for telegraph cable laying and repairing.

Newport (Mon.).—The Town Hall was lighted electrically for the first time on Monday. The current is supplied from the Corporation mains, and 425 incandescents are used. The work of wiring and fitting has been carried out by the Electric Installation Company, of Victoria-street, London, S.W., at a cost of £517.

Ogmore Valley.—Electric lighting is making great progress in this district. It is reported that nearly all the streets, shops and places of worship are now lighted electrically, and the general opinion is that it is cheaper and much better than gas.

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OSWESTRY.—A proposal to introduce the electric light into the Guildhall at a cost of £50 has been postponed to the next meeting of the Town Council.

PRIVATE HOUSE LIGHTING.—The Tayler-Smith Electric Company are installing the electric light at the town house of Mrs. Goldsmid, 45, Ennismore-gardens, London, W.

PROPOSED NEW AMERICAN CABLE.—A proposal has been submitted to the Hawaiian Senate by Mr. Spalding for the laying of an American cable between California and Honolulu, which stipulates for the payment of an annual subsidy of $50,000 for 20 years, exclusive of the cable franchise. The Bill passed the Senate on the 14th inst., the annual subsidy being fixed at $40,000 for 20 years. The construction of the cable, it is announced, now depends on the obtaining of a subsidy from the United States Government !

RHYL.—The District Council have been considering for some time past the question of the construction of a tramway. Three schemes were originally submitted, and, after consideration by the Road Committee, a system with gas motive power was recommended for acceptance. The Council, however, hesitated to endorse this plan, and decided to obtain the views of the ratepayers on the matter. Accordingly, a meeting was held on Tuesday, when Mr. Cheetham proposed that the system should be an electrical one. This was seconded by Mr. J. Morris, but the meeting was ultimately adjourned.

STORES LIGHTING.—The premises of the Tranent Co-operative Store Society, Glasgow, are now lighted electrically. Two arcs and about 120 incandescents are used, the installation having been carried out by Messrs. Higgs and Co.

SUNDERLAND.—The report of the Highways Committee presented at the meeting of the Town Council on Saturday, stated that the total capital expenditure to June 30th last on the Council's electric lighting works was £20,961. 1s. 5d., and it was anticipated that further extensions, &c., would necessitate the expenditure of about £23,000 additional. The committee also reported that there was a loss on the past year's working of £700. The Town Council have adopted the committee's recommendation that the salary of their electrical engineer (Mr. C. S. Vesey Brown) be increased by £60 per annum, and they have also decided to ask Prof. Kennedy to retain his position as consulting engineer at a remuneration of 2 per cent. on the cost of the extensions.

TARIFF CHANGES.—As a result of the recent Franco-Swiss Commercial Convention several modifications have been made in the French tariff on electrical machinery imported into that country from Switzerland. In future the duty on dynamos weighing 5,000 kilos, containing 50 per cent. of cast iron, will be 12fr. per 100 kilos, and on similar machines with less than 50 per cent. of cast iron, 20fr.; on dynamos from 2,000 to 5,000 kilos, with 50 per cent. of cast iron, 18fr. per 100 kilos; and on similar machines with less than 50 per cent. of cast iron, 20fr. On dynamos weighing from 1,000 to 2,000 kilos, 20fr.; from 50 to 100, 30fr.; and from 10 to 50, 80fr. per 100 kilos. Complete dynamo machines and detached pieces, worked parts of copper weighing less than 1 kilo, numbered and marked, fitted together or not, for machines weighing more than 2,000 kilos, 35fr.; from 1,000 to 2,000, 40fr.; from 200 to 1,000, 45fr.; from 1 to 200, 60fr.; and less than 1 kilo 75 centimes per 100 kilos. The new duty on arc lamps is 60fr.

TAUNTON.—In the report of the electrical engineer (Mr. H. W. Couzens), presented at the last meeting of the Town Council, it is stated that all the overhead wires in North Town and North-street have been removed, and that the underground mains are working satisfactorily. The demand for current is steadily increasing, and 73 additional 16 c.p. lamps were connected to the mains during the past quarter.

THE "NIAGARA" PULVERISER.—Messrs. Easton, Anderson and Goolden, of 3, Whitehall-place, London, S.W., and Erith, have secured the sole rights for the manufacture of the Niagara Crusher and Pulveriser (W. H. Coward's patent). This machine is adapted for the crushing of all classes of materials, and can be seen at work either at the Company's works at Erith or at the repairing shops, New Tothill-street, Westminster, S.W. The makers claim for the machine that it is very simple in construction, requires only small power, that no screens are necessary, and that it is very economical in working, to the extent, it is claimed, of 75 per cent. over the old type of pulveriser. Illustrated printed particulars can be obtained on request.

WORLD'S FAIR AWARDS.—It would really appear that those exhibitors at the late Chicago Exhibition to whom medals were awarded, are within measurable distance of receiving their long-delayed awards. According to latest information, the medals ought to reach the British exhibitors by the end of the current month. It is stated that the cause of the extraordinary delay (over two years) was due to the fact that the design of the artist who was originally chosen was not considered suitable, and another artist had to be selected. The medals, some 24,000 (!) in number, have now been made, and are ready for delivery.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

July 30, 1895.

14,481. T. G. POOLE and W. LOWRY. London. An improvement in imitation candles for electric lights.*

14,485. J. DEVONSHIRE. London. Improvements in alternating-current arc lamps. (C. E. Harthan, United States.)*

14,486. J. DEVONSHIRE. London. Improvements in four-motor reversing switches. (F. E. Case, United States.)*

14,492. S. PRIETO. London. An improved arc regulator for electric lamps.*

14,493. T. D. HOLLICK and F. W. HOLLICK. London. Improvements in electromotors and dynamos.

August 1, 1895.

14,577. C. B. CRAWSHAW and R. KENNEDY. Bradford. Improvements in multiple-circuit dynamo-electric machinery.

14,589. C. B. CRAWSHAW and R. KENNEDY. Bradford. Improvements in starting switches for electromotors, and in apparatus therefor.

14,615. E. DELANEY. Liverpool New or improved device applicable for use in connection with telephones.

14,627. A. C. BROWN and G. R. NEILSON. London. Improvements in electric fire-alarms.

14,638. J. C. CHAPMAN. London. Improvements in electric brakes. (W. B. Potter, United States.)*

14,639. J. C. CHAPMAN. London. Improvements in safety appliances for electric cars. (W. B. Potter, United States).*

August 2, 1895.

14,676. H. HIRST and W. E. GIBSON. London. Improvements in shade-holders for electrical and other lamps.

14,706. P. J. BUNAU-VARILLA. London. Mechanical and electrical apparatus for excavating and removing earth.

14,709. W. J. DAVY. London. Improvements in electric arc lamps.

August 3, 1895.

14,739. J. M. HUISMAN and H. C. GOVER. Glasgow. Improvements in holders for incandescent electric lamps.

14,792. THE ROGERS ARC LAMP COMPANY (LIMITED) and J. W. ROGERS. London. Improvements in electric arc lamps.*

August 6, 1895.

14,801. C. LUCKOW. Manchester. Improvements in the electrolytic production of oxides and salts which are insoluble, or practically insoluble, in the electrolyte.*

14,804. O. Y. RHODES. Leeds. Combined electric bell press, pear press, and holder.

14,840. F. W. DURHAM, Jun. London. Spray electrolysis.

14,842. W. P. THOMPSON. Liverpool. Improvements in electric condensers for use in polyphase and multiphase alternating current circuits. (C. S. Bradley, United States.)*

14,847. A. J. P. WHITAKER and F. G. TREHARNE. London. Improvements in electrically-insulated pipes and in the method of joining the same together, and in insulating cement or enamel used in connection therewith.

14,858. J. HARRIS. London. Improvements in electric meters.*

August 7, 1895.

14,902. G. FABBRO. London. Improvements in plates for secondary batteries.

14,914. W. J. BREWER. London. Improvements in overhead conductors for electric railways and tramways.

14,937. A. C. GORDON. London. Improvements in electric block signals for railroads.*

August 8, 1895.

14,973. W. WEBBER. London. Improvements in prepayment apparatus for attachment to gas, electricity, or other fluid meters. (Date applied for under Patents, &c., Act, 1883, Sec. 103, April 16, 1895, being date of application in United States.)

14,984. G. H. NISBETT. London. Improvements in the manufacture of insulated cables.

August 9, 1895.

15,024. E. ANDREOLI and G. ANDREOLI. London. Electrolytic production of amalgams, and their utilisation.*

15,057. SIEMENS BROS. AND CO. (LIMITED) and H. S. S. HARVEY. London. Improved means and apparatus for regulating or compensating for the variation of voltage in electric circuits.

August 10, 1895.

15,069. J. S. BIGGAR. Manchester. Improvements in and relating to telephony.

15,114. C. ERBEN and E. BERGMANN. London. Improvements in electric current meters.*

15,119. L. A. G. E. R. COMBOUL. London. Improvements in electrolysing apparatus.

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August 12, 1895.

15,126. W. H. WILLATT. Hull. An improvement in secondary batteries

15,134. C. W. WASHINGTON. Huddersfield. Improvements in apparatus for covering electrical and other wires.

15,166. J. H. PELETAN and E. CHRISTOPHE. London. Improvements in electrophones applicable as electric lighters. (Date applied for under Patents, &c., Act, 1883, Sec. 103, February 13, 1895, being date of application in France).

15,174. L. B. ATKINSON. London. Improvements in single-phase and multiphase alternate-current motors.

August 13, 1895.

15,178. E. J. PIPER. Westminster. Improvements in electric arc lamps.

15,215. C. L. BUCKINGHAM. London. Improvements in and pertaining to telegraphic and other printing apparatus.

15,216. F. A. WEBB. London. Improvements in electric lighting attachment for gas burners.

15,225. J. DEVONSHIRE. London. Improvements in electric brakes. (William B. Potter, United States.)

August 14, 1895.

15,259. M. S. PICKSTONE. Manchester. Improvements in and connected with dynamo electric machinery.

15,260. F. G. ROBINSON. Liverpool. Improvements in electromagnetic separators.

15,276. E. P. ALLAM. London. Improvements in self-recording electric meters.

15,288. H. H. LAKE. London. Improvements in electric clocks. (Société Anonyme La Précision, Belgium.)

15,292. H. TIPPING and J. B. HAMOND. London. Improvements in galvanic batteries.

15,295. E. J. COUSTAM and L. GASTER. London. Improvements in the manufacture of illuminating bodies for use in electric lighting.

15,301. H. V. KEESON. London. Improvements in electric exploders.

August 15th, 1895.

15,338. R. H. BARNETT. Newcastle-on-Tyne. Improvements in electric arc lamps.

15,343. H. HIRST. London. Improvements in couplings or joints for the sheathing of electrical conductors.

15,363. C. E. SPAGNOLETTI. London. Improvements in electrical distribution.

15,365 W. H. DINGLE and J. URQUHART. London. Improvements in and relating to electric switches.

15,369 J. B. TORRES. London. Improvements in secondary or storage batteries.

15,371 W. ROWBOTHAM. London. Improvements in and connected with primary batteries.

August 16th, 1895.

15,431 D. MATHIEU. London. Improved electric apparatus for striking bells and the like or giving signals.

15,432 D. MATHIEU. London. Improvements in or relating to batteries.

15,433 D. MATHIEU. London. Improved electric apparatus for striking bells and the like or giving signals.

15,442 H. FARADAY. London. Improved means for supporting or suspending electroliers and the like, and for facilitating the raising and lowering of the same.

15,445 W. S. STIELTJES. London. Improvements in step-by-step printing telegraphs.

15,450. S. R. F. LURASCHI and E. LURASCHI. London. Improvements in electric telegraphs.

15,461. S. H. SNOWDEN. London. Improvements in or relating to telephone receivers.

15,470. C. D. ABEL. London. Improvements in asynchronous electrical machines. (La Société Anonyme pour la Transmission de la Force par l'Electricité, France.)

15,471. G. BAMBURY. London. Apparatus for converting alternating electrical currents into continuous currents.

August 17, 1895.

15,511. J. BROCKIE. London. An improved hand-feed projector arc lamp.

15,513. A. DONAY. London. Automatic regulator for dynamo electric machines supplying electric motors.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

14,113. COOPER and OTHERS. Electric meters.

14,488. JEFFRYES and LEA. Arc lamps.

16,473. RITTER. Telephones.

16,916. TAYLOR. Lime and electric lights.

16,943. LANGLOIS. Ladder platform for telephone linesmen.

17,077. DANDO and GWYNNE. Lenses and electric lamps.

17,378. BLACKBURN and BOYDEN. Direct-current transformers.

17,542. LIARDET. Electric storage batteries,

17,808. LYON Arc lamps.

18,177. AUGUSTE GODCHAUX. Electrically actuated brakes, &c.

18,196. SIEMENS BROS AND CO. (LIMITED) (Siemens and Halske). Electric conductors.

18,273. IMRAY (Société Anonyme pour la Transmission de la Force par l'Electricité). Electric motors.

18,999. THOMPSON (Société M. Gaupillat and Co.). Electric fuses.

21,838. BEIN. Electrolysing chemical combinations, &c.

1895.

1,512. ROSS. Arc lamps.

6,756. BOULT (Rabbidge). Telephone apparatus.

9,708. DELANY. Electric heaters.

11,752. ANDREOLI. Electro-deposition of gold and silver.

11,842. NEWTON (Willms). Rheostats, &c.

12,229. VOIGHT and HAEFFNER. Electric resistances.

12,420. WEISE. Electric battery plates.

COMPANIES' MEETINGS.

Birmingham Central Tramways Company.

The annual general meeting of the shareholders of this Company was held on Wednesday at Birmingham, Mr. W. Neale presiding.

The CHAIRMAN, in moving the adoption of the report and statement of accounts, said each of the four departments of the Company (horse, steam, cable and electric) was worked from its own centre, and was practically independent. The steam and cable departments were progressive and profitable, and they mainly depended upon them for their revenue and for the dividend. The horse and electric departments were a constant source of difficulty and anxiety to the Directors. On the Bristol-road electric route they had run 138,925 miles, and had carried 1,154,345 passengers, a decrease of 149,488 ; and their receipts amounted to £9,093, a decrease of £641. Their loss on this section of the line was £1,735. 12s. 8d., and this result was principally caused by the bad weather during the past winter, and the fire at their terminus threw the traffic out of gear for some time. The omnibus competition on this route was very keen, but they were hopeful that this branch would soon earn a profit. They had made a very favourable contract for the supply of batteries, which, as the patent had expired, were falling in price. The maintenance of the tramways had cost £10,129, a sum far larger than they had ever before paid for upkeep. Although the dividend was small, yet he thought that the balance-sheet was one of the most satisfactory they had ever presented to the shareholders. They had set aside £10,000 for depreciation, which they were in a position to invest in securities outside their own business. In conclusion, the Chairman paid a tribute to the services of the late Chairman (Mr. Joseph Ebbsmith), and said that the present improved position of the Company was due more to that gentleman than to anyone else connected with the Company. A discussion on the general position of the Company took place, but the report and accounts were eventually adopted, and dividends of 5 per cent. on the Guaranteed shares and of 3 per cent. on the Ordinary stock were ordered to be paid. Messrs. J. T. Mantle and William Neale were re-elected Directors.

The Directors' report states that the reduction of the capital of the Company by lowering the nominal value of the Ordinary shares from £10 to £5 has been sanctioned by the Court. The receipts from the electrical department amounted to £8,960. 2s. 11d. The miles run were 138,925, and the passengers carried 1,154,345. The total profit for the year upon the various departments of traffic amounted to £55,924. 0s. 11d., against £52,804. 8s. 11d. for the previous year ; and the total working expenses cost of maintenance, repairs, &c., amounted to £40,917. 3s. 9d. The Directors recommend that, after the payment of the dividend on the Five per Cent. Guaranteed Stock, a dividend of 3 per cent. on the Ordinary shares be paid, and that £10,000 be placed to reserve and £671. 19s. 9d. be carried forward.

Exeter Electric Light Company (Limited).

The annual general meeting of the shareholders of this Company was held on Friday last at the works, Mr. W. H. Ellis presiding. The Directors' report, which the meeting was called to discuss, states that the accounts for 1894 showed a loss, notwithstanding a steady increase in the number of lamps connected. This result was due to the difficulty experienced in maintaining the supply during a large portion of the year. For some time the question of the stability of the Company's two large alternators had been a source of anxiety to the Directors, and during the last year the armatures of both machines had again to be renewed, but the second time since they were first put down, and as soon as these new armatures were put in, they proved to be utterly worthless, and later in the year a still further order for armatures had to be placed with the Brush Company, which, so far, had turned out to be somewhat better than the previous ones, although they could not be considered as wholly satisfactory. This had the effect of not only swelling up the expenditure on dynamos and increasing the bill for coal, oil, &c., but of largely augmenting the cost for repairs to other machinery through the necessity of keeping up the supply with plant only partially fit for running, and the result of these unexpected expenses had been to exhaust the small available balance of working capital. The Directors have, after careful consideration, come to the conclusion that the present site of the works is unsuitable to a large extension of the business, and to its most economical working with improved modern machinery,

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and that any scheme of further financial support or reconstruction should provide for the erection of a new station in a more suitable position. Therefore, having regard to the present financial position of the Company, it appeared impossible to continue the business without a further large subscription of capital. Under these circumstances the Directors, after negotiations with two large London companies, suggest the following schemes:—

1. A transfer of all the shares and debentures of the Company to the County of London and Brush Provincial Electric Lighting Company (Limited) for a fixed sum in cash.

2. The erection of a new station, with modern machinery and an improved method of electrical distribution, the cost to be secured by prior lien debentures, the capital and interest of which shall rank as a first charge on the whole undertaking in priority to the present debentures.

If the second scheme were adopted the Directors urged that the present stockholders might have a chance of participating in any ultimate success which the Company might attain, which would not be the case under Scheme No. 1. As the existing debentures were secured by a mortgage of the whole of the property of the Company, neither scheme could be carried out without the consent of the debenture-holders, and a meeting of such debenture-holders had been called for the same day as the meeting of Ordinary shareholders.

At the debenture holders' meeting it was, we understand, decided to agree to the transfer of the shares and debentures of the Company to the Brush Provincial Company for the sum of £7,000, on the understanding that the Company's title would not be altered and the existing Provisional Order would continue to hold good. The basis of sale agreed to by the debenture-holders was a division of the net sum received in the proportion of 75 per cent. for themselves and 25 per cent. for the Ordinary shareholders. This proposal was favourably received at the shareholders' meeting and, in the course of the discussion, the opinion was strongly expressed by a shareholder that an opportunity should first be given to the City Council to acquire the works. He urged that a concern of such importance should be in the hands of the municipal authorities. Ultimately a resolution was adopted in favour of accepting the Brush Provincial Company's offer, but the consent of every shareholder to the arrangement has, of course, first to be obtained.

STATUTORY RETURNS, &c.

ECUADOR TELEPHONE COMPANY (LIMITED).—The annual return to July 11th has been filed; 5,000 shares have been allotted out of a nominal capital of £100,000, in £5 shares, and the full amount has been paid thereon.

ELECTRIC GUEST CALL COMPANY (LIMITED).—The statutory return to June 21st has been filed. The nominal capital of £5,000 is divided into 1,500 "A" and 3,500 "B" shares of £1 each. All the latter have been issued as fully paid, and 1,062 of the former class have been allotted.

ENGLISH ELECTRIC CARBON COMPANY (LIMITED).—The annual return to June 26th has been filed. The nominal capital is £10,000, in £10 shares, and of these 789 have been allotted. The full amount has been paid thereon.

GORSEINON ELECTRIC LIGHT COMPANY (LIMITED).—The annual return to May 31st has just been filed. Of a capital of £1,000, in £1 shares, 926 shares have been taken up. On these 15s. per share has been paid.

GREENWOOD AND BATLEY (LIMITED).—The annual return to July 6th has been filed. The nominal capital is £400,000, divided into 14,000 Preference and 26,000 Ordinary shares of £10 each; 11,066 of the former and 18,052 of the latter have been taken up, and 2,666 Preference and 4,666 Ordinary have been issued as fully paid. The full amount has been called on 6,934 Preference and 12,134 Ordinary, and £3 per share has been called on the remaining 1,466 Preference and 1,252 Ordinary.

HARGREAVES AND SHAW (LIMITED).—The statutory return to June 10th has been filed. The capital consists of £5,000, in £5 shares; 43 shares have been taken up, and the full amount has been paid thereon.

HOOPER'S TELEGRAPH AND INDIA-RUBBER WORKS (LIMITED).—The statutory return to July 1st has been filed. The nominal capital is £50,000, divided into 1,000 Preference and 4,000 Ordinary shares of £10 each. 1,000 of each class have been taken up, and the Preference shares have been issued as fully paid. The full amount has been paid on 498 Ordinary, £2 per share on 250, and 2s. per share on the remaining 252 shares.

INTERNATIONAL ELECTRIC STORAGE (LIMITED).—The statutory return to April 14, 1894, was not filed until July 31st. The nominal capital is £200,000, in 36,000 Ordinary and 4,000 Preference shares of £5 each. Only seven Ordinary shares were then taken up, but nothing was called thereon. The first annual return to July 10th last has just been filed; 9,500 Ordinary and 600 Preference shares were taken up, and 9,200 Ordinary had been issued as fully paid. The full amount had been called on the remaining 300 Ordinary and 600 Preference shares. As will be seen from our issue of the 9th inst., this Company has gone into voluntary liquidation.

LONDON AND HAMPSTEAD BATTERY COMPANY (LIMITED).—The annual return to June 27th has been filed. Of a nominal capital of £50,000, divided in 7,000 Preference and 3,000 Deferred shares of £5 each, 993 Preference and all the Deferred shares have been taken up, and the latter have been issued as fully paid. The full amount has been paid on the Preference shares.

CITY NOTES.

BABCOCK AND WILCOX (LIMITED).—The Directors of this Company recommend a half-yearly dividend at the rate of 15 per cent. per annum.

BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED).—The Debenture Stock transfer books of this Company are closed from the 21st inst. to September 3rd, inclusive.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended 18th inst. were £924, against £861 in the corresponding period of 1894, a decrease of £63. The total receipts for the half-year amount to £6,008, against £6,063 for the corresponding period of 1894, a decrease of £55.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED).—An extraordinary meeting of this Company was held on Friday last, for the purpose of confirming the resolutions passed at the ordinary meeting on July 29th last, altering the Articles of Association so that the amount from time to time declared by the Directors as available for dividend might be applied in such a manner that there should be first set aside a sum equal to a preferential cumulative dividend of 7 per cent. per annum on the aggregate amount paid or credited on the "A" shares, and that out of the sum so set aside there should be paid a preferential cumulative dividend at the rate of 5 per cent. per annum on the amounts paid or credited as paid on the "A" shares without distinction. The alteration was unanimously adopted.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 18th inst. amounted to £1,374, and to £1,126 in the corresponding week last year, an increase of £248.

LIVERPOOL UNITED GAS LIGHT COMPANY.—At the annual meeting of this Company on Tuesday, Mr. Edward Lawrence, who presided, referred to the purchase of the undertaking of the Liverpool Electric Supply Company by the Corporation, and said he doubted whether they would be better able to persuade the public to take the more expensive illuminant than the electrical company had been. In spite of the progress of electric lighting the quantity of gas manufactured and sold by the Company showed an increase. To show their contempt for the competing illuminant the Directors announce a further reduction in the price of gas from 3s. to 2s. 10d. per 1,000 cubic feet, the reduction to take effect from the end of last quarter. The electric light is thus not only a direct but also an indirect boon to the community.

LONDON PLATINO-BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The half-yearly coupons, which fall due on September 1st, of the £100,000 Six per Cent. Debentures of this Company will be paid by Messrs. Glyn, Mills, Currie and Co., 67, Lombard-street, London, E.C., on and after that date. The coupons must be left three clear days for examination.

SMILLIE PATENT HIGH-PRESSURE PIPE AND TUBE COMPANY (LIMITED).—During the week this Company, which has a nominal capital of £75,000, in £1 shares, issued a prospectus inviting subscriptions for 25,000 shares. The Company has been formed to acquire the patent rights of Mr. R. D. Smillie (No. 17101 of 1893), and to construct, manufacture and sell steam pipes, tubes, and pressure cylinders. A brief description of the Smillie steam pipe was given in our issue of June 7th last, and the prospectus states that the desirability of obtaining a steam pipe which could be relied on to prevent the occurrence of accidents is fully recognised, and the numerous failures that have attended the use of copper pipes under modern high pressures in recent years have accentuated this desire. It is claimed that the Smillie pipe will obviate such failures and safeguard life, property, and machinery against loss or injury. The consulting engineer to the Company is Prof. George Forbes, and the Managing Director Mr. R. D. Smillie. The offices of the Company are Dashwood House, New Broad-street, London, E.C., and 145, St. Vincent-street, Glasgow, and the Secretary (*pro tem.*) is Mr. Alfred Ball. The lists opened on Monday last, and closed yesterday (Thursday).

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.—The report of this Company for 1893 and 1894 states that the present Directors are only responsible for the management since November 21st last. The receipts for 1894 exceeded those of the previous year by £528, and those of 1893 were £2,510 more than in 1892. The receipts per car mile for 1894 were 11·61d., against 11·90d. for 1893 and 13·47d. for 1892. This decrease is attributed to the increased car mileage run on the electrical sections. The total expenditure in 1894 was £1,653 more than in 1893, while the 1893 expenses were £2,294 in excess of the 1892 figures. This increased expenditure was largely caused, the Directors state, by the late Board consenting to the appointment of Receivers and managers in May, 1893. The Directors succeeded in obtaining an order from Mr. Justice Kekewich (which order was affirmed by the Court of Appeal) for the discharge of these Receivers and managers, and a declaration that the tramway was a public undertaking, and could not be broken up and sold in the same manner as an ordinary commercial concern, and that a Receiver of the net earnings only could be appointed. The Directors have commenced an action against Mr. Joseph Ebbsmith and Mr. W. J. Carruthers Wain (the late Chairman), claiming £15,000 damages and other relief, and this action is being pressed forward to trial as quickly as possible. The Directors state that, owing to the position of the Company, they were unable to hold the annual meeting in March, and it will, therefore, be necessary for the shareholders to sanction the meeting being held this month.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended August 16th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,753.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the half-month ended August 15th are £1,649, as compared with £1,638 in the corresponding period of 1894. The April receipts, estimated at £4,883, realised £5,024.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price, August 14.		Price Wednesday, August 21.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending August 21.	
			TELEGRAPHS					£ s. d.		Highest	Lowest
£1,012,88[illegible]	Stock	11 0	Anglo-American	47	49	47	49	4 13 9	Jan., Apr., July, Oct	..	..
£2,993,56[illegible]	Stock	22 0	Do. Preferred	88	89	88	89	5 1 2	" "	89	88
£2,993,56[illegible]	Stock	5/0	Do. Deferred	8½	9	8½	9	..	..	8½	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 16 4	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	13¾	14¼	13¾	14¼	4 7 2	Mar., June, Oct., Dec	14¼	14
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 7 4	June and December	..	..
10,000,00[illegible]	$100	1¾%	Commercial Cable Capital Stock	160	165	160	165	4 4 10	Jan., Apr., July, Oct.	..	..
1[illegible],000	10	5/0	Cuba Submarine xd	13	14	13	14	5 14 4	February and August	13½	..
6,0[illegible]	10	10%	Do. Preference 10 per Cent. xd	20	21	20	21	3 16 2	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 0 0	April and October	..	–
6,00[illegible]	5	10%	Do. Preference 10 per Cent.	9¾	10½	9¾	10½	4 7 7	" "	..	–
£[illegible],000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	
60,710	20	2/0	Direct United States Cable, 1877 xd	9	9½	9	9½	4 4 3	Jan., Apr., July, Oct.	9⅝	9[illegible]
400,00[illegible]	10	5/6	Eastern	17	17½	17	17½	3 15 4	" "	17½	17
70,00[illegible]	10	6%	Do. 6 per Cent. Preference	17¾	18¼	17¾	18¼	3 5 9	" "	18[illegible]	17¾
£[illegible]	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	126	129	127	130	3 1 7	May and November	127[illegible]	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105	108	105	108	4 12 7	February & August	..	..
250,000	10	2/6	Eastern Extension	17⅝	17⅞	17½	17⅞	3 18 11	Jan., Apr., July, Oct.	17[illegible]	17[illegible]
£820,00[illegible]	Stock	4%	Do. 4 per Cent. Debenture Stock xd	125	128	125	129	3 2 0	February & August	128½	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	102	106	103	106	4 14 9	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	102	106	103	106	4 14 9	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.) xd	105	108	105	108	3 1[illegible] 1	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112%	115%	112%	115%	3 10 2	May and November	..	
130,22[illegible]	10	3/3	Globe Telegraph and Trust xd	10[illegible]	10⅜	10½	10⅜	3 19 6	Jan., Apr., July, Oct.	10⅜	10¼
180,01[illegible]	10	6%	Do. 6 per Cent. Preference xd	16¾	17¼	16¾	17¼	3 10 1	" "	17[illegible]	16¾
[illegible]	10	5 0	Great Northern	21¾	22¼	21¾	22¼	3 16 3	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 10	March & September	..	..
17,000	25	37/6	Indo-European	50	53	50	53	4 11 4	May and November	..	..
37,548	10	2/6	London Platino-Brazilian	5	7	5	7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	107	111	107	111	5 10 10	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	107	110	107	110	3 12 11	..	–	..
11,83[illegible]	8	4/0	Reuter's	3½	4½	3½	4½	..	April and October	..	..
3,381	£100 Cert.	[illegible]	*Submarine Cables Trust 6 per Cent.	126	131	127	132	4 2 4	" "	128	..
15,609	10	2/0	West African Telegraph	5½	6½	5½	6½	..	January and July	..	–
£249,900	100	5%	* Do. 5 per Cent. Debentures (red.)	104	107	105	108	4 14 7	March & September	107¾	..
30,00[illegible]	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	104	99	104	7 13 10	June and December	10[illegible]	..
88,32[illegible]	10	6d.	West India and Panama	¾	1	¾	1	..	..	[illegible]	¾
34,56[illegible]	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10	10½	5 14 3	May and November	10½	1[illegible]
4,66[illegible]	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	5 13 [illegible]	" "	9[illegible]	9[illegible]
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110	113	110	113	4 8 11	June and December	..	..
64,242	15	6/0	Western and Brazilian	10½	10¾	10½	10¾	3 4 4	May and November	10¾	..
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	–	.	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4¼	4¾	4¼	4¾	..	–	4⅜	..
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	101	105	5 14 3	February & August	..	–
£214,80[illegible]	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	101	105	5 14 3	" "	..	–
$[illegible]211,00[illegible]	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	6 0 5	May and November	..	..
£166,90[illegible]	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102	104	102	104	5 18 5	March & September	..	–
			TELEPHONES.								
44,00[illegible]	5	2/6	Chili Telephone (fully paid) xd	3	4	3	3½	..	..	–	..
224,85[illegible]	10/0	1½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	–	May and November	..	–
171,504	£1	[illegible] 5d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	..	..
484,59[illegible]	5	2/6	National xd	5⅞	6⅜	5⅞	6⅜	4 0 0	June and December	6⅜	5[illegible]
15,00[illegible]	10	6%	Do. 6 per Cent. Cumulative 1st Pref. xd	16	18	16	18	3 6 8	" "	16½	..
15,00[illegible]	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid) xd	15	16	15	16	3 15 0	" "	..	..
119,23[illegible]	5	2/6	Do. 5% Non-Cumulative 3rd Pref. xd	6	6½	6	6½	4 0 0	–	6[illegible]	6
1,000,00[illegible]	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	105	107	106	108	3 5 1	January and July	107	105
58,0[illegible]	5	3,0	United River Plate	2½	3	2½	3	..	" "	..	..
£146,73[illegible]	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	92	97	92	97	5 3 1	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,00[illegible]	£10	5/0	City of London Electric Lighting (fully paid)	14½	15½	14½	15½	1 12 3	–	15½	14[illegible]
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15½	16½	15½	16½	3 12 9	–	16½	16[illegible]
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	131	134	131	134	3 12 9	June and December	..	..
19,90[illegible]	£5	..	Electricity Supply Co. for Spain	..		..		..	–	..	..
£30,000	£5	2,0	Charing Cross and Strand Electricity Supply Corp.	5½	5¾	5½	5¾	..	–	5[illegible]	–
£57,40[illegible]	£100	5%	Do. 5 per Cent. Debentures, 1900	..		–		..	–	..	..
8,32[illegible]	£5	..	House-to-House Electric	–		–		..	–	..	..
15,00[illegible]	£5	..	Kensington & Knightsbridge El. Light (fully paid)	–		–		..	–	..	..
10,00[illegible]	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	..	..
45,00[illegible]	£5	3/0	Liverpool Electric Supply (fully paid)	7⅞	8⅜	7⅞	8⅜	..	–	..	..
111,00[illegible]	5	..	London Electric Supply	..		..		..	–		
19,90[illegible]	£10	6/0	Metropolitan Electric Supply (fully paid)	11	11½	11	11½	2 12 2	..	11⅜	11[illegible]
£[illegible]	Stock	4½%	* Do. 4½% Debs.	116	119	117	119	3 16 1	June and December	117	..
6,452	£10	2 0	Notting Hill Electric	8½	9	8½	9	..	–	8⅞	–
19,980	£5	2 0	St. James and Pall Mall	8	8½	8¼	8¾	..	–	8½	8½
20,000	£5	7%	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	–	9½	9½
59,900	5	2 6	Westminster Electric Supply (fully paid)	8½	8¾	8½	8¾	3 2 10	–	8⅞	8½
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,00[illegible]	3	1/6	Brush Electrical Engineering	2	2½	2	2½	6 11 7	–	..	..
90,00[illegible]	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2	2½	2	2½	5 6 8	.	..	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	112	115	112	115	3 19 10	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1	2	1	2	..	January and July	..	–
12,139	5	[illegible]	Edison and Swan United xd	2	2½	2	2½		..	2½	..
£1[illegible],[illegible]00	Stock	4½%	Do. 4% Mortgage Debenture Stock	104	107	104	107	4 4 1	..	..	..
[illegible]	£5	..	Electric and General Invest. Ordinary (£1 paid)	–		..		..	..	..	..
120,000	2	..	Electric Construction	¾	1	¾	1	..	..	¾	..
12,845	2	2 9¾	Do. 7 per Cent. Cumulative Pref.	2	2½	2	2½	..	..	–	..
91,195	2	10/0	Elmore's Patent Copper Depositing	½	1	¾	1	..	..	–	–
20,000	5	..	Fowler-Waring Cables (fully paid)	½	¾	½	¾	..	..	..	..
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	19	21	19	21	4 15 3	February & August	20	19½
£[illegible],000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 8 3	March & September	..	..
15,99[illegible]	£10	..	International Okonite Ordinary	..		..		..	–	..	..
16,00[illegible]	£10	..	Do. 8 per Cent. Preference	–		..		..	December and June	..	..
20,00[illegible]	9		Manchester Edison-Swan "A" (£1 5s. paid)	¼	½	⅛	⅜	..	..	..	.
[illegible]	12	12/0	Telegraph Construction and Maintenance	43	45	43	45	4 0 0	March and July	44⅜	43½
£150,000	100	5%	Do. 5 per Cent. Bonds	104	107	104	107	4 13 6	January and July	..	..
37,514	£5	–	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	..
41,09[illegible]	£5	..	Do. Preference (fully paid)	..		..		..	..	..	..
£[illegible],000	10	6/0	W. T. Henley's Telegraph Works Ordinary	10½	11½	11	11½	..	..	11½	–
£30,00[illegible]	10	..	Do. 7 per Cent. Preference	15	15½	15	15½	4 10 4	..	..	..
£50,000	Stock	..	Do. 4½% Mortgage Debenture Stock	104	107	103	107	4 2 7	..	108½	..
			RAILWAYS AND TRAMWAYS.								
£630,00[illegible]	Stock	1½%	City and South London Railway xd	41	43	41	43	2 18 2	May and November	..	..
7,00[illegible]	10	5%	Do. 5% Perpetual Preference xd	14	15	14	15	3 4 6	..	..	..
£67,13[illegible]	Stock	4%	Do. 4% Perpetual Debenture	133	135	133	136	2 18 10	May and November	..	..
87,500	£10	2[illegible]	Liverpool Overhead Railway	10⅝	10⅞	10⅝	10⅞	2 1 4	–	–	–
6,29[illegible]	[illegible]	5%	Do. 5% Preference	15	15½	15	15½	3 4 6	..	..	–
25,00[illegible]	Stock	4%	Do. 4% Debenture	111	113	111	113	3 10 0	January and July	–	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 902. [No. 18. Vol. XXXV.] FRIDAY, AUGUST 30, 1895. PRICE SIXPENCE.

NOTES.

THE magnetic unit proposals contained in Dr. OLIVER LODGE'S Report to the Electrical Standards Committee of the British Association, published in our issue of August 2nd, have so far given rise to considerable adverse comment, and have received but little commendation. We should be glad to see the balance redressed somewhat; discussion so entirely one-sided savours too much of killing the slain. Prof. EWING, it is satisfactory to note, shares our own inability to comprehend the need for new names and units; as he aptly puts it, they may be made legal tender by the fiat of a B. A. committee, but nothing less than a real want can make them current coin. Mr. ESSON also fails to properly appreciate the gravity of the unit question, and protests with a vigour that becomes a practical engineer against a "senseless multiplicity of terms." Mr. RAVENSHAW is, indeed, a *rara avis;* he would be sorry to lose 4π. Mr. ANDERSEN, like most dynamo designers we suspect, has a system of units all his own. Of course, nothing short of an Order in Council can compel the adoption, even in public, of any particular system of magnetic units, and even then every dynamo builder could use in private the particular mixture of inches and centimetres, pounds and grammes, he had grown used to. The question is:—To make the best choice of definite symbols, units and designations adopted for international use, so that there may not arise in the near future a magnetic Babel? Whether Dr. LODGE'S proposals commend themselves to English mathematical physicists we shall learn more or less clearly at Ipswich; that they do not meet with much favour among English text-book writers, experimenters, and dynamo builders is tolerably evident already.

IN an article which we publish this week, Mr. J. WHITCHER deals with some of the principal questions involved when the separate conductors of an alternate-current system are armoured with iron. The author directs attention especially to the self-induction, and the consequent drop in the conductor and hysteresis loss in the iron. The extensive use of concentric and triple-concentric conductors puts a large proportion of alternating-current conductors beyond the range of Mr. WHITCHER'S remarks; yet, as he says, there are a great many places where single mains are run in iron piping, where a knowledge of the inductive drop due to the iron would be valuable. The tables and formulæ which accompany this article in some measure supply this information; though, from the fact that these are deduced from theoretical considerations based upon sine-wave currents, their application to any particular case must be made with necessary modifications. Mr. WHITCHER finds that under practical conditions the loss due to hysteresis is not of great moment and is comparable with the Foucault current loss in the iron. He does not, however, investigate a more important effect, viz., the extra copper loss due to the increased wattless current caused by the self-induction arising from the iron armouring, though it will be easy for the reader to deduce the expressions for the copper loss from the data which Mr. WHITCHER supplies.

AT the meeting of the shareholders of the Birmingham Central Tramways Company last year, the then Chairman spoke of the accumulator car venture of that Company as one of "mingled difficulty and hope," and went on to say that he had "distinct reason to believe that the Electric Department had seen its worst days"; a very restrained dose of prophecy for a chairman, seeing that a *bonâ-fide* profit of over £1,200 had actually been earned by accumulator cars for the first time in history. The circumspection exhibited by Mr. EBBSMITH has, however, been thoroughly justified. His successor had this year to chronicle a loss of £1,735, not attributable, of course, to the system of traction adopted, but to the bad weather, fire at terminus, and keen omnibus competition, a dismal tale which concluded in the customary manner, "they were hopeful that this branch would soon earn a profit," and "they had made a very favourable contract for the supply of batteries." It is very evident that accumulator traction still remains a tangle of hopes and difficulties; the former being served out to investors, the latter being left to engineers to solve—if they can.

THE main financial features of the past twelve months' operation of the battery cars at Birmingham are as follows:—With a practically stationary mileage, the receipts have decreased some 6 per cent., and the expenses have increased some 27 per cent., the total cost of the car mile having grown from about 14¾d. to nearly 18½d., the difference being due quite as much to increased wages as to increased cost of material. It is not considered particularly chivalrous to strike a man when he is down, and acting up to this laudable tradition we will not unduly enlarge on this matter. Suffice it to remark that the Birmingham line is not an abnormally trying one, that several types of cell have been employed, and

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that these experiments on a commercial scale have now lasted several years. And yet with the practical possibility of accumulator tramway traction still an open question, there are individuals who affect to believe in electric omnibuses. Would it not be as well to learn to walk before attempting to run?

A VALUABLE little article on an important branch of central station practice recently appeared in our contemporary, the *Electrical Engineer* of New York, and is given practically *in extenso* in our columns this week. We use the term *central* in a special sense, for the practice we refer to consists in the supply of electrical energy from one large station to a number of minor ones, at times when these latter are under light loads. So far back as August, 1892, our New York contemporary pointed out the advantage which might accrue to the then new station of the Edison Electric Illuminating Company, of Boston, U.S.A., if this station were cross-tied to the older and comparatively uneconomical ones in its vicinity, so that the latter might at times derive power from the former. The good advice was acted upon in 1893, and has been followed ever since. The effect of this practice upon station economy is recorded in the article to which we refer. As would be only reasonable to expect, the change of practice since 1893 has been a step in the direction of improved economy.

THE recent amalgamation, in so far as electric railway work is concerned, of the Baldwin Locomotive Works of Philadelphia with the Westinghouse Electric Manufacturing Company of Pittsburg, leads one to wonder whether, in that remote future when our trunk railway lines will have become electrical, similar business amalgamations will be made in this country. In England, locomotives and most other heavy railway apparatus are, as a rule, made by the railway companies themselves; and not only so, but railway companies are permitted to manufacture for sale. It would seem, therefore, more likely that the owners of extensive works, such as those at Crewe, Derby and Swindon, would not only find themselves able to dispense with the aid of any electrical firm, but might very well indulge in a little manufacturing for the general market. This latter contingency, however, is not less remote than the general working of our trunk lines by electricity upon which it depends.

IN a Paper read before the American Institute of Electrical Engineers, Mr. C. P. STEINMETZ expresses his opinion "that the names *polyphase* and *single phase* are really wrong, and the latter name meaningless, since *phase* becomes a meaning only as *difference of phase*." Thus Mr. STEINMETZ thinks that, like a quarrel, it takes two to make a phase; but the distinction is, we think, a little too finely drawn. The same kind of objection might be raised against the word *polycycle* which he proposes to substitute for *polyphase*, for it might be said that there is really only one cycle, all the cycles being identical, and differing only in phase. There is no good in straining at gnats, even though we do not swallow camels.

IN this country, where the tramcar is known only in one or two stolid business-like patterns, varied slightly only in summer time by the breezy open cars to be seen in many of our provincial towns, we have some difficulty in realising the gay profusion of variety in the cars on many of the American street lines. The gaiety is more in the variety than in the purpose of many of these cars; for the sober hospital or ambulance car and the gloomy funeral car are sombre enough. Besides these there are the mail cars with their Government colours, and scarcely a town but has its batch of decorated cars for the fashionable and popular "trolley parties." Newest of all is the ice-cream car, which, ornamented with coloured electric lights on its sides and roof, and fitted with a bar at which ices and drinks are retailed, flits merrily round the town. We wonder where next inventiveness and the love of creature-comfort will lead.

Electric Heating in the Workshop.—It is stated that reheating molten steel in the ladle by means of electricity has been successfully accomplished at the Homestead Steel Works.

Laval Steam Turbine.—The New York Edison Company is introducing into its new Twelfth-street station, now in course of construction, two 300 H.P. Laval steam turbines, also a storage battery.

The Telephone Service.—In reply to a question in the House of Commons, Mr. Hanbury stated that it was probable that the Government would carry out the recommendation of the late Telephone Committee by appointing a committee in the next Session to consider and report upon the evidence already taken.

A Substitute for Tramway Motor Commutators.—According to the *Electrical World* of New York, in a patent recently granted in America for an electrical motor, the inventor dispenses with the necessity of the "troublesome commutator" by substituting for it a make-and-break device through which the whole current flows!

Motor Equipment of American Government Printing Works.—According to the *Electrical Review* of New York an important change is about to be made in the government printing office in Washington, where the whole of the heavy shafting and expensive belting hitherto employed will be removed to make room for an electric equipment.

Weather Predictions by Telephone.—According to the *Western Electrician* Prof. E. B. Garriott, the new head of the Weather Bureau at Chicago, announces that the Bureau will henceforth make particular efforts to serve those interests that are likely to be injuriously affected by unusual weather conditions. Timely warnings by telephone are to be features.

Brown, Boveri and Co.—On the 24th inst. this firm completed at its works at Baden, after only 3½ years' existence, its 1,000th dynamo, the total capacity of these machines amounting to 55,000 H.P. During the same period the branches of the firm at Paris and Frankfort-on-the-Main have turned out 500 dynamos. At the Baden works there are about 500 employés.

Thomsistiana.—A statement is going the round of the Press to the effect that Lord Kelvin's name will survive in the Spanish language in the new word "*thomsista*," which is to mean "practical electrician," and has now come into general use, being derived from Thomson. There is a "School of Thomsists" in Cadiz, and the establishment of one in Madrid is being vigorously advocated.

Repair of the "P. Q." Cable.—The cable steamer "Faraday" left Woolwich on Wednesday, the 28th inst., to repair the former "P. Q." cable broken in mid-ocean in 2,500 fathoms. On her way she will first repair the Penzance-Brest section, which is interrupted. These breaks make the third which has occurred in this cable system since its acquisition by the Compagnie Française des Cables Télégraphiques in January last, and for which they have found it necessary to invoke outside assistance.

Retention of the Capital.—It is often a debatable matter whether the initial of a personal name which has been applied

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to some common object, as, for instance, a Nicol prism, should be spelled with a capital or a small letter—Nicol or nicol. An engineering contemporary reproves another contemporary for printing "telford paving," and thinks it should have been "Telford;" but it immediately afterwards speaks of "macadam paving" with a small "m"! It is probably the tendency of the capital letter, in all such cases, ultimately to be replaced by the small letter.

Relative Heating Properties of Various Sources of Light.—The following comparison, due to Prof. Palaz, will, the *Engineer* thinks, be useful to electrical engineers in presenting the advantages of electric lighting from the standpoint of coolness. The figures quoted are relative to a given quantity of light:—Arc light, 4; incandescence light, 14; kerosene, argand burner, 331; gas, argand burner, 380; candle, 473; gas, butterfly burner, 511. The heat question is a very important one, but it is as nothing compared with the question of vitiated atmosphere. In this respect, of course, electricity compares still more favourably with all other sources of artificial light.

Liquid Fuel.—It is stated by the *Engineer* that an improved method of burning liquid hydrocarbons or creosote oil has been patented. The intimate mixture of the hydrocarbon vapours and air is ensured by supplying the air from behind the fire bridge. The pipes from the blower pass under the fire bars of the furnace and terminate in fire brick chambers behind the fire bridge; from these the air issues through numerous holes, which are towards the furnace. In this way the already heated air is, as it were, sprayed into the furnace, where it meets the oil vapour, which is introduced above the fire bars, either from sprays in the front of the furnace or from perforated pipes running along the furnace walls.

Burying Wires in Boston.—The Commissioner of the Wire Department in Boston is, says the *Street Railway Gazette* of New York, extending his policy of burying wires and has determined what must be done in this direction during 1895. The feeder wires of the West End Street Railway Company are to be put under ground as far as Adams-square. It is the policy of the Department, where no conductors cross the trolley wires, to order the removal of guard wires. The West End Company would be glad, it is stated, to remove all guard wires, but the Wire Department has made the announcement that it is not yet ready to permit their removal, except in streets where other wires are so distant as to make it impossible for them to come in contact with the trolley wires.

The Thunderstorm of August 22nd in Jutland.—Our Copenhagen correspondent writes that a terrific thunderstorm, unprecedented in its effects, passed over a portion of northern Jutland during the night between Thursday, August 22nd, and Friday, August 23rd, causing the loss of several lives, over 50 fires, and the destruction of a great many horses and cattle in the fields. The storm came from the North Sea, and the principal sufferers are the small towns and villages on both sides of Limfjord. At Thisted 52 violent flashes were counted within two minutes; the lightning struck incessantly, and the inhabitants rushed out from their houses, although it was pouring with rain at the time. From Aalborg 12 fires could be observed, and a postman driving from Thisted to Aalborg saw 26 fires *en route*. At Säby the telephone suffered severely. The loss of property is very serious.

Thermal Conductivity of Copper.—Some experiments have been made by Messrs. R. W. Quick, C. D. Child and B. S. Lanphear, of Cornell University, with a view to determine the relation of the thermal conductivity of copper to its temperature, at low temperatures. The results show that an increase in thermal conductivity takes place with rise in temperature, which is in accord with the previous results obtained by Tait, Lorenz, Kirchoff and Hausemann, but is contrary to those of Stewart, who found a decrease in thermal conductivity with rise in temperature. Stewart, however, worked with electrolytically-deposited copper, while the metal used by the other investigators was obtained by dry processes. It is noteworthy that although, at ordinary temperatures, the thermal conductivity of metals is parallel with their electrical conductivities, yet with varying temperatures diametrically opposite changes in conductivity occur.

Fatality on the Portrush Electric Tramway.—An accident, which resulted in the death of a young man named Waller, aged 23, a native of Blackburn, occurred on Monday evening on the electric tramway at Bushmills. It appears that he and a friend were coming from Belfast around the coast to Portrush on bicycles, and when about a few hundred yards beyond the tramway station on the Portrush road, it is believed that the deceased, endeavouring to run his bicycle on to the tram line, struck the elevated kerbing of granite, about 5in. in height, which at this place divides the county road from the tram line, and was pitched over the machine on to the elevated third rail. His companion, who was a few yards in advance, hearing the deceased shout, returned to his assistance, and found him lying on the rail, and his bicycle on the top of him and also in connection with the rails. The unfortunate man was immediately removed to the waiting room at the station, where, despite the efforts of two doctors, he expired shortly afterwards. In trying to release the body from the rails the deceased's companion received a severe shock.

The Buffalo-Niagara Franchise.—After what seems to be an entirely needless delay, says the *Electrical World* of New York, the Buffalo municipal authorities have again taken up the matter of the terms of the franchise to be offered to the Niagara Company, and have made several notable concessions. The most important of these is in the section relating to the cost of electrical energy for municipal purposes. As originally drawn up, this section required that power should be sold to the city for £4 per annual 24-hour horse-power, and that street arc lamps should be supplied for £10 per year, or current sold to the contractors for city lighting, so that they could supply arc lights at that price; in the amended franchise these provisions are omitted. Another omission of importance is in the section relating to the life of the franchise, the clause governing the purchase of the plant by the city at the end of 25 years being left out, thus leaving the grantee at liberty to negotiate terms when the occasion arises. Another concession permits the Niagara Company, if it accepts the franchise, to transfer it to a company to be hereafter formed for the purpose of relieving the present Company of the necessity of carrying on a business of local distribution. The Niagara Company has not yet announced its intention with respect to accepting or rejecting the franchise as amended.

The Power Stations at Hoboken, N.J.—The North Hudson County Railway Company, of Hoboken, N.J., operates about 83 miles of tramways, of which a considerable and increasing proportion is electrical. The power station for the electric cars is 200ft. long and 100ft. wide, and is in two storeys. There are two Corliss steam engines of 500 H.P. each, and three Ball engines of 250 H.P. each. The larger engines run at 65 revolutions, driving two General Electric multipolar dynamos. Each of the smaller engines drives two 125 H.P. Thomson-Houston dynamos. Steam is generated in six 125 H.P. boilers. It is an interesting point, however, and one which leads us to notice this tramway system now, that not only does it derive current from its own station, but, in addition, is so fitted as to be able to tap power from the mains of the Hudson Electric Light Company. In order to give some idea of the relative magnitude of the tramway power station and the electric light station, we may state that the latter includes the following plant:—There are two vertical cross-compound 500 H.P. Corliss engines, one horizontal cross-compound 1,500 H.P. engine of the same make, and one 650 H.P. cross-compound engine. About 190 electrically-driven cars are worked in all by the County Railway Company.

Power Vehicles on French Roads.—According to *Engineering*, in France, power vehicles, intended for use on ordinary roads, fall, on the one hand, under the regulations that control the use of steam boilers and engines, and, on the other, under the legislation which regulates the circulation of all classes of vehicles on roads and streets; thus, although there is no special legislation on the subject, the application of existing laws and police *ordonnances* are sufficient to provide against all probable dangers that might arise from the use of such vehicles. The special regulations apply only to Paris and the surrounding districts; but if, as appears probable, there is shortly to be a general increase in the use of such vehicles, legislation on the subject will become necessary. If it is found by experience

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that the use of power carriages is not attended with inconvenience and danger to the ordinary pedestrian and to wheeled traffic, it is certain that a relaxation in the law will be permitted when expedient. Such an innovation in the means of locomotion may prove in the future, says our contemporary, to be of great value and convenience, but while it is in the experimental stage, it is only reasonable that the safety and convenience of the general public should be the first and principal consideration.

Reduction of Alumina by Carbon.—M. Moissan, says the *Engineering and Mining Journal* of New York, has shown that when crystals of corundum are heated in a carbon tube in the electric furnace metallic aluminium is obtained. At the high temperature of the electric furnace, produced by a current of 1,200 amperes at a pressure of 80 volts, the vapour of carbon is able to reduce the vapour of alumina. In another experiment 100 grammes of alumina were placed in a carbon tube (400mm. long by 40mm. internal diameter) closed at one end, and so arranged in the furnace that the closed end was raised to the highest temperature. On passing a current of 300 amperes at 65 volts for 15min., vapours were given off at the open end of the tube, which condensed on cold bodies, and proved, on examination, to be minute spheres of fused alumina. After cooling, the carbon tube was found to contain a white deposit of alumina, together with an ingot of alumina, while that portion of the tube which had been raised to the highest temperature contained a skin of graphite formed by the condensation of the vapour of carbon. On the walls of the tube were found small white or yellowish globules, consisting of a mixture of aluminum and its carbide. Starch, which supplies the carbon necessary for the reduction, may with advantage be mixed with the alumina before heating. Alumina may be melted in a carbon crucible without any reduction taking place, and it is only when the temperature is raised sufficiently high to vapourise both the alumina and the carbon that reduction is possible.

Proposed Light Electric Railway to the Peak District.—A large number of influential landowners and others in Derbyshire have been so long impressed with the great necessity for improved railway communication between Derby and Ashbourne that a proposal is now on foot for the construction of a light electric railway between those towns. Mr. John Shaw, jun., of Derby, with the assistance of Mr. Alfred Dickinson, has produced a scheme for the construction of this railway, and the proposal has already met with some favour. It is proposed that the line should be connected with the existing Derby tramway, which terminates on the Ashbourne-road, and thence it would run through the parishes of Mackworth, Kirk Langley, Brailsford, Ednaston, Osmaston, Compton, into the town of Ashbourne, terminating near Compton Bridge. On only one portion of the proposed line is there really a stiff grade, and that is for about one mile at the Asbourne end. It is suggested that the line should be laid on the western side of the high road, through nearly the whole length. Electric signalling would be adopted to enable the crossings to be placed at as great a distance as possible from one another. If the cars on the proposed railway are run at a maximum speed of 15 miles per hour the journey could be completed in an hour, thus showing a saving of time between the light railway and the ordinary railway on the North Stafford line. The gross rough estimate for the entire cost of the line is estimated at £62,300. The scheme has already received the sanction of a large public meeting of landowners and others, and a representative committee has been formed.

The Conductivity of Mixtures of Metallic Filings and Dielectric Substances.—In the *Comptes Rendus* for August 19th, M. G. T. Lhuillier contributes an account of some experiments made with mixtures of copper, aluminium or iron filings, and liquid and solid dielectric substances. His experiments go to show that the displacement of the filings in a liquid dielectric, or *vice versâ*, can be carried out without destroying the conductivity of the mixture, but also without producing it. These filings may be displaced in alcohol by means of a magnet; but the conductivity does not disappear, but is only slightly modified. Gentle tapping, on the other hand, completely annihilates the conductivity. Alcohol may be replaced by an equal volume of fresh alcohol without modifying the conductivity. A liquid dielectric may also be replaced by any other, provided the second has no chemical action on it, without the resistance of the mixture being affected. This is the case with water replacing olive oil. If, however, the second liquid dielectric can dissolve the first, as is the case with water taking the place of alcohol, the resistance, after remaining some time constant at 143 ohms, suddenly rose in one case in three or four minutes to about 500,000 ohms. This experiment, M. Lhuillier thinks, shows that if in the phenomena exhibited by these mixtures the dielectric plays an active part, it only does so through a very small distance. He thinks that each filing should be regarded as imprisoned in a sheath of liquid, which adheres by capillarity to the neighbouring sheath. The substitution of another liquid, identical or different, which has no dissolving action on the first, will thus leave the original equilibrium intact, and the conductivity will not be affected. The question then arises whether the dielectric becomes a conductor for short distances, and experiments by M. Lhuillier tend to show that it does not become conducting even at distances less than 1μ.

The Thunderstorm of August 22nd.—In a letter to *The Times* of Friday, Mr. G. J. Symons, writing from Camden-square, says :—

Lightning was, I believe, frequent from about 3 a.m., and thunder subsequently ; there is an irregularity in the Redier barograph trace at 4:30 a.m., which probably indicates a distant storm. Thunder was heard at 7:30, but I did not hear it until 15min. later, and I put the brontometer in action at 7:50. The storm was not a very bad one, the thunder being more noticeable than the lightning ; of the former there were 68 peals between 7:50 and 9:12 a.m. ; the rain began earlier in town than it did here, and was, I think, heavier, our total being about 0·05in., which fell in two little showers about 8:15 and 8:55 respectively. There was considerable barometric disturbance, but that cannot be clearly shown without a diagram. About twelve hours later a severe storm came on. My record begins at 7:52 p.m., with a distant storm in the S.W., but it was unimportant until 8 p.m., after which the storm became very heavy. I am sure that I missed the record of many flashes of lightning, and yet between 8 and 9 p.m. I have the times of 667, of which 111 are recorded between 8:15 and 8:20 p.m., 39 of them in the one minute from 8:16 to 8:17. The thunder was more continuous later; it was absolutely continuous from 8h. 26min. 50sec. to 8h. 28min. 30sec. (100 seconds), and, with two breaks amounting to perhaps 5sec., it was continuous from 8h. 26min. 50sec. to 8h. 29min. 55sec., or 3min. 5sec., I think an unusual duration in this country. The rain began at 8:23, and was over at 8:45, but it was heavy from 8:29 to 8:37, nearly all of the total 0·39in. falling in that time. There was a little hail from 8:35 to 8:40, but it was unimportant. The storm passed away to N.E.

The following are some of the fatalities and incidents that occurred :—An old gentleman named Gregson, aged 81, residing at Kingston, was watching the lightning from the window, and whilst standing there beside his wife he was struck, and expired almost immediately. Mrs. Gregson was unhurt.—A singular scene was witnessed at the Kingston Hotel. During the height of the storm it was crowded by people who had sought shelter, when a large ball of fire entered by the open door, and after shooting in a zigzag fashion through the bar, passed out of the door again. No damage was done.—The lightning caused the alarm bells of the Kingston and Surbiton Fire Brigade to ring continuously during the whole time the storm was raging.—Two large villas in Friern Park, North Finchley, were struck by lightning, and the roofs became ignited. —At Sandwich the spire of the Church of St. Bartholomew was struck by the lightning, and the tower was so shattered that it had to be taken down to prevent serious damage to the rest of the fabric. Some of the tiles had been hurled from the roof a distance of 120ft. from the building.—A young man named Ransome was struck by lightning, and killed, near Lancing College, Brighton.—Whilst the fishing smack "Albert," of Ramsgate, was at sea, the lightning struck the mast of the vessel, and the skipper, Mr. Alfred Wratten, who was standing just abaft, was instantly killed.—About half-past seven o'clock on Thursday night, a shepherd, employed by Mr. Thomas Peacock, of Willowrow Farm, near Littleport, was struck by lightning and killed.—A private of the 2nd Wilts Regiment is lying in a somewhat precarious state in the Cambridge Hospital, Aldershot, having received a great shock and severe burns under the arms and on the body. He was on guard on Thursday night, and during the storm sought shelter in the sentry-box. The rifle was twisted and doubled up.

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ELECTROMAGNETIC THEORY.—LXXIII.*

BY OLIVER HEAVISIDE.

(*Continued from page 483.*)

§ 283. Start with the characteristic equation of a coil, being the form taken by the second circuital law when applied to a linear circuit of constant resistance. Say

$$e = (R + Lp)C, \qquad (2)$$

where R is the resistance and L the inductance of the circuit, C the current and e the impressed voltage.

First, let it be given that C is steady from the initial moment, and zero previously. What is the corresponding e? The answer is immediate. We want two impressed forces, namely, $e_1 = RC$ to keep up the current, and $e_2 = LpC$ to start it. Since $p1$ is a unit impulse, e_2 is an impulsive force of total LC. First we require the impulsive force establishing the momentum LC instantly, and then the steady force RC to keep it up against the resistance.

Now this is an example, not of the working of the expansion theorem, but of its failure. But the treatment is sufficiently clear without it. If we tried to force it into the expansion theorem we should want the root of $(R + Lp)^{-1} = 0$, which has no finite root.

But now find the C due to steady e, which is quite a different problem. By (2) the answer is

$$C = \frac{e}{R + Lp}, \qquad (3)$$

which is of a proper form for the expansion theorem. Here Z_0 is R; p is $-R/L$; dZ/dp is L; so, by (1),

$$C = \frac{e}{R} + \frac{\epsilon^{-Rt/L}}{(-R/L)L} = \frac{e}{R}(1 - \epsilon^{-Rt/L}), \qquad (4)$$

showing the gradual rise of C to its steady value.

Since this case is fundamental, the operational way of getting the result may also be indicated. We have

$$\frac{e}{R + Lp} = \frac{e}{Lp(1 + R/Lp)} = \frac{1}{R}\left\{\frac{R}{Lp} - \left(\frac{R}{Lp}\right)^2 + \left(\frac{R}{Lp}\right)^3 - \dots\right\}e. \ (5)$$

This is got by expanding the fraction by division. The rest is done by

$$p^{-n}1 = \frac{t^n}{\lfloor n}, \qquad (6)$$

which makes, applied to (5),

$$C = \frac{e}{R}\left\{\frac{Rt}{L} - \frac{1}{\lfloor 2}\left(\frac{Rt}{L}\right)^2 + \frac{1}{\lfloor 3}\left(\frac{Rt}{L}\right)^3 - \dots\right\}, \qquad (7)$$

which is the expansion of (4), by the meaning of the exponential function. The steps (5) and (7) to obtain (4) may look cumbrous. But there is deception here, for it is, perhaps, a shorter and more direct way than any other. The deception comes in in the customary use of the short expression of the exponential function to denote a certain infinite series, and in taking its properties for granted. However, once done, of course there is no further need for the intermediate work. It will be observed that the case is that of equation (3), § 265, slightly modified. To obtain it as in the equation referred to, let e be impulsive, say $= pE$, where E is the impulse total. Then equation (3) above makes

$$C = \frac{pE}{R + Lp} = \frac{E}{L(1 + R/Lp)} = \frac{E}{L}\epsilon^{-Rt/L}, \qquad (8)$$

as in (3), § 265. The impulse E produces the equivalent momentum E = LC. There is no impressed voltage to keep it up, so it decays according to (8).

In doing (8) by the expansion theorem, notice that $p = 0$ makes C = 0, so there is no steady term. The rest is as in equation (4), only multiplying by p or $-R/L$. Thus, by (1),

$$C = \frac{pE}{R + Lp} = E\frac{p\epsilon^{pt}}{pL} = \frac{E}{L}\epsilon^{pt}, \qquad (9)$$

where p has the special value which makes $R + Lp = 0$.

Next consider another fundamental case, that of a leaky condenser; that is, a conducting leyden or condenser, or one made conducting (equivalently) by a shunt. We have

$$C = (K + Sp)e, \qquad (10)$$

where K is the conductance and S the permittance. The form is the same as for a coil, but current and voltage are interchanged, as well as conductance and resistance, and inductance and permittance.

In order that the voltage e should be instantly raised from zero to constancy, and maintained constant, we require the steady current Ke, and an initial impulsive current of total Se; that is, first the charge Se must be impulsively established, and then it must be maintained constant by the steady current Ke, which goes through the shunt K, of course. Without the steady current the charge of the condenser would disappear.

Now invert the problem. Say

$$e = \frac{C}{K + Sp}, \qquad (11)$$

and inquire what e is required to make C jump from zero to constancy. Here the expansion theorem applies. It is like equation (3) above. So

$$e = \frac{C}{K}(1 - \epsilon^{-Kt/S}) \qquad (12)$$

answers the question, either by translation of symbols or independently.

In another form, if the voltage be made to rise from zero to constancy in the way indicated by (12), the current will be constant, viz., C, during the whole time. This current is *the* current, the total current in the condenser and shunt. The part in the shunt is Ke; the rest is in the condenser. For convenience we assume that the conductance is supplied externally.

§ 284. As regards the simply periodic solutions in these cases, the working is perfectly simple, by means of the property $p^2 = -n^2$ which obtains in simply periodic states, or, which is the same, $p = ni$, applied to reduce the resistance or conductance operator to the standard form $a + bp$. The case

$$e = (R + Lp)C, \qquad (13)$$

when it is C that is given as a simply periodic function, say, $C = c \sin(nt + \theta)$, is obvious, for (13) is in the standard form already.

In the other case, when e is given instead of C, we have

$$C = \frac{e}{R + Lp} = \frac{(R - Lp)e}{R^2 + L^2n^2}. \qquad (14)$$

That is, we bring C to the standard form by multiplying the numerator and denominator by the operator conjugate to $R + Lp$, that is $(R - Lp)$. This realises the denominator. Whether this is done by $p^2 = -n^2$, or by $p = ni$, is indifferent. Only, it should be noted that i is not the imaginary of algebra, but, as I have pointed out before, the differentiator $d/d(nt)$; that is, p/n. It is a specialised differentiator, which may be treated like the imaginary because $p^2 = -n^2$ in simply periodic cases. But it must be finally interpreted correctly, as a differentiator, of course. There is sometimes, perhaps often, some confusion or indistinctness of ideas on this point.

Another point which may not be always understood is the assumption involved that both operand and resultant are simply periodic. This is essential. But it by no means follows that a simply periodic e produces a simply periodic C. It does practically, because there is resistance. But if it be given that there is no resistance, so that $e = LpC$; then if e is given, we obtain, by $p = ni$,

$$C = \frac{e}{Lp} = -\frac{pe}{Ln^2}. \qquad (15)$$

This is the solution *if* C is simply periodic, as well as e. But it would never reach this state without resistance. That is, given a little resistance, e would, in a long time, lead to the state (15) approximately; but if $e = LpC$ is rigidly true, and e starts when $t = 0$, the resulting C is, if $e = e_0 \sin nt$,

$$C = \frac{e_0 \sin nt}{Lp} = \frac{e_0}{Ln}(1 - \cos nt), \qquad (16)$$

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which is quite different. Here, of course, the reciprocal of p signifies integration from 0 to t.

We may easily show the complete establishment of the simply periodic state from (5), by taking $e = e_0 \sin nt$, but *not* assuming C to be simply periodic. Then the powers of p^{-1} are successive integrations from 0 to t; and the result is

$$C = \frac{e_0}{R}\left\{\frac{R}{Ln}(1-\cos nt) - \left(\frac{R}{Ln}\right)^2(nt - \sin nt)\right. \qquad (17)$$

$$\left. + \left(\frac{R}{Ln}\right)^3\left(\frac{(nt)^2}{\underline{|2}} - 1 + \cos nt\right) - \left(\frac{R}{Ln}\right)^4\left(\frac{(nt)^3}{\underline{|3}} - nt + \sin nt\right) + \dots\right\},$$

where the functions of t in the brackets are the successive integrals of $\sin nt$, which are obtainable at sight, or verifiable by differentiation.

By collection of terms, (17) may be put in the form

$$C = \frac{R \sin nt - Ln \cos nt}{R^2 + L^2n^2} + \frac{Ln\epsilon^{-Rt/L}}{R^2 + L^2n^2}. \qquad (18)$$

Here the second part cancels the first initially, though it ultimately vanishes and leaves the first in full play. But when R is zero we never arrive at the simply periodic state, but have the state (16) instead, which is the beginning part of (17), independent of R. As regards the establishment of (18), however, it is quite sufficient to first write down the final periodic state, and then add on a term to cancel it initially and subside at the proper rate. The above way of successive integration shows the internal working.

That p specialises itself to ni when there is simple periodicity of e and C rests upon $p^2 = -n^2$. That the transformation used in (14) is fully valid without escape may be seen thus:— Operate on (13), which is general, by $R - Lp$, making

$$(R - Lp)e = (R^2 - L^2p^2)C, \qquad (19)$$

which is also general. Now specialise, by letting C be simply periodic, and therefore, by (13), e also, though the converse is not necessarily true. We now have $p^2C = -n^2C$, and (19) becomes

$$(R - Lp)e = (R^2 + L^2n^2)C, \qquad (20)$$

which is (14) slightly changed in form.

In the case of a complicated operational solution, if we choose to clear it of fractions, we can generally bring it to the usual form of a differential equation, say

$$Ae = BC, \qquad (21)$$

where A and B are operators involving only direct operations —that is, integral positive powers of p. Then, by specialising e and C to be simply periodic, we make the power of p^n be constant when n is even, and be $p \times$ constant when odd. So we reduce (21) to the form

$$(A_1 + A_2p)e = (B_1 + B_2p)C, \qquad (22)$$

where the A's and B's are constants. A similar treatment applies in the case of irrational operators, as regards their reduction to the standard form.

Finally, if want e in terms of C, multiply by $A_1 - A_2p$. If C in terms of e, then by $B_1 - B_2p$ instead. This work is just as well, and it may be much better done in the operational solution itself, without preliminary conversion to the usual stretched-out form of a differential equation, by either $p^2 = -n^2$ or $p = ni$. Of course, the structure of the formulæ is plainer and simpler in the operational form. This is a very important matter, especially to the electrician, as he can use electrical ideas throughout rather than purely mathematical.

§ 285. In the above cases of a coil or of a condenser, there is but one degree of freedom. To make two, we may put the coil and condenser in sequence. The resistance operators are additive, so

$$e = \left(R + Lp + \frac{1}{K + Sp}\right)C \qquad (23)$$

is the equation of voltage, e being impressed on the complete arrangement. We need say nothing here about the simply periodic case. By inspection of (23) we see that the operator is peculiar, as the expansion theorem applies to one part of it, though not to the other. If C is zero before, and steady after the initial moment, we see that the corresponding e consists of three parts, namely, an impulsive voltage of total LC to generate the current instantly; a steady voltage RC to keep it up against R; and the variable voltage

$$\frac{C}{K}(1 - \epsilon^{-Kt/S}). \qquad (24)$$

The impulsive voltage, and the steady $C(R + K^{-1})$ are clear enough. The exponential term is required to keep the total current constant in the condenser and shunt. The initial impulse does nothing to the condenser. It is merely operative on the coil.

The case $K = 0$ is interesting. Then, by (24), or much more simply by (23), the voltage on the condenser is Ct/S, increasing uniformly with the time.

Only one root is concerned in the above. But if we inquire into the C produced by a steady e, then two roots come into play. Thus, by (23),

$$C = \frac{e}{R + Lp + (K + Sp)^{-1}}. \qquad (26)$$

Taking the denominator to be Z, and applying the expansion theorem, equation (1), we see first that Z_0 is $R + K^{-1}$, and next that

$$p\frac{dZ}{dp} = Lp - \frac{Sp}{(K + Sp)^2}. \qquad (27)$$

So, if p_1 and p_2 denote the two roots of $Z = 0$, the expansion of C is

$$C = \frac{e}{R + K^{-1}} + \frac{e\epsilon^{p_1t}}{Lp_1 - Sp_1(R + Lp_1)^2} + \frac{e\epsilon^{p_2t}}{Lp_2 - Sp_2(R + Lp_2)^2}, \qquad (28)$$

where, instead of $(K + Sp)^{-2}$, we have written $(R + Lp)^2$, because $Z = 0$ makes them equal. Into a discussion of (28) in detail it is unnecessary to enter, the object here being merely the application of the expansion theorem. The theory of circuits in detail would need a chapter to itself.

Another way is to convert (26) to

$$C = \frac{(K + Sp)e}{(R + Lp)(K + Sp) + 1}. \qquad (29)$$

This will give the same result by the expansion theorem, first as regards the steady state, and next as regards the terms variable with the time. In the numerator, p has to receive the two values in succession which make the denominator vanish; that is, if $C = (Y/Z)e$, and the subsidence constants of the normal systems depend upon the vanishing of Z, then

$$C = \frac{Y_0}{Z_0}e + e\Sigma\frac{Y\epsilon^{pt}}{p\dfrac{dZ}{dp}} \qquad (30)$$

expresses the expansion theorem, being equivalent to equation (1). That is, putting it in another form, it is on the infinities of Y/Z that the terms involving the time depend.

In (14), with the specialised meaning of p, the algebrisation was effected by introducing a common factor into the numerator and denominator. Comparing (29) with (26), we see that a common factor is also introduced, though unnecessarily. It does not alter the roots of the denominator. Suppose, however, that it did. Suppose, for instance, we multiply numerator and denominator in (26) by $r + lp$, thus introducing a fresh root $p = -r/l$ to the modified Z. It will make no difference in the working of the expansion theorem. The new term is of size zero, and is, therefore, automatically excluded.

There is an important principle involved here, which may be referred to in passing. Let $C = e/Z$ be the operational solution of an electromagnetic problem, say, involving a complicated combination of coils and condensers. If $Z = 0$ has m roots, there are m degrees of freedom, and m terms in the C expansion, besides possibly an outside steady term. Now, by introducing special relations amongst the resistances, inductances, &c., concerned in Z, we may be able to reduce it to a simpler form, involving a smaller number of roots, even down to one root, it may be. This means that the combination behaves, towards the impressed force, under the circumstances, just as though it were some simpler combination. So far as the expansion of $C = e/Z$ goes, there is no loss of generality by the simplification of Z mentioned. The reduced form used in

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the expansion theorem will give the proper result. The same applies to simply periodic solutions. Nevertheless, the combination does possess a greater generality than the simplified equivalent in other respects, as regards a differently situated impressed force for instance, or as regards free subsidence from an arbitrarily given initial state. It is very convenient to be able to eliminate simply the unessential and inoperative parts of the work, and the Z operators allow us to do this.

We also see, by reversing the reasoning, that when we alter $C = e/Z$ to $C = Ye/YZ$, and introduce thereby a number of new roots of the denominator, viz., those (if any) of $Y = 0$, we are really enlarging the problem, for YZ belongs to a larger combination. But then it is done in such a way that the larger combination is equivalent, as regards the relation between e and C, to the smaller. The extra terms in the expansion of C are of zero size. Thus, with unit operand,

$$\frac{1}{Z} = \frac{Y}{YZ} = \frac{Y_0}{Y_0 Z_0} + \Sigma \frac{Y \epsilon^{pt}}{p(ZY' + YZ')}, \qquad (31)$$

where the accent means differentiation to p. Now, with the roots of $Y = 0$ only, the vanishing numerators make the terms be zero; but this does not happen with those of $Z = 0$. We therefore get the original form of equation (1).

Returning to the condenser and coil, put them in parallel, and subject them to the same impressed force. The conductance operators are now additive, and therefore

$$C = \{(K + Sp) + (R + Lp)^{-1}\}e \qquad (32)$$

is the equation of current.

To have e steady after the initial moment, we require an impulsive current of total Se, a steady current Ke, and a gradually rising current

$$\frac{e}{R}(1 - \epsilon^{-Rt/L}),$$

by what has preceded. Only one time function is concerned.

On the other hand, if the current is steady after the initial moment, we have to expand

$$e = \frac{C}{(K + Sp) + (R + Lp)^{-1}}. \qquad (33)$$

Comparing with (26), and its expansion, we see that the result in the present case is

$$e = \frac{C}{K + R^{-1}} + \frac{C\epsilon^{p_1 t}}{p_1 S - p_1(K + Sp_1)^2} + \frac{C\epsilon^{p_2 t}}{p_2 S - p_2(K + Sp_2)^2} \qquad (34)$$

The roots p_1, p_2, are as before, in (28).

§ 286. As another example of two degrees of freedom, consider two linear conductive circuits. The second circuital law applied to them makes

$$E = (R + Lp)C + Mpc, \qquad (35)$$

$$e = (r + lp)c + MpC, \qquad (36)$$

using big letters for one circuit, small for the other, except in the case of M, the mutual inductance, which is common to both. This is ironless mathematics, of course. Young investigators need not be discouraged by the contempt which is too often poured upon ironless mathematics in engineering journals. It is fundamental, and very useful. Sometimes the contemners only indicate their own ignorance.

If both C and c are to suddenly become steady, we require the voltages indicated explicitly, viz., the steady RC in one and rc in the other circuit, following the initial impulses $LC + Mc$ and $lc + MC$ respectively.

If c is to be kept zero, put $c = 0$, making

$$E = (R + Lp)C, \qquad e = MpC. \qquad (37)$$

That is, we require the voltage MpC in the second circuit to prevent current in it. At the same time, the equation and behaviour of the first circuit are the same as if the second were taken away. The principle of the destruction of mutual induction by a suitable impressed force is a useful one in theoretical reasoning.

When, on the other hand, the forces are given, we should solve for the currents. Thus, by cross multiplication, we may eliminate C or c in turn. The equation of C is

$$C = \frac{(r + lp)E - Mpe}{(R + Lp)(r + lp) - M^2 p^2}, \qquad (38)$$

which, by (1), or (30) more conveniently, expands to

$$C = \frac{E}{R} + \frac{E(r + lp_1) - Mp_1 e}{Lp_1(r + lp_1) + lp_1(R + lp_1) - 2M^2 p_1^2}\epsilon^{p_1 t} \qquad (39)$$
$$+ \text{ditto with } p_2.$$

Here p_1 and p_2 are the roots of the denominator in (38).

The above examples, going only as far as two degrees of freedom, are sufficient to show how the expansion theorem is to be applied. They are not particularly good examples, but are chosen rather to show how to readily discriminate different operators, and see when the expansion theorem applies, and when it does not.

(To be continued.)

THE SELF-INDUCTION OF ARMOURED MAINS.

BY J. WHITCHER.

Mains protected with a surrounding of iron, either as a separate tube or as a lapping of wire or tape, fill the principal part in modern methods of electrical distribution, and without doubt they will continue to do so. Single conductors, or compound conductors in which the flow and return of current do not balance, protected in this way, are open to the objection, when used for alternating currents, that there is a more or less serious amount of inductive drop due to the iron. Concentric cables and conductors run in complete pairs or sets in one pipe are not, of course, subject to this disqualification, but it is sometimes a great practical convenience to be able to use single conductors. Particularly is this the case with a three-wire system of distribution. Moreover, concentric mains, especially if triple, are costly and cumbrous, and a pipe to take three heavy distributing cables must be excessively large, meaning expensive and troublesome service boxes.

It is of some importance, therefore, to know to what extent it is safe to ignore the inductive effects of the iron, and to this end it is necessary to determine the numerical dimensions of the drop occasioned thereby. The following is a brief statement of the theory of the extra self-induction of conductors, due to iron armourings or surroundings, leading to some useful practical formulæ and approximations :—

Taking firstly the case of a conductor in an iron tube, we have to determine the extra induction around the conductor caused by the presence of the iron, and its reactive effect, or the amount of counter E.M.F. it will set up in the conductor.

Put I = the nominal current in the conductor;
n = the frequency;
$B_{\prime\prime}$ = the maximum value of the induction in the iron or the magnetic flux per square inch;
μ = the permeability of the iron;
d = the mean diameter of the tube in inches;
t = the thickness " " ";
e = the E.M.F. of self-induction—the effective mean value.

We must assume that the current variations are according to the simple sine law, this being near enough to the average condition of things in practice; also that the effective mean value of e will be equivalent to that it would have if it varied after the same law. In this case the maximum value of the current will be $\sqrt{2}\,I$ and the effective mean value of e will be equal to 1·1 times the true mean.

Then, if there be no secondary or eddy currents created, the maximum magnetic flux in the iron per square inch of its area will be

$$B_{\prime\prime} = 1{\cdot}016\pi I \times \frac{\sqrt{2}\mu}{\pi d} = 1{\cdot}437\frac{I}{d}\mu. \quad . \quad . \quad (1)$$

The extra E.M.F. of self-induction due to the iron will be that produced by this flux cutting the conductor $4n$ times per second, since it changes from its positive to its negative maximum and back again in every alternation. This gives the true mean value of e; the effective value is therefore

$$e = 1{\cdot}1 \times 1{\cdot}437\frac{I}{d}\mu \times 4n \times 10^{-8} \text{ volts}$$
$$= 6{\cdot}321\frac{I}{d}\mu n \times 10^{-8}.$$

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This per square inch section of iron, which is equivalent to $1/t$ inches length of conductor. Therefore per 100ft. of conductor

$$e = 1{,}200\, t \times 6{\cdot}321\, \frac{I\, n}{d}\, \mu \times 10^{-8} = 0{\cdot}000076\, \frac{t}{d}\, I\, n\, \mu. \quad (2)$$

This E.M.F. is not exactly a counter force, but only so in degree. Instead of being opposite to, or 180deg. of phase behind the magnetising current, it is but 90deg. It must therefore be compounded with the prime electromotive force on the circuit by means of the parallelogram of forces. Thus putting E the E.M.F. impressed on the circuit and E_1 the effective E.M.F. at the far end, the total drop will be, of course, $= E - E_1$. Put D = the resistance drop, then the net drop due to self-induction is $E - E_1 - D$. By the parallelogram of forces $E_1 + D$ is the resultant of E and e; and e is in quadrature to $E_1 + D$. Therefore $E_1 + D = \sqrt{E^2 - e^2}$; and the total drop is equal to $E - \sqrt{E^2 - e^2} + D$. The diagram given later on will put this more clearly.

It may be observed that e may be rather large without producing an appreciable drop. Its chief effect is to make the current lag behind the impressed force E; and until it causes the angle of lag to be considerable its effect as drop is not very marked. Thus, for instance, if e be 10 per cent. of E, and D 2 per cent., the total drop will be only 2·66 per cent.

It is needless to pursue this simple case further, as it is only of theoretical interest. It is impossible but that there should be considerable eddy currents set up in the mass of iron, so that in practice the results will be largely modified by them. The effect of eddy currents will be to reduce the induction in the iron, and therefore e; yet it will increase the actual drop, as e is brought thereby into a greater degree of oppositeness to E.

To determine the influence of these eddy currents, we may consider them as equivalent to one current flowing longitudinally along the inner layers of the pipe and returning along the outer layers. It is clear that the resistance to this current will be equal to four times the longitudinal resistance of the pipe. Also that the equivalent current will be that due to one-half the E.M.F. impressed on the outermost circuit possible within the iron. For the E.M.F. producing the eddy current in any circuit marked out on any given longitudinal section of the tube wall, being due to the induction through the circuit, will evidently be greatest when the circuit is taken around the outer boundaries of the section, and therefore enclosing all the iron. And it will grade down regularly for circuits taken within this one, until it becomes *nil* at the centre line of the section. Thus the average E.M.F. on the whole section will be one-half that on the outermost circuit. Now the latter is actually the E.M.F. of self-induction in the conductor due to the iron, for it is generated by the alternations of the same magnetic flux.

Therefore, if ρ be the specific resistance of the iron in ohms per 100ft. of 1 sq. in. section, the resistance of the eddy current circuit in the same length of pipe will be $\frac{4\rho}{\pi t d}$. And the mean effective eddy current will be

$$i = \frac{e}{2} \cdot \frac{\pi t d}{4 \rho} = 0{\cdot}39\, \frac{e\, t\, d}{\rho}. \quad (4)$$

This current is necessarily in quadrature with the magnetising effect of the currents acting, *i.e.*, the prime current I and itself. The magnetising component is, therefore, the resultant of the two and equal to $\sqrt{I^2 - i^2}$. Substituting this for I we have :—

$$e = 0{\cdot}000076\, \frac{t}{d}\, n\, \mu \sqrt{I^2 - i^2} = \frac{0{\cdot}000076\, t\, n\, \rho\, \mu\, I}{d \sqrt{\rho^2 + (0{\cdot}00003\, \mu\, n\, t^2)^2}}. \quad (5)$$

To know μ it is necessary to know B; hence it is more convenient to write

$$e = 0{\cdot}000053\, t\, n\, B \left(\text{or } 2{\cdot}5\, \frac{P\, i}{t\, d}\right). \quad (6)$$

$$B = \frac{1{\cdot}437\, \mu\, \rho\, I}{d \sqrt{\rho^2 + (0{\cdot}00003\, \mu\, n\, t^2)^2}} \left(\text{or } 48{,}000\, \frac{P\, i}{n\, d\, t^2}\right). \quad (7)$$

Also $$i = \frac{0{\cdot}00003\, n\, t^2\, \mu\, I}{\sqrt{\rho^2 + (0{\cdot}00003\, \mu\, n\, t^2)^2}}. \quad (8)$$

These equations are unwieldy to handle, because of the difficulty of assigning values to μ. But taking a practical view of them, it becomes clear that the exact value of μ between limits is not of much consequence. Thus for every practical case it makes little difference whether μ is 1,000 or infinity; and for many μ may be anything over 50 or 100 without greatly affecting the results. In the tables given herewith, values for

Table I.—*Inductive drop in volts per 100ft. on conductors run singly in cast-iron pipes carrying current* I *amperes at 100 frequency. Maximum and minimum values.*

Internal diameter of pipe.	Thickness of metal.	Minimum values. $\mu = 250$.			Maximum values. μ = infinity.
		e	i	$e\frac{i}{I}$	e
Inches.	Inches.	I	I	I	I
¾	0·25	0·35	0·7	0·245	0·5
1·0	,,	0·28	,,	0·196	0·4
1·25	,,	0·235	,,	0·165	0·33
1·5	,,	0·2	,,	0·14	0·285
1·75	,,	0·175	,,	0·125	0·25
2·0	,,	0·155	,,	0·11	0·225
1·5	0·3125	0·195	0·84	0·16	0·23
1·75	,,	0·17	,,	0·14	0·20
2·0	,,	0·15	,,	0·125	0·18
2·5	,,	0·125	,,	0·105	0·15
3·0	,,	0·105	,,	0·09	0·125
3·5	,,	0·09	,,	0·075	0·105
4·0	,,	0·08	,,	0·065	0·095
4·5	,,	0·07	,,	0·06	0·085
3·0	0·375	0·09	0·92	0·085	0·1
3·5	,,	0·08	,,	0·075	0·085
4·0	,,	0·072	,,	0·065	0·075
4·5	,,	0·065	,,	0·06	0·067
5·0	,,	0·058	,,	0·055	0·06
6·0	,,	0·05	,,	0·045	0·052
7·0	,,	0·043	,,	0·04	0·045
4·0	0·5	0·055	0·98	0·053	0·056
4·5	,,	0·0495	,,	0·0485	0·05
5·0	,,	0·045	,,	0·044	0·046
6·0	,,	0·039	,,	0·038	0·04
7·0	,,	0·033	,,	0·0325	0·0335
8·0	,,	0·0295	,,	0·029	0·03

Table II.—*Inductive drop in volts per 100ft.* **run on single** *conductor in wrought-iron piping (gas barrel), carrying alternating current* I *at frequency of 100. Maximum and minimum values.*

Internal diameter of pipe.	Thickness of metal.	Minimum values. $\mu = 100$.			Maximum values. μ = infinity.
		e	i	$e\frac{i}{I}$	e
Inches.	Inches.	I	I	I	I
0·5	0·144	0·14	0·8	0·112	0·176
0·75	0·160	0·089	0·855	0·076	0·1
1·0	0·160	0·067	,,	0·057	0·08
1·25	0·166	0·051	,,	0·044	0·058
1·5	0·176	0·042	,,	0·036	0·048
1·75	0·176	0·036	,,	0·030	0·042
2·0	0·176	0·032	,,	0·027	0·036
2·25	0·192	0·027	0·9	0·024	0·03
2·5	0·192	0·024	,,	0·022	0·027
2·75	0·192	0·022	,,	0·020	0·024
3·0	0·192	0·020	,,	0·018	0·022

Table III.—*Inductive drop per 100ft. on conductor armoured with steel tape in spirals of d inch diameter.*

Thickness of tape.	Minima $\mu = 50$.			Maxima $\mu = 1{,}000$.		
	e	i	$e\frac{i}{I}$ *	e	i	$e\frac{i}{I}$
	I/d	I/d	I/d^2	I/d	I/d	I/d^2
0·032	0·012	0·03	0·00036	0·2	0·53	0·106
0·048	0·018	0·07	0·0012	0·21	0·8	0·168
0·064	0·024	0·12	0·0029	0·18	0·93	0·167
0·08	0·028	0·18	0·005	0·15	0·97	0·146

* Note that for values of i/I far from unity this approximation to the drop is considerably too low.

The numbers in the columns are constants to be multiplied by the dimension at top—I, I/d, or I/d^2.

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e and i are calculated for mains run in cast-iron pipes taking μ as 250, and also as infinity. For wrought-iron pipes minimum values are shown for $\mu=100$, and maximum values taking it infinity. The true value must be within this range, which it will be seen is sufficiently narrow for most purposes.

For wrought iron this range includes all values of the magnetising force, from the highest to the lowest; for Ewing shows that for the lowest inductions observed μ tended to a minimum of 183 for a specimen of soft iron, and 81 for hard. The case of cast-iron is not so definite. To keep the range narrow, the lower limit of μ is set at 250, which is doubtless too high to take in low or high inductions. But there are no determinations of the permeability of cast-iron at low inductions; and probably it varies greatly with different specimens. Hence it is not well to put it lower, since for thin cast tubes the results vary much for varying values of μ.

The specific resistance ρ has an important influence; and it varies considerably, over a range of about 100 per cent. for wrought, and an indefinite and undetermined one for cast iron. Hopkinson has put the resistance of cast-iron at ten times that of wrought. Therefore, putting for wrought $\rho=0{\cdot}005$, and for cast $\rho=0{\cdot}05$, the formulæ reduce thus for given values:—

For cast iron, when $\mu=250$ and ∞,

$$e=0{\cdot}125\,\frac{i}{d\,t} \qquad \text{and} \qquad 0{\cdot}125\,\frac{I}{dt} \quad . \quad (9)$$

$$i=\frac{0{\cdot}15\,n\,t^2\,I}{\sqrt{1+(0{\cdot}15\,n\,t^2)^2}} \qquad \text{and} \qquad I \quad . \; . \; . \quad (10)$$

For wrought iron, when $\mu=100$ and ∞,

$$e=0{\cdot}0125\,\frac{i}{d\,t} \qquad \text{and} \qquad 0{\cdot}0125\,\frac{I}{dt} \quad . \quad (11)$$

$$i=\frac{0{\cdot}6\,n\,t^2\,I}{\sqrt{1+(0{\cdot}6\,n\,t^2)^2}} \qquad \text{and} \qquad I \quad . \; . \; . \quad (12)$$

To note the full significance of these results we must have some idea of the phase relations of I and i. The clock-

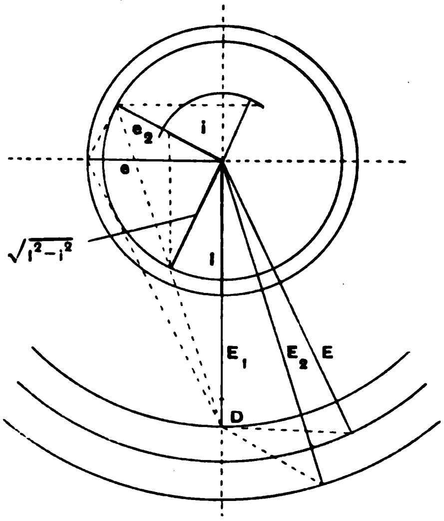

Fig. 1.

face diagram (Fig. 1) illustrates this. Two cases are shown, the one ignoring eddy currents, as already described, and the other taking them into account. The thick lines represent currents, the thin ones electromotive forces. For the first case E_1+D is shown as the resultant of E and e, the current I being the only one acting. For the second case the current i disturbs the influence of I so that the magnetising force is due to their resultant, the line $\sqrt{I^2-i^2}$. Hence E_1+D is now the resultant of E_2 and e_2. By the construction we have the total drop

$$E_2-E_1=E_2+D+e_2\frac{i}{I}-\sqrt{E_2{}^2-e_2{}^2+e_2{}^2\frac{i^2}{I^2}}. \quad . \; . \quad (13)$$

When i is approximately equal to I, which happens when the pipe is thick or of high permeability, this reduces to

$$E_2-E_1=D+e_2,$$

meaning that e_2 is opposite in phase to E_2, and therefore wholly effective as drop; and when E_2 is large compared with the drop, which is generally the case, we have very approximately

$$E_2-E_1=D+e_2\,\frac{i}{I}. \quad . \; . \; . \; . \; . \quad (14)$$

Accepting these simple and practical approximations, we have the inductive drop in forms independent of the E.M.F. on the conductor, and therefore it is possible to tabulate results.

There will be a certain amount of loss due to hysteresis in the iron, but it is difficult to account for it in a practical manner. However, B is most generally low, as may be seen by working out formula (7), assuming $\mu=\infty$, which gives for cast iron $B=\frac{2{,}400\,I}{n\,d\,t^2}$, its highest possible value. The hysteresis loss cannot therefore be very significant. Its effect is very similar to that which would result from an increase in the specific resistance of the iron.

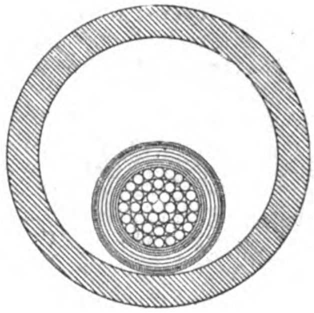

Fig. 2.

It is of more relative prominence in the case of thin metal. To estimate its amount, assuming it not to affect the self-induction, get the loss in watts from the weight of the pipe and the hysteresis per lb. at the given induction. From this the equivalent drop can be found. Take the hysteresis of the wrought at twice, and that of the cast at six times the tabulated values for soft iron.

As a practical example of the foregoing, take a conductor, carrying, say, 200 amperes at 100 volts, run in a cast-iron pipe of $2\frac{1}{2}$in. inside diameter, as shown in cross-section in Fig. 2. The weight of this pipe, including faucet, would be about $9\frac{1}{2}$lb.

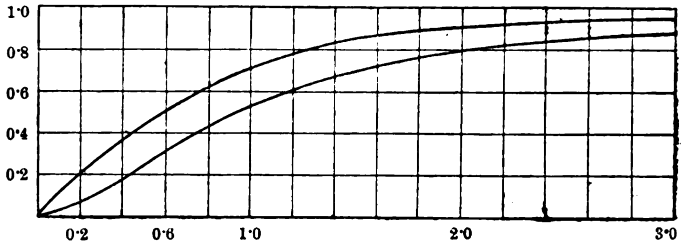

Fig. 3.

Upper Curve=Sine-Tangent, or $y=\frac{x}{\sqrt{1-x^2}}$,

Lower Curve=(Sine)²-Tangent, or $y=\frac{x^2}{1+x^2}$,

where $x=0{\cdot}006\,\mu\,n\,t^2$ for wrought iron, and $0{\cdot}0006\,\mu\,n\,t^2$ for cast iron.

per foot, giving an average thickness of $\frac{5}{16}$in. The mean diameter d is therefore $2\frac{13}{16}$in.

From (9) and (10) we have, per 100ft. run, when $\mu=50$

$e=8$ volts, $\quad i=53$ amperes,

$e\frac{i}{I}=2{\cdot}15$ volts, $\quad B=4{,}000$ per square inch;

when $\mu=250$

$e=25$ volts, $\quad i=166$ amperes,

$e\frac{i}{I}=21$ volts, $\quad B=14{,}000$;

when $\mu=\infty$,

$e=30$ volts, $\quad i=200$ amperes, $\quad B=17{,}400$.

The true drops for the first two cases as calculated by (13) are 2·45 and 22 volts, so that the approximation $e\,i/I$ gives 12 per cent. and $4\frac{1}{2}$ per cent. errors.

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The range between the maximum and minimum chosen values is only about 30 per cent. For practical purposes it suffices to take their mean, which in the above is roughly 26 volts.

This case is impractical, of course, but it is of interest to note that the hysteresis loss would be something like 1,400 watts, meaning 7 volts.

A very useful form of main for street work is that armoured with two crossing lappings of steel tape. Magnetically this armour may be regarded as a single closed tube of thickness equal to the gauge of the tape. Granting this, its effect may be calculated as that of a tube, but it will be noticed that the influence of μ is much more important in small thicknesses like these. The curves given in Fig. 3 will facilitate an understanding on this point. The upper one represents the variation of e in relation to either μ or n when one or the other is constant. It also represents i for varying values either of μ, n, or t. The lower curve represents $e\frac{i}{I}$ relative to μ or n. The former is a "sine tangent" curve; the latter is a "sine squared tangent."

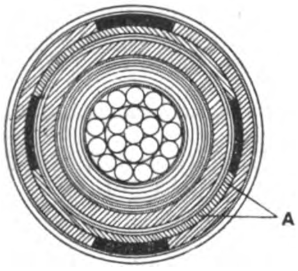

Fig. 4.

For pipes thicker than $\frac{1}{4}$in. if cast iron, and $\frac{1}{8}$in. if wrought, the possible values will lie on the curve somewhere to the right of the ordinate 2. For thinner tubes, and particularly armour, they will lie most probably to the left. Hence near approximations are impossible. In Table III. are given maximum and minimum values for armour of four different gauges, the maxima being for $\mu = 1{,}000$, which is never likely to be attained, and minima $\mu = 50$. These, of course, are the resultant permeabilities of the iron and air-gaps.

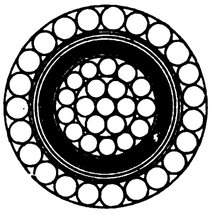

Fig. 5.

Fig. 4 is a typical instance of this class of armouring, representing a 19/12 cable, lead covered and armoured with four steel tapes of 16 S.W.G. in two layers. From Table III its higher limit is $0{\cdot}16\frac{I}{d} = 0{\cdot}15\,I$, or 15 volts per 100ft. run, if $I = 100$ amperes at 100 frequency; and its lower limit $0{\cdot}003\frac{I}{d} = 0{\cdot}0027\,I$, or 0·27 volts. This is a long range, and practically the mean is half the higher value, or $7\frac{1}{2}$ volts. Probably this is too large, but in lieu of actual determination by experiment it would be safe to take it thus.

Another class of armoured cable is shown in Fig. 5, which represents a 19/12 cable armoured with 24 10 S.W.G. galvanised iron wires—rather a heavier armouring than usual. It is difficult to estimate the reluctance of the ring of iron cylinders that make up the magnetic circuit; but probably Prof. S. P. Thompson's formula for the reluctance between cylindrical magnet limbs will give a fair approach to the reluctance between each adjacent pair of semicylindrical faces. This is per inch length of limb,

$$R = \frac{0{\cdot}4}{\pi}\log_e \frac{1}{x + 1 - \sqrt{x^2 - 2\,a\,x}},$$

where x is the ratio between the distance between the cylinders, and their diameter. If there are N wires the total reluctance is N R. The reluctance of the ring of air displaced would be $= N$. The value of R for any probable case will be between 0·1 and 0·2, for the distance separating the wires is a film of zinc and air, and assuming this to be 0·01in., and an average diameter of wire to be 0·1in., then $R = 0{\cdot}068$, the ratio x being $= 0{\cdot}1$. Also if $x = 0{\cdot}05$, $R = 0{\cdot}044$.

Working out formula for e we have

$$e = \frac{0{\cdot}00024\,I\,n\,t}{N\sqrt{R^2 + (0{\cdot}00048\,n\,t^3)^2}},$$

from which it is clear that for the usual values of t the last term in the surd is negligible, meaning that the eddy current effect is inconsiderable. Hence

$$e = 0{\cdot}00024\frac{I\,n\,t}{N\,R} = 0{\cdot}000076\frac{I\,n\,t^2}{d\,R} = 0{\cdot}0015\,I\,n\frac{t^2}{d},$$

taking $R = 0{\cdot}05$ as a fair average.

Evidently this is of very small account in practice. The actual inductive drop, it should be observed, per 100ft. run is $E - \sqrt{E^2 - e^2}$, as in the simple case first given.

THE LOCALISATION OF EARTH FAULTS ON ELECTRIC LIGHT CIRCUITS.

BY J. PIGG.

If the two mains supplying an electric light network are connected by a suitable resistance, the middle point of which is connected to earth through a galvanometer, the latter will not be affected so long as the insulation resistance remains perfect.

If an earth fault exists on either main, in the distributing network or in the dynamo circuits, the galvanometer will show a deflection, and the direction of the deflection will depend whether the fault exists on the + or − side. Further, the amplitude of the deflection will be a measure of the magnitude of the fault which it indicates.

If we move the point of connection with the galvanometer along the resistance towards the faulty cable, we will find the magnitude of the deflection decrease, and when the fault exists on the main, or in the distributing network, a point will be found at which the potential at the point of connection on the resistance will be balanced by the potential at the fault, and there will be no deflection of the galvanometer. In this case the fall of potential through the artificial circuit to the point of connection with the galvanometer and earth is exactly the same as that down the leaky main to the fault.

Let E = Difference of potential at point of test;
E_1 = Difference of potential at distributing point;
R = Resistance of artificial circuit;
R_1 = Resistance of lighting circuit at time of test;
C = Current in lighting circuit at time of test;
c = Current in artificial circuit;
r = Resistance between the leaky main and the galvanometer connection on the artificial circuit when balance is obtained;
r' = Resistance between point of test and the position of fault of main.

Then $\frac{E}{R} = c$ and $\frac{E}{R_1} = C$;

also $cr = Cr_1$,

from which $r_1 = \frac{r\,R_1}{R}$;

but $R_1 = \frac{E}{C}$ at the time of test.

$\therefore\quad r_1 = \frac{r\,E}{R\,C}.$

From this equation we obtain the resistance between the point at which the test is made, and the point at which the fault exists, in terms of the resistances of the artificial circuit,

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the difference of potential at the point of test and the lighting current, all of which quantities are easily obtained.

Let r_2 = the resistance of each of the two mains under test.

Then if $r_1 < r_2$,

the fault exists on the main between the point of test and the distributing point. When this is the case we have, since the resistance of the main is practically uniform throughout its length,

$$\frac{x}{L} = \frac{r_1}{r_2}, \text{ whence } x = \frac{L r_1}{r_2},$$

where L is the total length of the main, and x the distance to the fault.

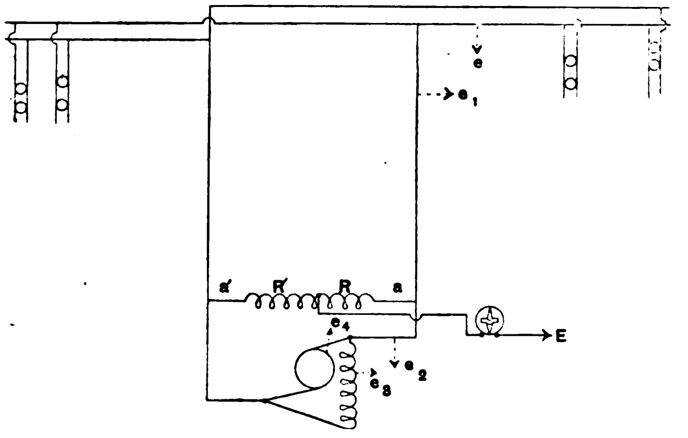
Since $$r_2 = \frac{E - E_1}{2C},$$

the above equation may be written

$$x = \frac{L\, 2\, r_1 C}{E - E_1}.$$

If $r_1 > r_2$ the fault exists on the distributing network.

Considering the lamp circuits of an electric lighting system alone, the resistance at any time may be considered as composed of two parts in series; one part, the mains, having a constant resistance, and the other part, the distributing cables and lamps, having a resistance which varies with the number of lamps connected. By dividing the artificial circuit into a similar number of parts, the localisation of earth faults on the mains is rendered easier, and becomes a simple matter of inspection when the parts are properly proportioned. In the diagram the artificial circuit is divided into four parts a, a', R, R′.



a and a' are fixed resistances of the slide-wire pattern. R and R′ are resistances which are capable of being varied, by units, through a range which depends on the difference between the maximum and minimum currents to be transmitted by the cables under test. If we arrange the various parts of the artificial circuit so that

$$a + a' : R + R' :: 2\, r_2 : \frac{E_1}{C},$$

then, if the resistances a and a' are uniform throughout their length, the distance of a fault on either main will be proportional to the distance from the leaky cable at which a balance is obtained on a or a'. If the slide wires are divided into a number of equal divisions, corresponding to the length of the cable in yards, the point at which a fault exists may be read off without calculation.

Suppose, for example, we have a circuit feeding a distributing network 300 yards away. Let the maximum and minimum currents be 400 amperes and 40 amperes respectively. Let the resistance of each main be 0·02 ohm, and the difference of potential maintained at the distributing point 100 volts. Let the resistances $a\,a'$ be fixed at 10 ohms each, or 500 times that of the cables they represent. When the maximum current is being transmitted the resistance beyond the distributing point will be ¼ ohm, and the sum of the resistances R R′ must be 500 times this value, or 125 ohms.

Hence R and R′ will each require to be 62·5 ohms.

When the minimum current is being transmitted, R and R′ must each be 625 ohms, and these resistances must be capable of adjustment within this range. The maximum fall of potential down each main will be 8 volts, or 0·027 volt per yard, and the fall of potential down $a\,a'$ will have this value per division.

A short consideration of the diagram will show that the apparatus, as developed, will distinguish between a fault in the dynamo circuits and one in the lamp circuits. Such faults as are indicated by e and e_1 have been considered. A fault at e_2 would deflect the galvanometer in precisely the same way as faults at either e or e_1, but it would be found impossible to obtain a balance on a however near to the cable the galvanometer connection was brought, since the potential of e_2 is greater than that at any point on the artificial circuit.

A fault at e_3 may be distinguished from e and e_1 by varying the current slightly in the shunt circuit and keeping the currents in the lamp circuit constant, after obtaining a preliminary balance. If the point of balance is altered, the fault exists in the shunt winding.

A fault at e_4 may be readily detected by the unsteady deflection of the galvanometer, due to it being traversed by alternating currents.

A faulty main may be distinguished from others worked from the same 'bus bars by varying the currents in them in turn until one is found which requires a fresh adjustment on the slide wires to preserve the balance previously obtained.

COAL CONSUMPTION IN AN EDISON STATION OF 1890 TYPE.*

At the new station of the Edison Electric Illuminating Company, of Boston, the possibility of feeding the old and comparatively uneconomical stations from it at times of light load by means of tie lines has been tried. This policy was begun in May, 1893, and besides proving a decided financial success, it has furnished some data as to the use of coal when the station is supplying the same

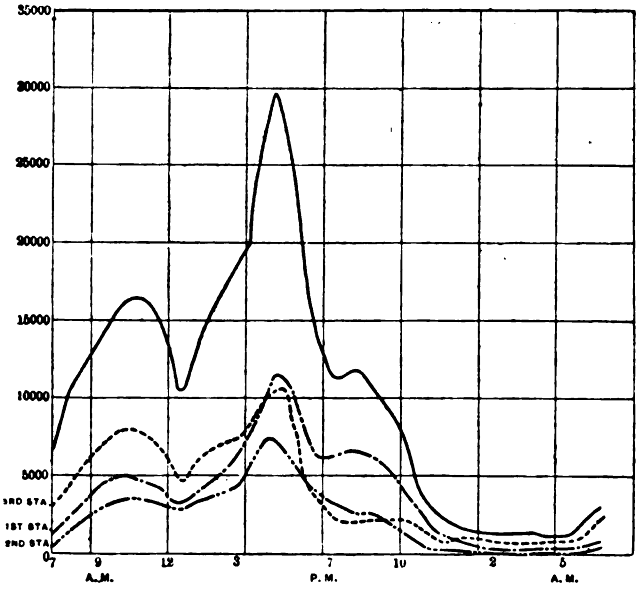


Fig. 1.—Date, December 12, 1894. Weather Cloudy.

maximum but very different average loads. The complete data are given by Mr. R. S. Hale in a Paper recently read before the Boston Society of Civil Engineers, entitled "Approximate Analysis of the Use of Coal in an Edison Electric Station of the Type Standard about 1890." The station selected by the author consists of 10 non-condensing Armington and Sims engines 15in. by 15½in., each belted to two No. 20 bipolar Edison 50-kilowatt dynamos, and supplied with steam at 100lb. gauge pressure from five boilers, Heine and Babcock and Wilcox, aggregating 12,390 sq. ft. of heating surface.

Comparing the monthly records of coal used and kilowatt hours generated since January, 1893, it is found that whenever the station is completely ready to run, the coal used may be expressed by the relation: Coal used = 500lb. per hour + 7½lb. per kilowatt-hour. 7½lb. per kilowatt-hour, or, roughly, 5½lb. per electrical horse-power hour is—after allowing for the over and under-loading of the

* Abstract from the *Electrical Engineer* of New York.

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engines and for the fact that the valves may not be absolutely tight—not much worse than the figures obtained on this class of engines on test runs, and with this quality of coal. The constant loss of 500lb. per hour is divided into: Hot chimney gases, radiation from boilers, radiation from steam pipes, and steam leaks. The two latter, or steam pipe losses, were measured directly and found to amount to 300lb. and 600lb. steam per hour, or about 33lb. and 67lb. coal, respectively. The first two were measured together by shutting the stop valve of a boiler and finding how much coal it took to keep up the pressure without making any

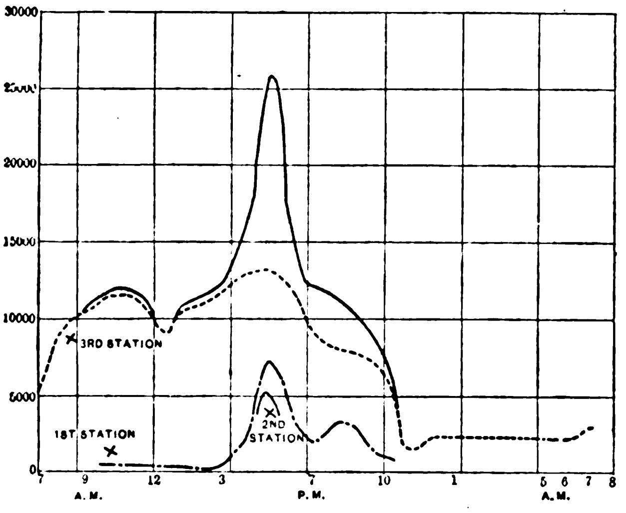

Fig. 2.—Date, December 13, 1894. Weather Fair.

steam, and this was found to nearly account for the remaining 400lb. of constant loss. This gave as the coal consumption:

33lb. coal per hour radiation from steam pipes.
67lb. ,, ,, steam leaks.
400lb. ,, ,, hot gases and radiation from boilers.

500lb. ,, ,, constant loss independent of load.
7½lb. per kilowatt-hour for all power produced.

In an appendix the author has given data from a similar Edison station where, on assuming the loss constant and comparing the Sunday and week-day figures, the loss was found to be about 1,750lb. per hour for a station about three times the size of that in Boston, and the net rate about 6·8lb. per kilowatt-hour, with higher steam pressure and some compound engines.

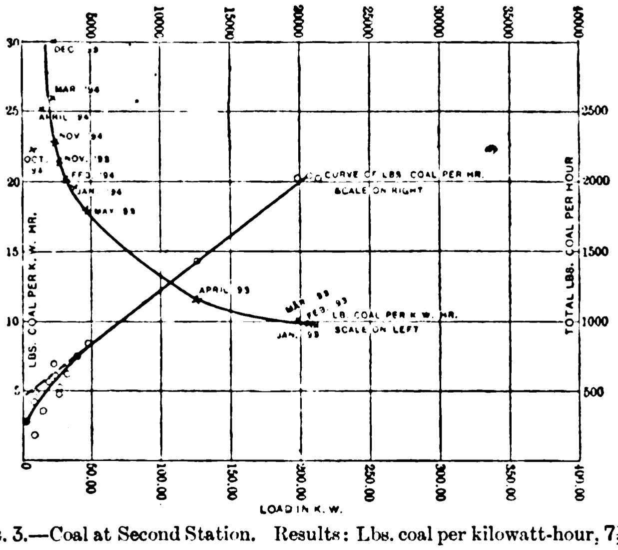

Fig. 3.—Coal at Second Station. Results: Lbs. coal per kilowatt-hour, 7½lb. Constant waste, 500lb. coal per hour = 180 tons per month.

We add from the Paper three curves. The first is an ordinary load diagram of the Boston system and of each of its three districts. The second gives the load generated at the different stations and the total, showing the effect of the tie lines in throwing the load to the economical station. The third gives the relation between the average kilowatts and the pounds of coal per hour and per kilowatt hour from which the equation which is the subject of the Paper is deduced. The Paper expressly disclaims being anything more than an approximation, but is of the greater value since its results are those of actual commercial running.

ON THE ELECTROLYSIS OF GASES.*

BY J. J. THOMSON, F.R.S.

In the experiments described in this Paper I have used the spectroscope to detect the decomposition of gases by the electric discharge and the movement of the ions in opposite directions along the discharg tube.

The method consists in sending the electric discharge through a tube so arranged that the spectra close to the positive and negative electrodes can easily be compared, thus the presence or absence of certain ions at these electrodes can be ascertained. This method is capable of much wider application than the one I previously used in my experiments on the "Electrolysis of Steam" † (*Proc.* Roy. Soc., Vol. LII., p. 90), the use of which is attended with very great difficulty for any substance other than steam. The earlier method has, however, the advantage of being a quantitative method—the present one is only qualitative.

In my former experiment with steam, when I worked at atmospheric pressure and varied the length of the spark, I found that when the spark length exceeded a certain length, d_1, there was an excess of hydrogen at the negative electrode and of oxygen at the positive, equal in amount to the quantities of hydrogen and oxygen liberated from a water voltameter placed in series with the steam tube. When the sparks were shorter than a certain length, d_2, the hydrogen appeared at the *positive*, the oxygen at the *negative* electrode, but the quantity of these gases was again equal to the quantities liberated in a water voltameter placed in series with the steam tube.

When the spark length was between d_1 and d_2 the effects were irregular, and there seemed to be no connection between the amounts of gases liberated in the steam tubes and those liberated in the voltameter.

In the following experiments in which the sparks were of constant length and the pressure was altered, corresponding effects were observed. Within certain limits of pressure definite and perfectly regular evidence of the separation of the ions of the gas sparked through was obtained; and the electrode at which a given ion appeared could be reversed by altering the pressure; there was, however, a range of pressures in which the separation of the ions was either not well marked or was irregular in character.

I shall begin by describing a very simple method of showing the separation of the ions produced by the discharge of electricity through a compound gas such as hydrochloric acid gas, which is applicable when the discharges through the constituent gases of the compound are of distinct and different colours; this is eminently the case with the hydrochloric acid gas, as the discharge through hydrogen in a capillary tube is red, through chlorine green.

Take a capillary tube of very fine bore, the finer the better (the tube I used was thermometer tubing of the finest bore I could procure), and insert platinum wires for electrodes in two small bulbs blown on the ends of the tube; then fill the tube with HCl gas, allowing it to run through the tube for a considerable time so as to get rid of any extraneous gas, and exhaust the tube so that the gas in it is at a very low pressure. Then when the discharge from a large induction coil passes through the tube, the following phenomena are observed. When first the discharge passes through the tube the colour is uniform throughout and of a greenish-grey; after the discharge has been passing for a little time the end of the tube next the cathode gets distinctly red, whilst that next the anode gets green; this difference in the colour at the ends of the tube goes on increasing until the tube presents a most striking appearance, the part near the cathode being bright red, while that near the anode is a bright green. The difference in colour attains a maximum value, and if the discharge is allowed to run for several hours the contrast between the two ends disappears to a very great extent; the discharge throughout the whole of the tube being pinkish and apparently passing mainly through hydrogen. This is doubtless due to the diffusion through the tube of the hydrogen which in the earlier stages of the discharge had accumulated about the cathode; one advantage of using very narrow tubes is that with them this diffusion is slow. When the tube is in this condition the colour of the discharge sometimes changes suddenly, and for a second or two is green instead of pink, showing that though in the main the discharge passes through hydrogen, it occasionally leaves the hydrogen and passes through the chlorine. This transference of the discharge from one constituent to another of a mixture of gases is not infrequently observed when the gases are mixed in certain proportions.

Some of these capillary tubes showed after the discharge had been passing through them for some time a peculiar patchy appearance, some portions of the tube being a much brighter red than the others, while other portions were green. In some tubes this occurred to such an extent that the discharge showed an irregularly striated appearance. This effect is due, I believe, gases or

* Paper read before the Royal Society.

† *The Electrician*, Vol. XXXI., pp. 291 and 316

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moisture condensed on the walls of the capillary tube, and in some cases to irregularities in the chemical composition of the glass. I found that it did not occur if the tube before being used was heated for some time along its whole length to as high a temperature as it would stand without collapsing; this heating would tend to cleanse the walls of the tube. That differences in the quality of the gas also conspire to produce these patches is shown, I think, by the following phenomenon. A capillary tube of fine bore containing mercury vapour and a little water vapour developed a well-marked red patch; the tube was then heated for some inches in the neighbourhood of the patch. In general heating the tube makes the discharge yellow from the sodium vapour given off from the glass; in this case, however, the whole of the heated portion, with the exception of the patch, turned yellow; the patch itself withstood the heating, and continued to show the bright red colour characteristic of hydrogen.

Electrolytic Transport of one Gas through another.—A tube of the shape shown in Fig. 1 was made of the finest bore thermometer-tubing; the extremities, C and D, of the tube in which the electrodes were fused were bent down so as to be parallel to each other, and so near together that a slight motion of the tube suffices to bring either of the extremities in front of the slit of the spectroscope. The tube was mounted on a board moved by a lever; by moving this, the observer at the spectroscope could readily bring the spectrum of either the positive or negative electrode into the field of view. A side tube, A B, was fused to the middle of the main tube, and was provided with two taps; in the space between these taps a small quantity of any gas which it was desired to introduce into the main tube could be imprisoned, and could, by opening the tap A, be introduced into the discharge tube. The experiment consists in filling the main tube with a gas at a low pressure, observing the spectra at the two electrodes, then introducing by the side tube a very small quantity of gas into the main tube, and again observing the spectra at the two electrodes.

A tube was filled with hydrogen, and showed no trace of the chlorine spectra; a very small quantity of chlorine was then let in through the side tube (in performing this experiment it is necessary to be careful that only a very small quantity of chlorine is introduced). After the discharge had been running through the tube

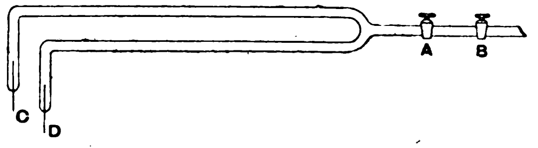

Fig. 1.

for a short time, the chlorine spectrum was found to be bright at the positive electrode, though no trace of it could be detected at the negative. When the discharge was kept on for some time, the chlorine spectrum, though still visible at the positive electrode, got fainter; it did not appear at all at the negative. If a considerable quantity of chlorine was introduced through the side tube, the chlorine spectrum was visible at both electrodes, though it was brighter at the positive than at the negative.

When the induction coil was reversed, so that what was before the positive electrode became the negative, the first effect observed was that the chlorine spectrum flashed out with great brilliancy at the old positive electrode, and was much brighter than at any previous period. This, however, only lasted for a second or two; the chlorine spectrum rapidly faded away and for a time was not visible at either electrode. Soon, however, the chlorine spectrum appeared at the new positive electrode, having thus been transferred from one end of the tube to the other.

On again reversing the coil the same phenomenon was repeated. There was apparently no limit to the number of times this effect may be obtained; at any rate, I have driven the chlorine from one end of a tube to the other 14 times in succession by reversing the coil. The chlorine is always driven to the positive electrode, showing that the chlorine ion carries a charge of negative electricity. The same effect was obtained when a little vapour of bromine was introduced into the tube instead of chlorine. When, however, the capillary tube was filled with chlorine instead of hydrogen, and a little vapour of bromine let into the tube, the bromine went to the *negative electrode* instead of the positive, as it did when introduced into the hydrogen tube. These experiments suggest that the two gases in the tube combine, and that the compound gas so formed is split up into ions which travel along the tube; that bromine when in combination with hydrogen is the negative ion, and therefore travels to the positive electrode; when, however, it is in combination with chlorine the bromine is the positive ion, and travels to the negative electrode.

Another experiment tried was to let a little vapour of sodium into the middle of a capillary tube filled with air at a low pressure. To prevent the sodium vapour condensing on the walls of the tube the whole tube was placed on a sand bath and the temperature raised so high that no condensation took place. After the discharge had run through the tube for about two hours the sand was removed from the tube, and the movement of the sodium vapour to the *negative* electrode was very apparent, even without using a spectroscope, as there was a great patch of yellow light near the negative electrode, and none in any other part of the tube.

Another experiment was to introduce a small quantity of hydrogen into a tube filled with air at a low pressure: the hydrogen made its way to the *negative* electrode. This experiment is a somewhat troublesome one, as it is exceedingly difficult to get these very fine capillary tubes so dry that the spectrum of the discharge does not show the hydrogen lines even before the hydrogen is introduced into the middle of the tube; indeed, I never succeeded in getting rid of the hydrogen lines at the very lowest pressures. By heating the tube and allowing dry air to run through it for a long time, however, I got the tube so dry that it did not show the hydrogen lines at a pressure quite low enough to allow the discharge to pass freely through it. When the tube was in this state and hydrogen was let into the middle of the tube, the hydrogen spectrum appeared at the negative electrode, but not at the positive.

The appearance of hydrogen at the negative electrode when mixed in a discharge tube with other gases has been described by Mr. Baly in a very interesting Paper in the *Phil. Mag.*, Vol. XXXV., p. 200.

The preceding experiments suggest, I think, that this separation of two gases, A and B, by the discharge is due to the decomposition by the discharge of a chemical compound formed of A and B, in which the A atoms have a charge of electricity of one sign, the B atoms a charge of electricity of the opposite sign; these charged atoms under the influence of the electromotive force in the tube travel in opposite directions. Further, it follows from the experiment with the bromine vapour in an atmosphere of chlorine that the sign of the electrical charge on an atom of the same substance is not invariable, but depends on the substance with which this atom is in combination. We shall find numerous other instances of this change in the sign of the charge on an atom in experiments described in a later part of this Paper.

Polarisation of the Electrodes.—This in the electrolysis of liquids is due to the accumulation at the electrodes of ions which have

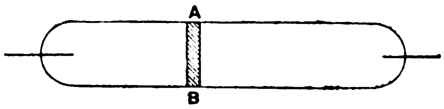

Fig. 2.

ceased to act as carriers of electricity. We have, I think, distinct evidence of a similar accumulation in the electrolysis of gases. For, as has been already described, after the discharge has been running for some time in one direction, giving the spectrum of some gas at one of the terminals, the spectrum of the gas at that terminal is momentarily brightened to a very great extent by suddenly reversing the direction of the discharge. After the current has been flowing for some time in one direction through, say, Cl in an atmosphere of H, the spectrum of the chlorine, though still visible at the positive electrode, gets faint, the chlorine apparently to a great extent ceasing to carry the discharge; when, however, the current is reversed, the atoms of chlorine can move freely, as they are not obstructed by the electrode, so that immediately after the reversal of the current there is probably more of the discharge carried by the chlorine than at any other time, and the chlorine spectrum is consequently brightest.

Discharge through a Compound Gas.—The separation of the ions by the discharge can be readily observed in a tube of the kind shown in Fig. 2.

It differs from an ordinary discharge tube merely in having a flat metal plate, A B, fastened across the tube. When the discharge passes through the tube, one side of the plate acts as a positive, the other as a negative, electrode. The tube is mounted on a stand, which the observer at the spectroscope can move by means of a lever so as to bring one side or other of the plate opposite the slit of the spectroscope; a very slight movement of the lever is sufficient to do this, so that the spectra at the two sides of the plate can readily be compared. I found that the results were more satisfactory when the current was kept flowing through the tube in one direction, and the tube moved so as to bring the spectra at the two electrodes into the field of view, than when the tube was kept fixed in one position and the current reversed. The latter method, however, suffices to show the separation of the ions in many cases, and it has the advantage of not requiring a plate across the tube; all that is necessary is to use for one of the terminals a disc whose plane is parallel to the slit of the spectroscope.

If the plate A B is thin it is necessary to fuse it into the glass tube all the way round; otherwise, when the pressure is low, the

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discharge, instead of crossing the plate, goes through any little crevices there may be between the plate and the tube. The easiest way of making the tube is to use a plate about 0·5cm. thick, cut from an aluminium cylinder which tightly fits the tube; with a plate of this thickness the narrow spaces between the tube and the plate are so long that the discharge goes through the plate rather than through the crevices.

The tube was filled with the gas to be observed, and the spectra at the two sides of the plate compared. These spectra were in many cases found to differ in a very remarkable way; it was, however, only in exceptional cases that a line which was bright at one side of the plate was absolutely invisible on the other. The method used was to take two sets of lines, say A and B, as close together in the spectrum as possible and compare the brightness of these sets of lines on the two sides of the plate; if it was found that the A lines were brighter on the positive side of the plate than on the negative, while on the other hand the B lines were brighter on the negative side of the plate than on the positive, then it was inferred that electrolytic separation had occurred, and that the substance giving the A lines was in excess on the positive side of the plate, that giving the B lines on the negative. It is not safe to draw any conclusions from the variations in intensity of one line or one group of lines on the two sides of the plate, as the total quantity of light coming from the neighbourhood of the cathode often differs considerably from that coming from the anode. When, however, we get an increase in the brilliancy of one set of lines accompanied by a diminution in the brightness of another set, when we move across the plate we eliminate this source of error. The differences in the spectra at the two sides of the plate are most easily observed at pressures where there is not any very great difference between the luminosity of the cathode and the anode. As was mentioned at the beginning of the Paper, there is a range of pressure within which the effects are irregular, and no decided differences are observed between the spectra at the two sides of the plate. It is desirable in these experiments to keep the tube on to the pump as long as the experiment lasts, for the discharge always decomposes the compound gas, and unless the products of decomposition are continually pumped off and replaced by fresh supplies of the compound gas, the spectra of the discharge keep changing. With organic compounds this is especially necessary, as the character of the spectrum often changes entirely very shortly after the commencement of the discharge unless fresh gas is continually introduced.

In the following experiments the current was produced by a large induction coil with a mercury slow break.

When the tube was filled with hydrochloric acid gas at a low pressure, the separation of the hydrogen and chlorine was seen very distinctly, the hydrogen line being much brighter on the side of the plate which acted as the cathode (which we shall call the negative side of the plate) than on the positive side, while the chlorine, on the other hand, was brighter on the positive than on the negative side of the plate.

When the tube was filled with ammonia gas, the hydrogen lines were bright on the negative side of the plate, but were absent from the positive side, while on the positive side of the plate there was the positive pole spectrum of nitrogen, and on the negative side of the plate the negative pole spectrum of nitrogen and the hydrogen spectrum.

Sulphur Monochloride.—When the tube was filled with the vapour of this substance at a low pressure, the chlorine lines were brighter on the *negative* side of the plate than at the positive, while the sulphur lines were brighter at the positive side than at the negative. Thus the chlorine in this substance behaves in the opposite way to the chlorine in HCl; in the latter compound the chlorine ion has a charge of negative electricity, while in the sulphur monochloride it has a charge of positive electricity.

Influence of the Chemical Constitution of a Compound on the Sign of the Charge of Electricity on one of its Constituent Atoms.—In many organic compounds an atom of the electro-positive element hydrogen can be replaced by an atom of the electro-negative element chlorine without altering the type of the compound. Thus, for example, we can replace the four hydrogen atoms in CH_4 by chlorine atoms, getting successively the compound CH_3Cl, CH_2Cl_2, $CHCl_3$, and CCl_4. It seemed of interest to investigate what was the sign of the change of electricity on the chlorine atom in these compounds. The point is of some historical interest, as the possibility of substituting an electro-negative element in a compound for an electro-positive one was one of the chief objections assigned against the electro-chemical theory of Berzelius.

When the vapour of chloroform, $CHCl_3$, was placed in the tube, it was found that both the hydrogen and the chlorine lines were bright on the negative side of the plate, while they were absent from the positive side, and that any increase in the brightness of the hydrogen lines was accompanied by an increase in the brightness of those due to chlorine. The spectrum on the positive side of the plate was that called the carbonic oxide spectrum; when first the discharge passed through the tube, the spectrum on the positive side was the so-called candle spectrum, but this very rapidly changed to the carbonic oxide spectrum. The appearance of the hydrogen and chlorine spectra at the same side of the plate was also observed in methylene chloride and in ethylene chloride. Even when all the hydrogen in CH_4, was replaced by chlorine, as in carbon tetrachloride, CCl_4, the chlorine spectra still clung to the *negative* side of the plate. To test the point still further, I tried the analogous compound silicon tetrachloride, inserting a small jar in the circuit to brighten the spectrum. The chlorine spectrum was again brightest at the *negative* side of the plate, while the silicon spectrum was brightest at the positive. This is a very favourable case for the application of this method, as there are two silicon lines (wave-lengths 5058, 5043) quite close to two chlorine ones (wave-lengths 5102, 5078), so that their relative brightness can easily be compared. The experiment with the silicon tetrachloride is more conclusive than those with the carbon compounds, as with the latter the spectrum on the positive side of the plate is a band spectrum, and since the potential gradient when the discharge is passing is very much steeper on the negative side of the plate than on the positive, the effects observed might be supposed to be due to the circumstances on the negative side being better adapted for the production of line spectra than those on the positive. This explanation is not, however, applicable to the case of silicon tetrachloride, where the spectra on both sides of the plate are line spectra.

From these experiments it would appear that the chlorine atoms in the chlorine derivatives of methane are charged with electricity of the same sign as the hydrogen atoms they displace.

When we can determine the signs of the electrical charges carried by the atoms in a molecule of a compound, we can ascertain whether any given chemical reaction does or does not imply interchange between the electric charges on the atoms taking part in the reaction. Thus take the reaction

$$CH_4 + Cl_2 = CH_3Cl + HCl.$$

If we represent the sign of the charge of electricity carried by an atom by + or − placed below the symbol representing that atom, we may write the last reaction as

$$\underset{-}{C}\underset{+}{H_4} + \underset{+}{Cl}\underset{-}{Cl} = \underset{-}{C}\underset{+}{H_3}\underset{+}{Cl} + \underset{+}{H}\underset{-}{Cl},$$

so that this reaction could be produced by a rearrangement of the atoms without any alterations of their electrical charges.

If, however, we take the reaction—

$$\underset{+}{H}\underset{-}{H} + \underset{+}{Cl}\underset{-}{Cl} = 2\underset{+}{H}\underset{-}{Cl},$$

we see that in addition to a rearrangement of the atoms there must in this case be an interchange of electric charges between the atoms; for before combination half the hydrogen atoms had a negative charge, and half the chlorine atoms a positive one, whereas after combination no hydrogen atom has a negative charge, and no chlorine atom a positive one. We may thus distinguish between two classes of chemical reactions: (1) those which do not necessarily require any interchange of the electrical charges carried by the atom, and (2) those which do. It might, perhaps, repay investigation to see whether the occurrence of chemical change is affected by the presence of a third substance in the same way in these classes of chemical combination.

Another point to be considered is the effect of this difference between the chemical actions on the amount of heat developed during chemical combination. When hydrogen and chlorine combine the heat produced may be regarded as the joint effect of three processes:—

1. The splitting up of the molecules $(\underset{+}{H}\ \underset{-}{H})$ and $(\underset{+}{Cl}\ \underset{-}{Cl})$ into the atoms $\underset{+}{H}$, $\underset{-}{H}$, $\underset{+}{Cl}$, $\underset{-}{Cl}$.

2. A transference of electricity, by which the negative charge on one atom of hydrogen is replaced by an equal positive charge, while the positive charge on an atom of chlorine is replaced by an equal negative charge.

3. The combination of the positively electrified hydrogen atoms with the negatively electrified chlorine ones to form hydrochloric acid.

In that class of chemical action where the atoms retain their charge (2) is absent, so that if the change in energy occurring in the process (2) were considerable compared with the changes occurring in processes (1) and (3), the thermal effects of the two types of chemical combination ought to differ considerably. If the changes in energy occurring in the process (2) had a great preponderance over those occurring in (1) and (3), the thermal effects produced by the combination of two elements ought to follow very simple laws. For if $2\{H\}$ is the excess of the energy of an atom of hydrogen charged with the negative electron over the energy of the atom charged with the positive electron, $2\{Cl\}$ the excess of the energy of an atom of chlorine charged with the positive electron over the energy of the atom charged with the negative electron, then, if we could neglect the energy changes in

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(1) and (3) compared with those in (2), the mechanical equivalent of the heat developed when a molecule of hydrogen combines with one of chlorine to form two molecules of hydrochloric acid would be equal to $2\{H\}+2\{Cl\}$. Thus we see that if the energy changes in (2) preponderated largely over those in (1) and (3), the heat produced when an element A combined with another element B to form the compound AB, could be expressed as the sum of two numbers {A} and {B}, where {A} depends solely on the element A, {B} solely on the element B. In some cases of chemical combination between dilute solutions there seems evidence that the heat produced can be expressed in this way (see Lothar Meyer, "The Evolution of the Doctrine of Affinity," *Phil. Mag.*, Vol. XXIII., p. 504), but when we attempt to apply the same law to combination between gases, it seems utterly to break down ; indicating that in such cases the greater part of the changes in energy occur in the splitting up of one set of molecules and the subsequent formation of others. This view seems to be supported by the phenomena attending the discharge of electricity through rarefied gases, for the smallest difference of potential which can send a discharge through an electrified gas (which we have reason to believe involves the splitting up of molecules into atoms), is very many times the electromotive force required to liberate the ions from an electrolyte, though the latter process requires changes in the electrical charges on the ions. These reasons seem to indicate that we can hardly expect to get any clear indication of the charges carried by the atoms in gaseous compounds from the study of the thermal changes which occur when gases enter into chemical combination.

Vapours of Organic Compounds.—These show very interesting differences between the spectra on the two sides of the plate when the discharge passes through them. Thus, when the discharge first passes through the vapour of ethyl alcohol, C_2H_6O, the spectrum on the positive side of the plate is the candle spectrum, that on the negative side the carbonic oxide spectrum. For some little time after the discharge commenced I could not detect any hydrogen lines on either side of the plate ; after a time, however, they appeared on the negative side but not on the positive. If the discharge was kept running for some time without letting a fresh supply of alcohol into the tube the "candle spectrum" on the positive side of the plate was replaced by the CO spectrum, which now occurred on both sides of the plate, accompanied on the negative side by the hydrogen spectrum. This is the appearance presented by all the compounds of carbon, oxygen, and hydrogen which I examined, when the spark had been passing through them for a considerable time, and it is what would occur if the vapour were decomposed by the spark into carbonic acid, water, and hydrogen.

The appearance of the candle spectrum on the positive side of the plate with the CO on the negative was observed in many other cases. Thus, on sparking through a tube filled with CO, I could not detect any difference between the spectra on the two sides of the plate, but when a little hydrogen was let into the tube the "candle spectrum" appeared on the positive side of the plate, the carbonic oxide spectrum on the negative. The same effect was observed in a tube filled with cyanogen mixed with a little hydrogen. When the tube was filled with the vapour of methyl alcohol, CH_3OH, the candle spectrum was on the positive side of the plate, the carbonic oxide and hydrogen spectra on the negative ; with this vapour, unlike that of ethyl alcohol, I could not detect any stage when the hydrogen spectrum was absent.

The first explanation which occurs to one of this phenomenon is that it is owing to the potential gradient at the negative side of the plate being steeper than that on the positive, so that we may imagine we have a fierce spark on the negative side, a mild one on the positive, and that the fierce spark gives the CO spectrum, the mild one the candle spectrum. There are, however, some phenomena which seem inconsistent with this explanation : in the first place, if the current is reversed after flowing in one direction, traces of the former spectra linger for some time at the sides of the plates, and, secondly, if the difference is due to the greater decomposition at the negative side of the plate, how is it that in the case of the vapour of ethyl alcohol the hydrogen spectrum is not seen, at the commencement of the discharge, on the negative side of the plate ? It only appears after the discharge has passed through for some time, when hydrogen has probably been set free by the decomposition of the vapour by the discharge. If the absence of the candle spectrum from the negative side of the plate is due to the spark being so intense that the hydro-carbon which is supposed to be the origin of this spectrum cannot exist, then we ought to see the spectra of the substances which result from the decomposition of the hydro-carbon—*i.e.*, we ought to see the hydrogen spectrum at the negative electrode. The view which seems most in accordance with the results of observations on the discharge through these vapours is that the "candle spectrum" is the spectrum of carbon when the atom is charged with negative electricity, or of some compound of carbon in which its atom is negatively charged, while the "carbonic oxide" spectrum is the spectrum of carbon when the atom is charged with positive electricity, or of some compound in which the carbon atom is positively charged.

Discharge through an Elementary Gas.—It has long been known that when the discharge passes through some elementary gases, the spectra at the two electrodes are different. This was first shown to be the case for nitrogen ; then Dr. Schuster showed that the same thing occurred with oxygen, and recently Mr. Crookes has shown that it is also true in the case of argon. I have observed a very striking change in the relative brilliancy of the red and green hydrogen lines at the two electrodes. When the tube with the plate across it was filled with hydrogen at a low pressure, then on the positive side of the plate the red line tends to be brighter than the green, while on the negative side the green line tends to be brighter than the red ; in some tubes this was so marked that on the positive side of the plate the red line was bright, and the green invisible, while on the negative side of the plate the green line was bright, and the red invisible. The spectroscope I was using weakened the red rays much more than the green, so that I cannot be sure that the red rays were really altogether obliterated on the negative side of the plate ; the above experiment is, however, sufficient to show that on the positive side of the plate the red rays are more easily excited than the green, while on the negative side the green line is more easily excited than the red. On the negative side of the plate we have an excess of positively charged hydrogen atoms, while on the positive side of the plate there is an excess of negatively charged hydrogen atoms, and I am inclined to attribute the difference in the spectra partly at any rate to the difference in properties between a positively and a negatively charged hydrogen atom. The reason I do not attribute it wholly to the difference in the potential gradient on the two sides of the plate is that the effect is not reversed immediately, but only gradually on reversing the coil, the former spectra clinging for some time to the sides of the plate.

Chlorine.—I have made a great many experiments to see if there is any difference between the spectra given by chlorine on the two sides of the plate, but with negative results. Chlorine seems a gas in which we might expect to find this effect, for as Dr. Schuster, in his Report on Spectrum Analysis, says, the behaviour of its spectrum indicates that we have several spectra superposed. I have not, however, been able to effect a separation of its spectra ; the differences I observed between the spectra on the two sides of the plate were irregular, and due, I think, to impurities producing effects like those observed when the discharge passes through a compound gas. However, as has been mentioned before, there is even in the case of gases where distinct evidence of separation can be obtained, a region of pressure within which the effects are irregular, and I ascribe my failure to observe separation in the case of chlorine to my having failed to get the relation between the intensity of the discharge and the pressure so adjusted as to get outside this irregular region. The cases, however, in which distinct differences between the spectra of a simple gas occur at the two electrodes, seem to indicate that the spectrum given by an element is influenced by the sign of the electrical charge carried by its atoms.

I have made some experiments to determine whether there was any separation produced in a mixture of equal volumes of hydrogen and chlorine kept in the dark, when a considerable difference of potential though not sufficient to produce discharge was maintained between the two electrodes. The parts of the tube adjacent to the two electrodes could be shut off from each other by a tap, and the amount of chlorine in the two sides was determined by absorbing it by caustic potash. The mixture was at atmospheric pressure, and the electrodes were maintained at a potential difference of about 1,200 volts by connecting them to a large battery of small storage cells. The potential difference between the terminals was maintained for about 16 hours on three separate occasions, but on analysing the vessels surrounding the two electrodes, the amount of chlorine in the vessel adjacent to the negative electrode did not differ from that in the vessel adjacent to the positive electrode by more than 1 per cent., and this could be accounted for by errors of experiments, as test experiments in which the mixture had not been exposed to the electric field, gave differences comparable with these. We should conclude from the preceding experiments that the molecules of a gas are not acted on by any appreciable translational force tending to move them from one place to another, when they are near to a body charged with electricity. To test this point further, two large terminals were placed in bulbs which were connected by a horizontal capillary tube, in which a drop of sulphuric acid was placed ; a difference in the pressure of the gas would cause the sulphuric acid to move, and the arrangement acts as a very delicate pressure gauge. The bulbs and tube were filled with chlorine at atmospheric pressure. The terminals were then connected to the electrodes of a battery giving a potential difference of 1,200 volts, but not the slightest movement of the drop of acid could be detected.

I wish to acknowledge the help I have received in making the preceding experiment from my assistant, Mr. E. Everett.

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The Oldest Electrical Journal, 1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as evidence of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices.*

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ELECTROLYSIS OF GASES.

Since the time when Prof. J. J. THOMSON gave experimental proof of the astonishing fact that, in the electrolysis of steam by a spark discharge, the ions of hydrogen and oxygen may each become either positively or negatively electrified, our ideas of the electrical condition of isolated atoms and single molecules have undergone considerable modification and enlargement. The time is probably past when we could affix a definite quantity of a definite kind of electricity to the atoms of each element, and believe that under no condition whatever could there be any alteration. In fact, we have learned that what in 1893 was regarded as exceptional, supernormal, almost it seemed paradoxical, must now be considered the expression of a law, as yet inexactly defined but nevertheless perceived, which extends over a wide range of chemical phenomena. Not alone the ions of electrolysed steam, but certainly a wide class of, and possibly all, electrolytic ions are capable of this remarkable reversal of electrification.

This fact, among a number of others of equal importance relative to molecular physics, is very cogently demonstrated in the series of charming experiments with which Prof. J. J. THOMSON recently delighted a Royal Society audience. Our readers will find a reprint of Prof. THOMSON's Paper in our issue this week. One of the most striking of the confirmations of the fact we have just referred to is the series of experiments on the group of compounds formed by the successive replacement of the hydrogen in CH_4 by chlorine atoms. It must be borne in mind that in the electrolysis of simple HCl the hydrogen collects at the cathode, being positive, while the negative chlorine is found at the anode. But in the series of compounds just referred to, the electrolysis of the vapours results in both hydrogen and chlorine collecting at the negative electrode, both these ions therefore becoming positive. And even when all the hydrogen in CH_4 has been replaced by chlorine, in carbon tetrachloride, the electrolysis of the vapour results in chlorine being found only at the negative electrode.

Further—and this supports the view that in certain allied groups of compounds, such as the tetrachlorides, an element will be electrically opposite to what it is in other groups, such as the chlorides—if the analogous compound, silicon

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tetrachloride, is substituted for the carbon compound the chlorine behaves in precisely the same way as before. Prof. THOMSON points out the historic interest there is in this series of experiments; inasmuch as, by showing that a "normally" negative element may replace a "normally" positive one, it disproves the objection raised against the electro-chemical theory of Berzelius.

The explanation which Prof. THOMSON puts forward, of the transport in opposite directions of the two ions of an electrolytic gas, is the perfectly natural one that "the separation of two gases, A and B, by the discharge is due to the decomposition by the discharge of a chemical compound formed of A and B, in which the A atoms have a charge of electricity of one sign, the B atoms a charge of electricity of the opposite sign." It is easy to see that this might be the case where the gases are already introduced into the apparatus in a combined state; but it is not so evident that where two gases are merely admixed, a true chemical combination between them, atom by atom, must momentarily ensue before there can be any directive motion of the ions. If this latter supposition is correct, only those admixed gases could be electrolytically separated by spark discharge, which are in themselves capable of direct chemical combination. A test case might be instituted, by making one of the gases argon and the other an elementary gas with which it has stubbornly refused to enter into combination. Yet, even then, there would be room for the horrid doubt, whether the argon had not accommodatingly entered into an evanescent combination in order ultimately to get further separated from the other element!

The new addition to the instruments of electro-chemical research which Prof. THOMSON has made in his method of spectroscopically examining gases in the process of being electrolysed, seems likely to prove doubly useful; for on the one hand it enables us to learn more of molecular and atomic phenomena, while on the other hand it reveals new phases of the habits, so to say, of a spark discharge. Referring briefly to this second matter, we may notice the curious fact that a spark discharge, when passing through a seemingly homogeneous mixture of two different gases, will sometimes confine itself to the molecules of the one, and sometimes equally exclusively to the molecules of the other. It is as if lightning should sometimes pass entirely through the nitrogen, and at other times only through the oxygen, of the atmosphere.

Reverting to the chemical side of the matter once more, we may note, in conclusion, the importance of this method of investigation as a further test of the elementary condition of a gas. Its value in this respect lies not so much in its ability to prove an elementary state as to disprove it. If the lines of the spectra at one of the spark terminals become altered, relatively to those at the other terminal, when the discharge is reversed, the presumption is strongly in favour of there being a compound in the tube, but if there is no relative change it would be hasty to infer an elementary state. Yet it is curious that chlorine, believed to be an element, but the spectrum of which in some respects behaves like that of a compound body, exhibits not the slightest indication of its complexity when examined spectroscopically under spark discharge. The spectra at the two terminals, Prof. THOMSON has found, are absolutely identical; or, in other words, the atom is spectroscopically the same whether at the anode or the cathode. So far as this is any test, it goes to support the view that the complexity or compositeness of the chlorine spectrum arises from an infra-elementary complexity of the chlorine atom. Prof. CROOKES has delighted us with his charming hypothesis of the genesis of the elements; and his view that the atoms of any element are not always identical, but seem to vary between certain limits, is supported by the spectra of the metals of the rare earths. The explanation Prof. CROOKES has offered is, that an atom is built up of a number of slightly different subatoms of infra-elementary bodies, the differences between them being finely shaded. Possibly it is to some such complex atomic structure as this that the complications of the chlorine spectrum are due. Yet this is not made absolutely certain by the failure of the electric spark discharge to resolve chlorine into simpler constituents; for it is logically conceivable that chlorine may consist of two real elements, which, however, cannot be electrolytically separated in this way.

REVIEWS.

The Management of Dynamos. By G. W. LUMMIS-PATERSON. (London: Crosby Lockwood and Son.)

There has been a tendency of late to flood the book market with small unpretentious volumes purporting to give instructions to mechanics, engineers, students, and others interested in the running of dynamo electric machinery. It is needless to say that the majority of these are not only useless, but in many cases probably productive of harm. They cover too much ground to state anything in a clear manner and usually make a terrible mess of the theoretical parts of the subject, involving the units in inextricable confusion, and hopelessly mixing up power and energy. If it be necessary for the authors to appear in print they should confine themselves to practice, wherein they are generally fairly safe, and leave the exposition of theory to its legitimate exponents who occupy the seats of wisdom in our technical colleges. The book before us is perhaps rather above the average of its class; but if a knowledge of the principles touched upon in the first three chapters were taken for granted—no reader will ever grasp them from the text—much time might be saved. And if the reader were referred to one of the standard works for the construction of dynamos it would be much to his advantage, and he would have more time and perhaps more inclination to study the section on the practical management and working of dynamos, which is well written and contains some instructive hints. We cannot help thinking, however, that hints to dynamo tenders, to be of real use, should be confined to one side of a printed sheet pasted on a board and hung up in the engine house.

Solution and Electrolysis. By W. C. DAMPIER WHETHAM, M.A. (London: C. J. Clay and Sons.)

In this work of 283 pages we have a concise account of the modern theories of solution and electrolysis, and of the experimental facts on which they are based. For a considerable portion of the first six chapters the author expresses his indebtedness to Ostwald's "Lehrbuch der Allgemeinen Chemie," and for a fuller account of the developments of the dissociation theory he refers the reader to the second volume of that book, and to Prof. Nernst's "Theoretische Chemie." In these chapters the properties of solutions and of Van't Hoff's application of Boyle's law to them are very clearly set forth. In the succeeding pages we have an historical sketch of the principal facts of electrolysis as they have been noted from time to time, leading us up to the modern theories based on the intimate relation which has been observed to exist between the conductivity of electrolytes and their other physical and chemical properties. The quantitative agreement which has been observed to exist between the molecular conductivities, the abnormal value of the osmotic pressures, and the specific chemical affinities of electrolytes, certainly show that the peculiar condition which the author terms "ionisation" is the chief cause of them all. The explanation of the real physical meaning of ionisation is then sought, but the author is careful to point out that no hypothesis advanced merely to explain

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observed facts rests on the same sure ground as a theoretical idea which is a necessary consequence of those facts. The dissociation theory of electrolytes, which has been worked out by Arrhenius, Kohlrausch, Ostwald and Nernst on Van't Hoff's view of the nature of solutions is explained, and the hydrate theory of solution as put forward by Armstrong, Pickering and others is discussed, and the author shows how the two hypotheses may be reconciled.

This book is a valuable addition to the literature on the subject, containing, as it does, a great number of tables and curves; and the way in which the equations are numbered, and the frequent references from one part of the book to the other, render the mathematical reasoning much more easy to follow than is often the case in such works. In the appendix is given a reprint from the British Association Report of 1893 of the valuable collection of data on the conductivity and migration constants of solutions which was made by the Rev. T. C. Fitzpatrick.

Indicator Diagram Record Book. Compiled by J. Wright, M.I.M.E. Edited by H. T. Wright. (London. 1895.)

The title of this book clearly indicates the use for which it is prepared—to contain the graphic and tabular records of indicator diagrams. To suit this special purpose, the book is made some 10in. wide and 3¼in. long, the pages being bound at the shorter side. The early parts include "Hints on Taking Diagrams," and a number of mathematical and steam tables. Then follow 100 forms, upon which the records of actual diagrams are to be made. Each form bears, at the left-hand end, squared rulings with scales for plotting diagrams; and the rest of its surface is ruled for various numerical entries and remarks. Each form extends over two pages, and is so complete that we are unable to think of any further engine datum that could be added; indeed, we fancy most engineers get along without troubling themselves about half the things that have a place provided for them in this sumptuous record book. We would suggest, however, that these forms should be numbered consecutively; and that somewhere in the book, preferably at one end or the other, a a blank index should be provided, so that the user might be able quickly to hunt up his elegant records. As matters stand now the user must number the forms for himself; and he will be sorely put to it, to find a place for an index. But, after all, when do engineers stand in need of a gilt-edged, leather-bound, fifteen-shilling repository of their indicator tests?

NOTES ON SOME EXPERIMENTS WITH ELECTROMAGNETIC MECHANISM.

BY P. V. McMAHON.

(Continued from page 496.)

Another experiment on the shape of cross-pieces was tried. The results are given on Fig. 14 (see page 495, *The Electrician*, August 9th). A zig-zag shaped cross-piece (Fig. 18) was used in *b*, and a cigar-shaped cross-piece (Fig. 19) in *c*. The zig-zag shape was used to allow the end of the core to go more into the coil; the straight cross-piece prevented this by reason of the flange of the coil stopping further travel. Comparing the curves we see that the ½ sq. in. straight cross-piece gives the greatest travel, 5·3in., for a variation of 1,100 ampere-turns. The zig-zag and cigar-shaped cross-pieces (curves *b* and *c*) have a travel of 4·4in. for the same variation. The zig-zag cross-piece gives a much straighter curve in the middle, but bends over earlier than *a* or *c*. The cigar-shaped cross-piece seems to have no advantage over the ordinary straight iron cross-pieces. The sketches of these cross-pieces are about one-fourth actual size. The curve *b* starts higher up on diagram than *a* or *c*. This is due to the point of the core being 1in. outside the coil at the beginning of the travel, on account of the knee of the cross-piece resting against the flange of the coil at starting.

The curve obtained with the ½ sq. in. iron cross-piece is drawn again on Figs. 13 and 14 (as this cross-piece gave the best result) in order to more readily compare the change in the shape of curve produced by the alteration in the cross-piece.

On Fig. 20 are given eight curves, obtained under the following conditions:—In *a* the brass cross-piece was as in Fig. 12, curve *a*, but the travel is measured higher up on the curve to

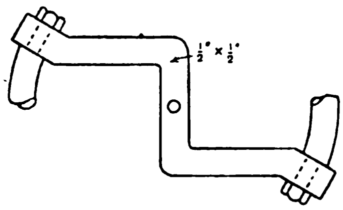

Fig. 18.—Zig-Zag Cross Piece.

compare with *b*, in which one core was 6in. and the other 8in. long. The travel with the two 8in. cores for a variation of 1,250 ampere-turns was 3·7in., while the travel in which the shorter core was used was only 2·6in. for the same variation of excitation. Inspection of this curve makes it clear that it is quite different from those which preceded it. The curve seems to be made up of two straight lines, with a small irregular piece connecting them. This irregular piece corresponds with that part of the travel where the ends of the cores are passing through the weak magnetic

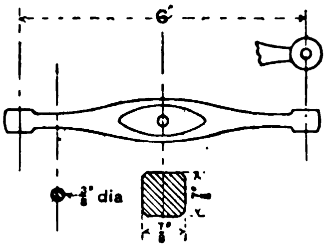

Fig. 19.—Cigar Cross Piece.

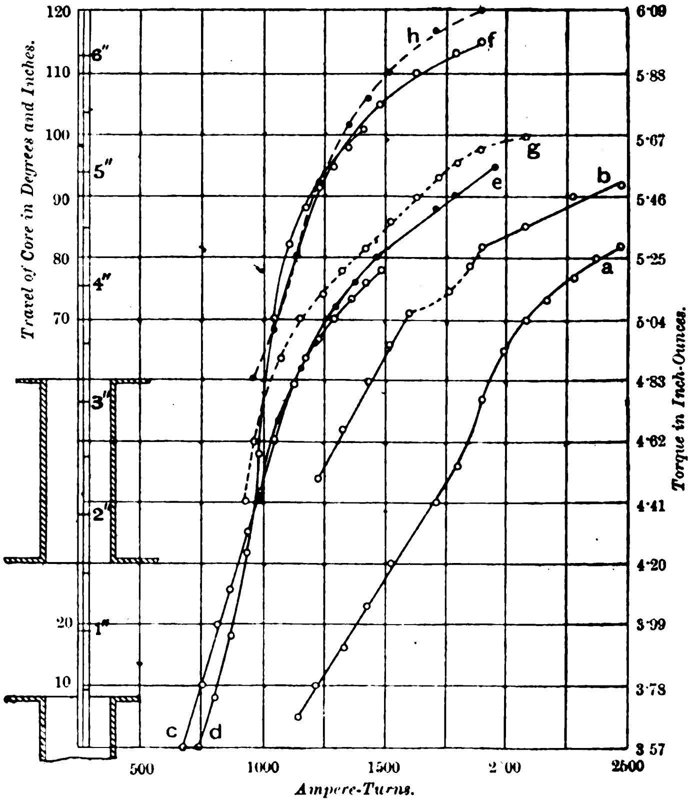

Fig. 20.

field between the coils. The first point on the curve, or the first position in which balance was obtained between the controlling spring, and the force due to the ampere-turns, is about 2in. higher than in the *a* curve, or when both cores were 8in. long; the curve then continues a straight line

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until the point of the 8in. core is 3·3in. outside its coil, and the 6in. core 1·3in. outside the other coil; the travel then proceeds at a slower rate for a distance of 0·55in., and continues in a straight line again to the end of the travel, a distance of 0 55in. A point worthy of notice in connection with this irregular part of the curve is that when the two 8in. cores are used, the travel of the cores is quicker than the first part, and with one 8in. and one 6in. core the state of affairs is reversed. It may be mentioned that in this and the following experiments, with one 8in. core the spindle was balanced by a brass sector on the opposite side to the core.

The remaining six curves (c to h) were obtained from one eight inch core, as shown Fig. 21, which is drawn to scale half-size. The coils were arranged in this manner to try the effect of making the coil longer with respect to the core, and also the effect of bunching the winding or making the coil itself taper. This latter effect was obtained by shunting the top coil with a resistance equivalent to its own; thus the top coil had half the number of ampere-turns the bottom coil contained. Owing to the coils being square the arrangement was not quite the same as if the whole space between the outside flanges was filled with wire; this becomes more evident when we examine the position of the second coil on Fig. 20, which shows the position if the coil was straight instead of circular.

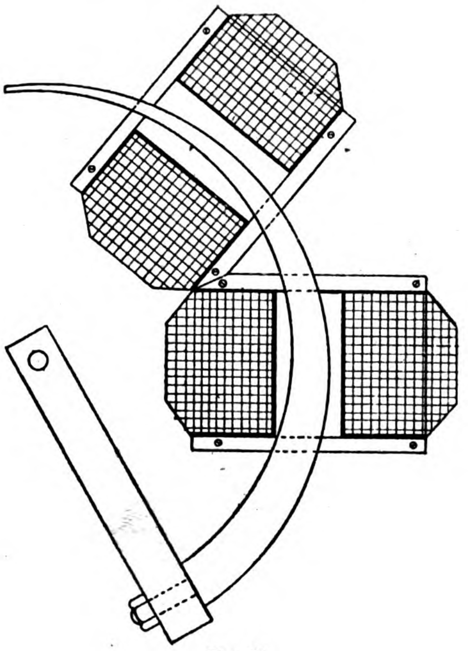

FIG 21.

The curve c was obtained with one 8in. core, and the bottom coil with the brass cross-piece; here for a variation of 750 ampere-turns the travel was 3·8in.; where the iron cross-piece was used, curve d, the travel for the same variation of excitation was 5·4in. Here the effect of using the iron cross-piece is more apparent than when the two cores were used, the increase in travel with the iron over brass being about 42 per cent. Comparing this travel with one core and one coil with curve d (Fig. 12), we have a travel of 5·4in. for 750 ampere-turns variation, as against 5·7in. for 1,250 ampere-turns variation, and the curve d (Fig. 20) is a nearer approach to a straight line than that obtained with two cores. However, the curves have the same general shape; d (Fig. 20) rises at first in a straight line (nearly) and thence more quickly; this seems to happen as the iron cross-piece comes into the influence of the coil's stray field, then the curve bends over as if the iron were getting saturated, but not so much as in the curve d, Fig. 12.

The effect of shunting the top coil was next tried with both brass and iron cross-pieces, curve e and f. The travel here was 2·3in. in each case for a variation of 750 ampere-turns. It is noticeable that the straight part of the curve comes last with the brass cross-piece and first when the iron cross-piece is used; also the core is drawn further into the coil when the iron cross-piece is used.

Next the two coils were tried coupled in series under the same conditions, as in e and f, as regards cross-pieces. For the same variation of excitation the travel, when the brass cross-piece was used, curve g, was 1·5in., and with the iron cross-piece, curve h, the travel was 2·6in. The curve g is a straight line from the first point on the curve (here the top of the core is about one-third into the second coil) for about $1\frac{1}{4}$in. and bends over, giving a second straight line for almost the remainder of the travel. The curve h is very similar to curve d (one

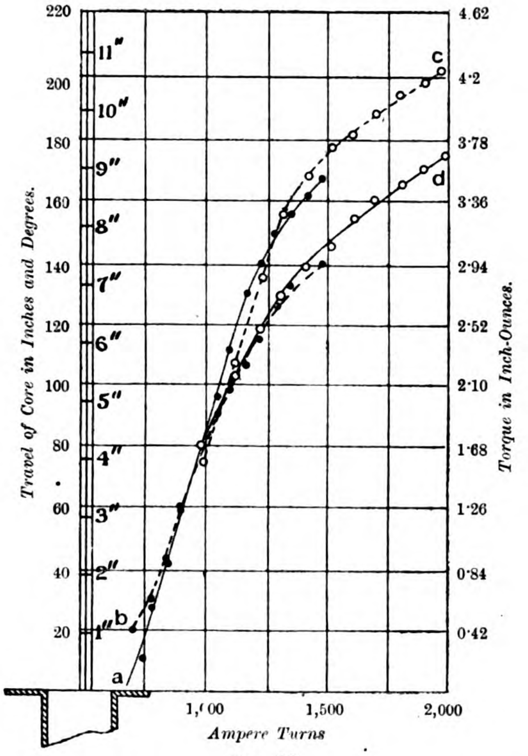

FIG. 22.

coil), but has a much shorter travel. Inspection of the curves also shows that when two coils are used (top not shunted) the core is drawn more into the coil with both iron and brass cross-pieces than when the top coil is shunted.

Lastly, four curves were obtained with these coils, and a core 14in. long, $\frac{9}{16}$in. diameter at bottom, and $\frac{1}{8}$in. diameter at top, bent into an arc of 3in. radius as before (Fig. 23). In the two curves a and b (Fig. 22) one coil was used—a with iron cross-piece, and b with brass cross-piece; here, for a variation of

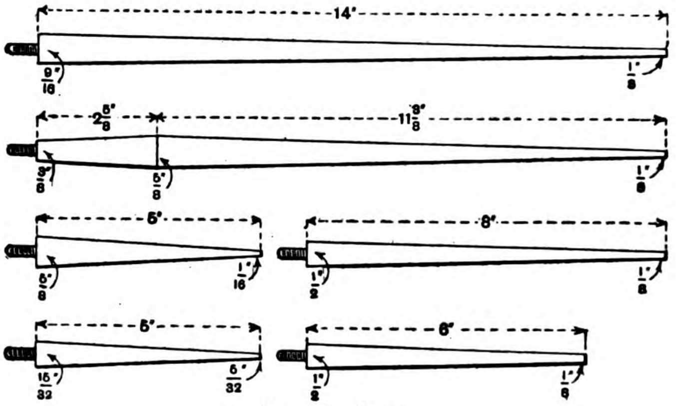

FIG. 23.—Cores.

750 ampere-turns, the travel is 8·1in. and 6·2in. respectively, as against 5·4in. and 3·8in. when the 8in. long core was used. Using the two coils in series, as in g and h (Fig. 20), the travel for the same variation of excitation was in e (iron cross-piece) 6·1in., and d (brass cross-piece) 4·4in. It is noteworty that the curves obtained under all conditions with the 14in. core are more nearly straight lines than those obtained with the 8in. core under similar conditions of torque and variation of

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excitation. In fact, the curve *a* is a perfectly straight line for 7·5in. of its travel, and *d* the same for 4in. Here not only is a straighter curve obtained when the iron cross-piece is used, but the total travel is also greater than with the brass cross-piece. In this experiment the point of the core was flush with the outside edge of the coil when the spring had no initial tension and no current flowing.

For greater convenience the results are tabulated in Table IV., which requires no further explanation.

Table IV.

References to curves.	Travel of core in inches.	Variation of ampere turns.	Description of cross-pieces.	—
Fig.				
12 *a*...	3·95	1,250	½in.sq.brass	...
b...	4·55	1,250	⅝in. sq. iron	...
c...	5·7	1,250	⅝in. sq. iron	...
d...	5·7	1,250	½in. sq. iron	...
13*a* ...	4·9	900	½in. sq. iron	Same curve as plotted in Fig. 12 *d*.
b...	5·0	900	½in. sq. iron	Iron disc on end of cores (*see* sketch).
c...	4·9	900	½in. sq. iron	Iron disc btw'n cores on spindle (*see* sketch).
14*a* ...	5·3	1,100	½in. sq. iron	Same curve as plotted in Fig. 12 *d*.
b...	4·42	1,100	½in. sq. iron	Zig-zag shaped (*see* sketch, p. 7).
c...	4·45	1,100	iron	Cigar-shaped (*see* sketch, p. 7).
20 *a*...	3·7	1,250	½in.sq.brass	Same curve as plotted in Fig. 12 *a*.*
b...	2·6	1,250	½in.sq.brass	One core 2in. shorter than the other.
c...	3·8	750	½in.sq.brass	One core and one coil only.
d...	5·4	750	½in. sq. iron	One core and one coil only.
e...	2·3	750	½in.sq.brass	One core and two coils, top coil shunted.
f...	2·3	750	½in. sq. iron	One core and two coils, top coil shunted.
g...	1·5	750	½in.sq.brass	One core and two coils (curve dotted).
h...	2·6	750	½in. sq. iron	One core and two coils (curve dotted).
22 *a*...	8·1	750	½in. sq. iron	14in. core and one coil.
b...	6·2	750	½in.sq.brass	14in. core and one coil.
c...	6·1	750	½in. sq. iron	14in. core and two coils.
d...	4·4	750	½in.sq.brass	14in. core and two coils.

* Position taken higher up on curve to correspond with curve *d*, Fig. 20.

From the foregoing remarks and curves it would seem that the best results may be obtained with one core and one coil only, or, in other words, the core must be as long as possible and the coil short. Also when the core is long in comparison with the coil, the disturbance due to the external field of the coil seems to decrease with both iron and brass cross-pieces.

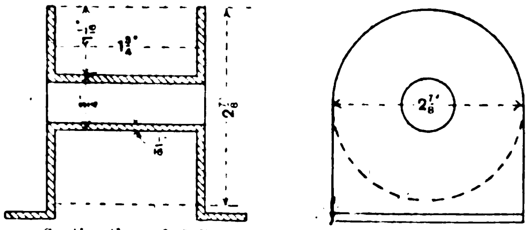

Fig. 24.

As it was necessary to use the piece of mechanism (when a suitable one was found) on a circuit of about 300 volts, the coils in the remaining experiments on the solenoid and core were made with two coils of very high resistance wound with platinoid wire. It was found more convenient to wind the bobbin with platinoid wire to stand 300 volts than winding it with copper wire and putting a resistance in series with the coil, although the latter method would have been the least expensive. Before winding the coil it was found impossible to get any published data as to what gauge wire to use; therefore full particulars of the two coils and some temperature tests are given in the hope that the results may prove useful.

The smaller coil was wound with No. 30 B.W.G. double silk-covered platinoid wire, had 5,650 turns, and a resistance 4,326 ω at 22°C. The dimensions of the bobbin are given in annexed sketch (Fig. 24).

With a difference of potential of 350 volts across the terminals for about an hour, the temperature, as shown by a thermometer placed inside the coil, with its bulb touching the metal and covered with wool, was 70°C., the temperature of the room being 22°C.

The other coil was wound with 6,154 turns of No. 28 B.W.G. double silk-covered wire, and had a resistance of 4,390 *w*. The weight of wire on coil was 3lb. 5oz. The dimensions of the bobbin are given in the annexed sketch (Fig. 25).

With a difference of potential of 285 volts across terminals of coil for an hour, and the thermometer arranged as in the smaller coil, the temperature rose to 50°C., the room being 22°C. The thermometer was then placed on the outside of the coil, its bulb touching the winding and the metal flange, the remaining portion of the bulb being covered with wool. The

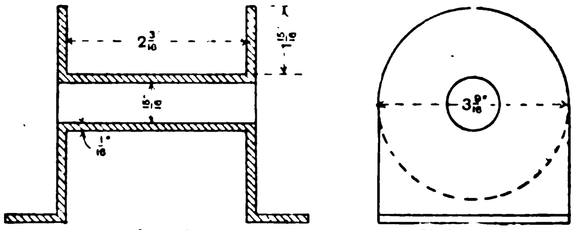

Fig. 25.

coil was kept in circuit for 2½ hours, and the temperature rose to 75°C., that of the room being 22°C. as before.

In Fig. 26 are given three curves obtained with the large coil, and three different cores under the same conditions as regards the spring, which was smaller and weaker than that used in the first set of experiments. This spring was 36in. long by 0 275in. wide by 0·013in. thick in convolution, and was calibrated as before, giving a perfectly straight line. Every 10deg. turned through by spring corresponding to a torque of 0·11 inch-ounces. The curves *a*, *b*, *c*, are chosen from several

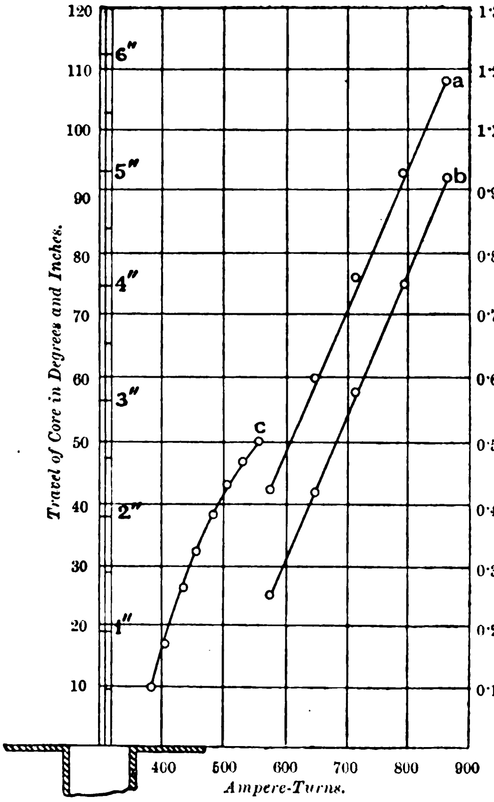

Fig. 26.

as being the best suited for our purpose (or nearest a straight line), and show the effect of different cores, each with the ½ sq. in. iron cross-arm. Here for the same variation of excitation, viz., 200 ampere-turns, the travel is practically the same, although the cores are widely different, *a* being obtained with a core 14in. long (Fig. 23); in *b* the core was 14in. long, but was double-tapered (Fig. 23), and in *c* the core was only 5in. long. As regards the shape of curve, there is no difference between the single and double-taper core of the same length,

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but the single-taper a is drawn more into the coil for the same excitation than the double-taper b. The curve c is straight until the point of the core is 1·7in. outside coil, and then bends over slightly. Although this 5in. core does not give as good a curve as the 14in. cores, yet the arrangement with the 5in. core is very much more sensitive than with the 14in. cores, the smallest variation in the excitation giving an immediate movement of the core, and, in addition, it is more dead-beat. This is no doubt due to the lightness of the short core as compared with the long one.

Fig. 27, curves a and b were obtained with the smaller coil and the 5in. core (Fig. 3), and show the effect of using the iron

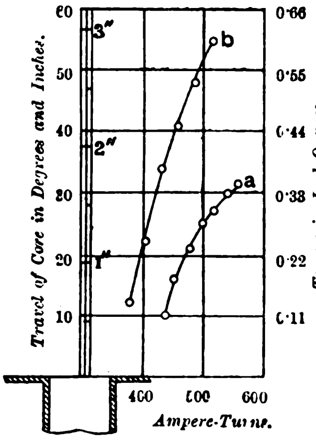

FIG. 27.

and brass cross-pieces. For a variation of 120 ampere-turns the travel in a, where brass cross-piece was used, was only 1·1in., as against 2·3in. travel when the iron cross-piece was used. Here, where the core is short compared with the length of the coil (or the core about $2\frac{3}{4}$ times the coil length), there is a decided gain by using an iron cross-piece, both as regards travel and shape of curve.

Fig. 28, curves a, b and c show the effect of altering the taper of the core and of adding the iron disc used in curve b, Fig 13, to the base of the core. The smaller coil was used here, and the two 5in. taper cores, a $\frac{5}{8}$in. diameter at base and $\frac{1}{16}$in.

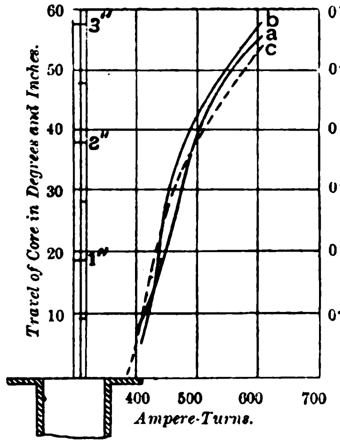

FIG. 28.

diameter at point, and c $\frac{15}{32}$in. diameter at bottom and $\frac{5}{32}$in. diameter at point (Fig. 23); the curve b is that obtained with the iron disc on the base of the 5in. core used for a. The $\frac{1}{2}$ sq. in. iron cross-piece was used in this experiment, and for a variation of 200 ampere-turns the travel is practically the same, being 2·8in. for a (quick taper core), 2·7in. for c (slow taper core), and 2·6in. for b (quick with disc attached). Here, in addition to a giving the greatest travel, it is also the straightest curve; c comes next in order of shape, and the addition of the disc to the end of the core gives a curve somewhat similar to that obtained when the two cores and two coils were used.

(To be continued.)

THE ELECTRIC LIGHTING OF THE CITY OF LONDONDERRY.*

BY JOHN CHRISTIE.

The idea of public lighting by electricity was first discussed by the Corporation so far back as March, 1888, but was allowed to drop. The matter was again brought up two years later, and it was then agreed to take out a Provisional Order. As the time wore on, and the Board of Trade required the Corporation to take some active steps in the matter if they wished to retain their powers, they, in September, 1892, called in Mr. H. W. Blake as consulting engineer, to advise them on a scheme. The following year the Corporation finally decided to adopt a scheme for the public lighting of the city by means of arc lamps. This scheme, prepared by Mr. Blake, was submitted to Dr. John Hopkinson, and on his approving of the specifications, &c., tenders for the plant were invited by advertisement, accepted, and gone on with as soon as the permission had been granted by the Local Government Board to borrow the necessary estimated capital of £15,000.

In the selection of a site for the station, the Corporation were particularly fortunate in obtaining on very favourable terms what had formerly been an old saw mill, situated in the Strand, at a distance of some 700 yards from the centre of the city, and extending back 230ft. to the quay, and having an opening on to the river, thus affording every facility for storing coal direct off the steamer, and also an ample supply of water for condensing purposes. At present there are only two boilers laid down. They are of the Lancashire type, constructed for a working pressure of 125lb. per square inch. The feed-water arrangements comprise two duplex double direct-acting pumps, each capable of supplying 900 gallons per hour against the maximum working pressure. The water is drawn from a storage tank of some 20,000 gallons capacity, placed on the roof of the boiler house, and supplied direct off the town mains. The economiser is one of Messrs. Green's. The steam is conveyed to the engine room by two lines of 9in. wrought-iron pipe, having 6in. branch pipes to each boiler; both lines are common to each engine. In the engine room are placed along one side three vertical compound-condensing engines of 150 I.H.P., made by a local firm of engineers, Messrs. Brown and Sons. The diameters of the cylinders are, high-pressure 11in., low-pressure 22in., and the stroke 18in. The average speed at which they are run is 145 revolutions per minute. Each engine has a jet condenser of its own placed under the floor of the engine room, the air pump being operated on a crank disc on the end of the shaft. The condensing water is supplied to each engine by a separate 4in. cast-iron pipe laid direct to the river, each pipe being fitted with a clack valve, rose head and mud box. A 9in. cast-iron pipe serves as a common discharge to all the engines. An auxiliary injection pipe off the town mains is provided to each engine to assist at starting if the tide is very low or a suction pipe gets choked. The speed of the engines is controlled by Hartnell's patent automatic expansion governor fitted on the crankshaft, which, by shifting the angle of advance of the high-pressure eccentric, varies the cut-off of the valve to suit the load. The distribution of steam is effected in the high-pressure cylinder by a piston valve, admitting the steam in the middle and exhausting at the outer edges, and in the low-pressure cylinder by an ordinary trick slide valve; by this arrangement the high-pressure piston gland is the only one which is subjected to the full working pressure. The fly-wheels are 8ft. in diameter and 24in. broad, and each weighs about 3 tons.

By means of two 10in. leather belts, each engine drives two dynamos, placed on sliding rails one behind the other. The dynamos are of the constant-current series type, made by Messrs. Siemens Bros. and Co. They are designed for an output of 10 amperes at 3,000 volts at 750 revolutions per minute. The machines have ring armatures rotating in a double magnetic field, and are fitted with copper commutators 18in. diameter, divided into segments, and insulated with mica. We have had them running constantly for nearly 18 months at 2,500 volts, and often having them subjected to the most severe strains possible, and they have given no trouble whatever; the sparking is not excessive and the wear on the commutators very small. To keep the current constant a very ingenious regulator is provided, which automatically varies the voltage to suit the number of lamps on circuit by rocking the brushes back or forward; with these regulators in gear it is almost impossible to get more than 10 amperes for any time, and they give the current just as well on short circuit as when the whole resistance of the circuit is on. Last winter we had ample opportunity of testing them through the high winds which were so prevalent.

The lighting of the city is divided into sections, each section having two circuits with lamps arranged alternately on different circuits. At present we have the lamps arranged on the four

* Abstract of a Paper read before the Incorporated Association of Municipal and County Engineers, at Londonderry.

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circuits as follows: 40, 43, 41 and 48, or 172 in all; but extra lamps will most probably soon be looped in to bring the numbers on each circuit up to over 50, and do away with some more of the gas lamps which still exist in some of the smaller streets.

The cables consist of $\frac{7}{16}$ copper strand heavily insulated with vulcanised india-rubber, served with a covering of bituminised jute, armoured with galvanised steel wires, the whole being covered with jute steeped in a preservative compound and laid in the ground direct. The armouring is earthed at every lamp, and also at the station ends. There are some 34 miles of this cable laid, the longest circuit being about nine miles round, and the area lighted is, I think, one of the largest in the country. During the first six months after the plant was taken over by the Corporation we had a most unfortunate time of it, through failures of the lamp cut-outs, cables and other causes incidental to the start of such a large scheme. For a long time this made the electric light most unpopular with many, but Messrs. Siemens successfully surmounted all the many difficulties as they cropped up, and in the very depth of winter entirely relaid the whole of the cables without interrupting the lighting of the city. All these failures are happily a thing of the past, and now we rarely have even a single lamp failure reported.

All the lamps are of the well-known Brockie-Pell double-carbon 32-hour type, so that in winter they only require trimming every second day, whilst in summer once a week suffices. The lamps are fixed on ornamental cast-iron pillars 25ft. high, and pitched from 75 to 250 yards apart.

A brief description of our method of detecting faults on the circuits may be of interest to some of you. Daily insulation resistance tests of all the circuits are taken, and if any one shows below the normal it is carefully watched; should it become dangerously low, the position of the fault is first roughly located by means of a Kelvin electrostatic voltmeter of the ordinary type, reading up to 6,000 volts; the weights on the vane are adjusted so that the scale reads 50 volts per division. One terminal of the instrument is then earthed, and the other terminal connected to the positive and negative ends of the faulty circuit, and two readings obtained, which, assuming the voltage per lamp at 50, reads directly the number of lamps from either end about which the fault exists. By referring to the map we can at once go to almost the exact lamp, and by freeing the ends at the switch tell by means of a detector whether the fault lies in a lamp or a section of the cable between two lamps. This method I find saves an immense deal of trouble, rendering it unnecessary to split up a long circuit into several parts until the faulty one is found; and if the readings are carefully taken we can always spot the section within two lamps either way. If the fault proves to be in a lamp it is immediately remedied by replacing it with a spare one, and if in the cable and of low enough resistance it is at the earliest opportunity burned out dead to earth by temporarily earthing one end of the line at the station, when by means of the loop test taken on the section with a portable testing set, the exact position of the fault is located and cut out. I am glad to say, however, that such faults never occur in the cable we now have through any inherent weakness of the insulation, but have always been clearly traceable to pick marks caused by some careless workman, when opening the streets, accidentally striking the cable and neglecting to report it.

The cost of the whole scheme up to the present amounts to between £18,000 or £19,000. In winter during the long nights the works cost per lamp-hour were as low as 0·65d., and in summer when the runs were shortest they reached as high as 1·70d. per lamp-hour. So far as can be judged, the total costs, including everything, should not much exceed £19 per lamp per annum, which, considering the number of hours we run (over 3,000) is by no means excessive.

No attempt has yet been made by the Corporation to introduce private lighting.

CORRESPONDENCE.

MAGNETIC UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is after hesitation, and with some reluctance, that I comply with your request to take part in the discussion of this question. The fact is I have not been able to see that the proposed new names and new units are needed. When so clever a man as Prof. Lodge takes all these pains, I should like to believe that his proposals are meeting a felt want. But by whom is the want felt? I hold strongly that in this matter necessity should be the mother of invention. Dr. Lodge offers us sundry bantlings for adoption, but where is the maternal parent? New names and new units will be worse than useless unless they quickly become familiar. The B. A. Committee may make them legal tender among electricians, but will they come to be current coin? Will the success that attended the invention of ohms, volts and amperes be repeated, even in minor degree? Only if the new names allow us to conceive magnetic quantities more easily or to specify them more tersely than we can already do. We are accustomed to say that the permeability of air is 1. Will the advantage of calling it the "inductivity" instead, and of saying that it is one millihenry per kilometre, be immediately obvious to practical men?

In some cases it is proposed simply to give a name to the C.G.S. unit, and in other cases to use a multiple of the C.G.S. unit and give that a name. Thus Mr. Evershed would have us call the C.G.S. unit of magnetic induction a "thom," while Dr. Lodge would take 10^8 of the same unit and call it a "weber." Why do either? So long as we stick faithfully to C.G.S. a number is enough. To say that the total induction through an armature is 25 millions is at least as convenient and precise as to say that it is 25 million "thoms" or 0·25 "webers." Dr. Lodge has chosen the magnitude of the "weber" so that an E.M.F. of one volt shall be excited in a conducting circuit through which the total induction changes at the rate of one "weber" per second. But this endeavour to connect the new unit with the volt, the ampere and the ohm results in making it inconveniently large. Better, I think, use C.G.S. pure and simple in dealing with the magnetic quantities, and introduce the needful power of 10 when we want to reckon volts.

Again, we are asked to accept a new name for the line-integral of magnetic force, which most of us (following Mr. Bosanquet) call the magnetomotive force. This quantity is of first-rate importance in relation to the magnetic circuit as a whole. But I doubt if the occasion ever arises in practice to reckon magnetomotive force except for the whole circuit. And so long as we are dealing with the magnetic circuit as a whole it is not likely that any new name will be more serviceable than the familiar and eminently practical "ampere-turns." When we want, for purposes of reckoning, to express the magnetomotive force in C.G.S. units, it is easy to multiply by $\frac{4\pi}{10}$; but ampere-turns is too expressive and explicit a phrase to require addition or change.

As to the magnetic force at any point (H), no new name is wanted, and the C.G.S. unit is all that could be wished in respect of magnitude.

I understand that it is proposed to use one and the same unit for the permeance of a magnetic circuit and for the self-induction of a coil or the mutual induction of two coils. These are quantities of the same dimension, and as Prof. Lodge points out, the self-induction of a coil of n turns is $4\pi n^2$, the permeance of the magnetic circuit through its coil. Mr. Baily's objection that the self-induction of a coil would be liable to confusion with the permeance of its core has much force. As to permeance, which is total induction divided by magnetomotive force, no special unit name seems necessary. Whether a unit name for self-induction and mutual induction is practically important I have no opinion. The invention and partial use of "secohm" on this side of the Atlantic and "henry" on the other suggest that it is. But in any case it would be unfortunate and confusing to give the "henry" a value different from that which has already been assigned to it. Will American electricians consent to make their old name have a new meaning? Moreover, though this is of less consequence, the unit now proposed is, like the "weber," inconveniently big. These are large prices to pay for the kind of consistency that is aimed at in Prof. Lodge's proposals.

One or two points may be noticed that have come up incidentally in this correspondence. Prof. S. P. Thompson speaks of the quantity which we write B as "unfortunately sometimes miscalled the induction, as though induction were not the operation of inducing." I have rarely heard it called anything else, and am content to follow Maxwell, who probably believed that induction, like deduction, might properly name the result of a process as well as the process itself.

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To define μ as $\frac{d\mathbf{B}}{d\mathbf{H}}$ would, in regard to iron, make μ useless. It should be remembered that, owing to the complications of hysteresis, the term permeability as applied to iron has a special meaning. It is used to name the ratio of **B** to **H**, when **H** is either (*a*) applied without previous magnetisation, or (*b*) applied after previous magnetisation by an equal and opposite magnetic force. These two definitions do not give strictly the same result; but the values are so nearly alike that the difference is, in practice, unimportant.

As to Mr. Heaviside's invitation to formulate a theory of the process of magnetic induction in iron, I fear that the relation of **B** to **H** is far too complex—as depending on previous values of **B**—to admit of mathematical statement. That at least is the conclusion to which a study of the model with small magnets seemed to point, where the process of magnetisation was seen to occur through the breaking up and rearrangement of inter-molecular ties under the influence of the applied field.—Yours, &c., J. A. Ewing.

Festiniog, North Wales, Aug. 26, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to the correspondence on the subject of magnetic units now going on in your columns, I am sorry to say that Prof. Thompson could not have named in this connection a less sympathetic individual than myself; as the alleged necessity for new units does not in the least appeal to me.

It is unnecessary to seek a new name for "one line of force" or for "1,000 lines of force," or for "a million lines of force." As well might we coin a new term for "one revolution," follow that up with another for "100 revolutions," and still a third for "1,000 revolutions"—a *kilorevolution* to wit. It is as easy to say that the total flux is "5,000 lines" as to say that it is 5 *kilolines*; and the "thom" of my friends at Woodfield Works I have never been able to understand. Substituting *thom* for *line*—I put it shortly, without writing *of force* after it—I have always regarded as the most awful example of unit mania extant.

As regards *the number of lines per square centimetre* or *induction*, denoted by **B** the world over, I do not see that we require special names for particular values of it. "Lines per square centimetre" = so many, or "the induction" = such a figure, or **B** = so much, seems to meet all cases. There are some I know who would like to have a name invented for 1,000 lines per square centimetre, but I am not amongst them. *Engineers* have gone on very well without such variety of terms. *They* do not require a distinct name for a speed of 30 miles an hour, and another for 60, or a special term for 100lb. pressure per square inch, and another for 120lb. Proposals of this kind made by anyone would very properly be regarded as ridiculous, and having been brought up in a practical school, I am consequently inclined to look down upon the senseless multiplicity of terms some electricians would have us adopt.

There remains *magnetising force* to be dealt with, and here I am still at a loss as to what is requiring new definition. Magnetising force is expressed in two different ways, either as the *line-integral* or *ampere-turns* accordingly as the constructive engineer regards one or other as the more convenient. What he has to determine is the magnetising force required for a given circuit, and this he finds from his iron data in the usual manner; but how it will help him to give a name to some particular value of magnetising force, whether expressed as the "line-integral" or "ampere-turns," and call it *unit magnetising force* I fail to see. Altering the unit of current is not to be thought of seriously for a moment. Magnetic quantities are only dealt with professionally, if I might so put it, while amperes, volts, watts and horse-power are dealt with commercially by everyone having the slightest connection with electrical matters. These quantities have become stereotyped as part and parcel of an industrial system, and even if a change were desirable, which it is not, they could not be altered with any greater facility than could the horse-power.

The advantage of having a universally received meaning for the terms in Prof. Thompson's paragraphs 5 and 6 seems to be more apparent than real. Whenever the relation between magnetic force and flux is given by any writer he is careful to state which way the magnetising force is computed, so I do not think any confusion has arisen or is likely to arise under this head.

Of course I am writing solely from the constructive engineer's point of view, and it may be here observed that practicians who write on questions of construction are likely to adopt the language they have found most useful, whatever new names may be invented by the physicists. Probably Mr. Evershed would not give up his "thoms," nor Mr. Kapp his "English lines," nor the writer his "ampere-turns" without a pang. Again, it is unlikely that anything the practician urges will be considered by the high-and-dry theorist, for the latter seldom understands the mode of thought of the former, and when he does comprehend, he fails to appreciate it.

Probably all engineers do not share my views, but the engineers—I bar *electricians*—who are represented as thirsting for fresh units I have never met. We have done wonderfully well for some time with the existing terminology, and the "swallowing of camels," to use Mr. Heaviside's expression, has not impaired our faculties. By all means let the "scienticulists" invent units and names for units, as many as they please, but they should not delude themselves into the idea that the practician is benefited thereby; it makes not the slightest difference to him.

I understand Mr. Heaviside is the ringleader of the unit movement, and for that gentleman's work I have the greatest respect. But as the heavens are higher than the earth, so are Mr. Heaviside's thoughts loftier than those of a mere practician, and his conclusions correspondingly obscure to the average intelligence. Nevertheless in his own domain he has done work which will endure. And conscious that the practician can never degrade it by application to dynamo design or other things useful, he ought to be both proud and happy.—Yours, &c., W. B. Esson.

London, August 27, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am ashamed to say that for many years I designed dynamos without using the orthodox **H** and **B**, until the sarcasm of a third-year student, who wasted hours in drawing the most beautiful German capitals, at last induced me to multiply my square inches by 6·45 and my minutes by 60. It looks better, but it is more trouble.

As to the new units, they should certainly have the same relations to each other as the volt, ampere, and ohm; this will remove a great difficulty from the path of many students who have to teach themselves, and who always seem to find it so hard to get beyond Ohm's law. I do not see that any other units are wanted.

With regard to the 4π question I do not think that it is generally known that 2 **H** = the ampere-turns per inch long within 2 per cent. This is immensely useful, as all lengths can be taken in inches, so that I should be very sorry to see 4π disappear.

I hope that "thom" will not be adopted among the new names; it is nearly as offensive as "practician."—Yours, &c.,

110, Cannon-street, E.C., Henry W. Ravenshaw.

August 26, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: So long as the unit of length of the mechanical engineer is not a centimetre, it is unreasonable for us to reckon lengths and areas in machine designs by that unit. Conversions of the dimensions in a design from centimetres into inches are a serious nuisance, which an engineer cannot afford to submit to merely in order to support a theoretical system of measurements. Hence I consider the units for magnetic quantities per centimetre (**H**), or per square centimetre (**B**), and consequently the names for such units, as of little interest (What about a name for the unit of current density in amperes per square centimetre?) until the mechanical engineer takes to the centimetre, or, let me say, until he decides whether he will have that unit of

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length or not. For, suppose the electrical and mechanical engineers, whilst waiting for the millenium of metrical measurements, were to agree upon, say, a decimal foot (10 English inches) and 1lb. avoirdupois as fundamental units, then they might any day, *without changing tools and gauges*, have the immense advantages accruing from the use of a rational system—advantages which otherwise seem to be still in the blue. It must be remembered that the C.G.S., besides having unsuitable fundamental units, is not a rational system.

I have a number of years ago constructed my **B-H** curves and tables with 1 kilo C.G.S. per square inch as unit **B**″, and 1 ampere-turn per inch as unit **H**″. With these units wrought iron and dynamo steel goes in the habitual ranges from 30 to 120 **B**″ under 3 to 570 **H**″, and the net magnetic pole in a dynamo, when it is running light, is (1 kilo C.G.S. being unit magnetic pole) $m = \frac{6 \times 10^6 E}{N h}$ (m = magnet pole, E = volts, N = revolutions per minute, C = number of bars effective), which are convenient values.

My **H**″ unit, 1 ampere-turn per inch, being $\frac{0 \cdot 4\pi}{2 \cdot 54}$, and my **B**″ unit $\frac{1,000}{2 \cdot 54^2}$ times greater than the respective C.G.S. units, my ratio $\frac{B''}{H''}$, multiplied by $\frac{1,000}{0 \cdot 4\pi 2 \cdot 54}$, or 313·3, brings μ based upon unity for air; my quantities are those given in practice. If we use the C.G.S. system, the practical data are ampere-turns per centimetre and pole (or lines) per square centimetre, and μ is obtained by multiplying their ratio by $\frac{1}{0 \cdot 4\pi}$, or 0·7958, a figure which is no more convenient than my 313·3.—Yours, &c.,

F. V. Andersen.

14, Westdown-road, Catford Bridge, London, S.E., August 27, 1895.

BRITISH v. CONTINENTAL TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I was pleased to notice that Mr. G. L. Addenbrooke, in your issue of August 16th, has, with the help of figures taken from my recently-published book on "Continental Telephony," pointed out, in a manner which you, in your leader, justly commend, that one of the most persistently-advanced excuses for high telephone subscriptions in this country is devoid of foundation. For many years the shareholders of the National Telephone Company, Parliamentary Committees and the general public have been told that one of the chief causes of high rates is the much greater cost of labour of all kinds in this country. That this is not the case was one of the facts my book was designed to prove, and Mr. Addenbrooke has very neatly clinched the demonstration.

While admitting as much in your leader, you say "it is for him or others to prove that the cost of erecting, maintaining and working a telephone system is in the same state, that the Continental concerns honestly pay their way and something over." Now the lowest rates on the Continent are nearly invariably granted by companies who issue detailed and clear accounts at regular intervals; and had Mr. Addenbrooke dipped deeper into my book when reviewing it, he would have found that particular care had been taken to prove the very thing that you infer still calls for proof. Translations of the recent accounts and balance-sheets of several Continental companies are given in full, and these show conclusively that dividends even better than those habitually paid by the National Telephone Company are earned year after year on subscriptions which the Directors of the National Telephone Company have on numberless occasions stated to be ridiculous and unworthy of serious notice; and this after providing (which the National Telephone Company has never done) sickness and accident funds for the benefit of the male and female employees, and after putting aside adequate provision for deterioration and renewals. These accounts show that low subscriptions pay handsomely in exchanges larger than any possessed by the National Telephone Company, as well as in medium-sized and small towns. It is fortunate that these companies' accounts exist, since the various States adopt methods which render it impossible for an outsider to tell whether their systems are remunerative or the reverse.

If Mr. Addenbrooke cares to search even deeper within the book, he will find several other pet illusions and excuses effectually disposed of.—Yours, &c.,

A. R. Bennett.

22, St. Alban's-road, Harlesden, N.W., August 22, 1895.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is NOW READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices:—*

Laboratory Notes and Forms.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett (*now ready*). Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A Large-Sheet Table, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s. —each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

A Sheet Table showing Total Capital Outlay and Receipts and Expenditure for the year 1894 of the Statutory Electric Supply Undertakings of the Metropolis is now ready, printed on thick paper, price 6d. each.

A Sheet Table giving similar particulars in relation to Provincial Statutory Electric Supply Undertakings is now ready, printed on thick paper, price 6d. each.

"The Work of Hertz."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. nett, is now ready.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d. post free (abroad 11s.).

"Electrical Engineering Formulæ," a pocket-book by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"Drum Armatures and Commutators."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson, price 6s. 6d., post free.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

Tenders Invited.—Tenders are invited by the Vestry of Hammersmith, London, W., for complete schemes for public and private lighting, and for the supply of motor power in the compulsory area of the Vestry's Provisional Order. Particulars can be obtained of Mr. H. Mair, Surveyor to the Vestry. Tenders have to be sent in by 6:30 p.m. of *Wednesday next*, Sept. 4th.

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TENDERS INVITED.—The Urban Sanitary Authority of the Borough of Bedford requires tenders for the supply of vulcanised rubber cables. Tenders to Mr. T. S. Porter, Town Hall, Bedford, by Wednesday next.

——— The Municipal Authorities of Braila, Roumania, invite tenders for the concession for (*a*) lighting about 64 kilometres of public streets by both electricity and gas, and (*b*) 64 kilometres of public streets by electricity alone, and also for the concession for the construction and operation of a network of electric tramways in the principal thoroughfares. Tenders to the Maire, Hôtel de Ville, Braila, by October 2nd.

——— The Urban Sanitary Authority of Chepping Wycombe (Bucks.) invite tenders for working their Provisional Electric Lighting Order. Tenders, by noon of October 14th next, to the Town Clerk, High Wycombe.

——— The Queenstown Town Commissioners require tenders for the erection of works and the necessary plant for generating electric current for the public and private lighting of the town. Tenders to be in by September 26th.

——— The Staffordshire County Infirmary Committee require tenders for wiring and fitting up the Infirmary for the electric light. Specifications, &c., may be had at the Infirmary and at the offices of the engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, London, S.W. Tenders, addressed to the Secretary (Mr. Ellis E. Crisp), County Infirmary, Stafford, must be in by noon on Saturday, September 14th. Some additional information appears in our advertisement pages.

——— The Baths Committee of the Oldham Corporation invite tenders for supplying and fixing wires, fittings, &c., for lighting a portion of the Central Baths, Oldham, by electricity. Specifications may be had from the borough electrical engineer, Mr. S. Willmott Newington, and tenders, addressed to Mr. A. Nicholson, Town Clerk, Town Hall, Oldham, must be in by noon on September 11th. Further particulars are given in our advertisement columns.

——— The Portuguese Posts and Telegraphs Department require tenders for the supply of 19½ tons of iron and steel wire (from 1mm. to 4mm. dia.) and 2½ tons of bronze wire. Tenders by Sept. 4th to the Director General of Posts and Telegraphs, Lisbon.

——— The French Posts and Telegraphs Department requires tenders for the supply of 100 tons of copper wire and 24,000 copper cylinders. Tenders by September 10th to the Direction Générale des Postes et des Télégraphes, 103, Rue de Grenelle, Paris.

——— Tenders are invited by the municipal authorities of Jerez de los Caballeros (Badajoz), Spain, for the supply and erection of the necessary plant for the electric lighting of the town. Tenders to be addressed to the Ayuntamiento de Jerez de los Caballeros (Badajoz).

——— The Spanish Posts and Telegraph Department invites tenders for the supply of 20 tons of sulphate of copper and 12,000 zinc cylinders for telegraph purposes. Tenders to the Direccion Generale de Correos y Telegrafos, Madrid.

——— The Corporation of Sunderland invite tenders for (*a*) high-tension and low-tension concentric cables, (*b*) cast-iron pipes and box frames and covers, (*c*) stoneware casing, boxes, and bell-mouth protectors; (*d*) high-tension transformers for alternating current, and (*e*) meters for alternating current. Specifications may be obtained from the Borough Electrical Engineer (Mr. C. S. Vesey Brown), Electricity Supply Station, Sunderland. Tenders must be in by 6:30 p.m. on Friday, September 13th. Some further particulars appear in our advertisement columns.

TENDERS ACCEPTED.—The following tenders have been received for wiring and supplying the necessary fittings for the electric lighting of the County Council Offices, St. Mary's Gate, Derby, to the specification of Mr. J. Somes Story, M.I.C.E., architect and surveyor to the County Council. Current is to be taken from the Corporation mains:—

Fletcher and Hirst, Burnley (*accepted*)	£397	0	0
J. Davis and Sons, Derby	600	0	0
Paterson and Cooper, London	519	0	0
C. Smith and Son, Birmingham	487	17	6
E. Haslam, Derby	478	0	0
S. J. Waring and Son, Liverpool	475	0	0
B. Verity and Sons (*withdrawn*)	431	0	0

——— The Belfast Town Council have accepted the tender of Messrs. Wormald and Co. for covering the exhaust pipes at their electricity works.

SALE.—Our advertisement columns contain particulars of some high-class second-hand electric lighting machinery for disposal. The plant includes two 12 H.P. Davey-Paxman steam engines and boilers, two Crompton and two Edison-Hopkinson dynamos, a Crompton-Willans direct-coupled steam dynamo, two 40 H.P. Davey-Paxman locomotive boilers, a switchboard, and a battery of Crompton-Howell cells, together with feed-water injectors, beltings, steam pump, &c. Further information and orders to view may be had from the Hove Electric Lighting Company, Mansion House-buildings, London, E.C., or Cromwell-road, Hove.

BANKRUPTCY.—The following is a list of some of the creditors in the bankruptcy of Ronald A. Scott, lately carrying on business as an electrical engineer at Acton Hill:—

Fraser and Fraser	£50	0	0	Archdale (J.) and Co., Birmingham	£333	0	0
Gapp Bros.	86	0	0	Hill & Smith, Brierley Hill	12	3	8
General Electric Co.	12	2	3	Glover (W. T.) and Co., Salford	29	9	0
Highton (E. G.) & Co.	1,143	0	0	Colver Bros., Sheffield	21	15	0
Lloyd and Lloyd	12	5	0	Fully-secured creditor	4,180	0	0
Reeves and Son	100	0	0	Partly-secured creditor (Brecks, C.W.), Brough	2,775	0	0
Taylor and Hobson	51	10	0				
Willcox (W. H.) & Co.	12	16	8				
Farquharson, J.	1,060	0	0				
All of London.							

LIQUIDATION.—Last week an application by Mr. J. L. Fuller, electrical engineer, of Bush-lane, Cannon-street, London, E.C., for the compulsory winding-up of the New British Electrical Installation Contractors (Limited), was heard at the Worcester County Court before Sir R. Harington. Mr. Bell, who appeared for the petitioner, stated that the Company were indebted to creditor in the sum of £85. The old British Installation Company had a capital of £20,000, but upon the shares taken up only £1,075 had been subscribed. The new Company purchased the business of the old Company for £3,000, for which amount Six per Cent. Debentures were created in favour of the old shareholders as supplementary capital. In July last, on the application of the debenture-holders, who claimed the whole of the assets of the Company, Mr. Justice Kekewich appointed a Mr. H. A. Leicester receiver for the debenture-holders. The petition alleged that the old Company was insolvent and its shares valueless. After a patient hearing the judge made an order for the compulsory winding-up of the Company, and appointed the Official Receiver liquidator.

——— An application was made to Mr. Justice Mathew on Tuesday in the Chancery Division to sanction a scheme of arrangement by which the Otis Steel Company (Limited) could be got out of liquidation. Meetings of the shareholders had been held, and had approved of the proposed arrangement, the new company to take over the liabilities of the old. His Lordship granted the application, subject to a report from the Registrar that no meeting of creditors was necessary.

INFORMATION INVITED.—A correspondent of the *Financial Times* pertinently (perhaps we should say impertinently) desires to know something of the details of the winding-up of Messrs. J. E. H. Gordon and Co. (Limited). The correspondent appears to think this information is somewhat overdue. There are, however, other liquidations regarding which some information would be appreciated. A very long time back a concern called the Electrical Engineering Corporation (Limited) reached the winding-up stage after a tortuous career. We have ourselves made several attempts to obtain information, for our own and our readers' benefit, concerning this liquidation, but particulars are very difficult to obtain. Some information relating to the affairs of Poole and White (Limited), of J. G. Statter and Co. (Limited), and of several other concerns would be welcome. Perhaps some of the gentlemen who figured conspicuously in these concerns would volunteer some information, which, we feel sure, would be received with thanks.

APPOINTMENT VACANT.—The Portsmouth Town Council require a clerk of works to superintend the laying of conduits, &c., in connection with their electric lighting extensions. Salary £2 per week. Applications to the Chairman of the Electric Light Committee, Gunwharf-road, Portsmouth, by Thursday next, September 5th.

PARTNERSHIP.—Messrs. Percy H. Tewson and Roland H. Streatfield have entered into partnership, and will carry on business as electrical engineers and contractors under the style of Tewson and Streatfield, at 35, Bucklersbury, London, E.C. Both members of the firm were formerly with Messrs. Laing, Wharton and Down.

DISSOLUTIONS OF PARTNERSHIP.—Messrs. Dadge and Fraser, carrying on business as electrical engineers under the style of Dadge and Co., at 18, Cecil-court, Charing Cross-road, London, W.C., have dissolved partnership.

——— Messrs. Broadbent and Reaney, electrical and mechanical engineers, 80, Manningham-lane, Bradford, have dissolved partnership.

——— The partnership business of mathematical instrument makers hithero carried on by Messrs. W. E. and C. Barker, under the style of Francis Barker and Son, at 12, Clerkenwell-road, London, E.C., has been dissolved.

CHANGE OF ADDRESS.—Until further notice the Glasgow address of the Eastern Telegraph Company is changed from 5, Royal Bank-place, to 141, Buchanan-street.

PERSONAL.—Mr. R. S. Bozon, who has for some time past been in the service of the Post Office at Birmingham, has been appointed

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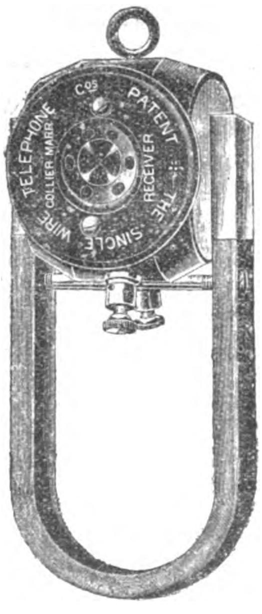
electrical engineer at the Palace Theatre of Varieties, London. Before his appointment to Birmingham Mr. Bozon was engaged at Brighton, and he was for some years in the States.

Dividend.—A final dividend on the shares of the International Cable Company (Limited) (in liquidation), at the rate of 5s. 3¾d. per share, has been declared, and is now payable at the Offices of the Official Liquidator (Mr. F. S. Lucey), 15, George-street, Mansion House, London, E.C.

Hermite Sanitation Plants.—Messrs. Paterson and Cooper have received instructions from the War Office Authorities to proceed with the erection at Netley Hospital of the Hermite Sanitation Plant, the cost of which has been provided for in this year's parliamentary estimates. The Corporation of Cape Town have also ordered a plant for producing electrolised sea water, with a view to the Hermite process being applied to the sanitation of Cape Town.

The Collier Receiver.—The accompanying illustration shows the latest form of the Collier receiver, the patent rights in which have been acquired by the Single-Wire Multiple Telephone Signal Company (Limited), of 50, Old Broad-street, E.C. The instrument has been before the public for some years, but has not, in the opinion of those who know it best, yet received the attention it deserves. The Company claim that it is without doubt the most sensitive, loudest and clearest telephone receiver in the market, and where, from any cause, the currents available to operate the receiver at the end of a telephone line are much reduced this form of receiver has very great advantages, and will enable communication to be kept up. The only objection that could, in the Company's opinion, be formerly urged against it was its outward appear-



ance, which has, however, now been modified as shown. The extreme sensitiveness of these instruments is due to two causes : (1) the use of two diaphragms arranged in combination with a specially-shaped air chamber, so that each reinforces the sound waves produced by the other ; and (2) the fact that the magnetic polarisation, owing to the special arrangement by which the lines of force are carried through almost a closed circuit of thick iron all the way, is exceptionally strong ; and, the coil being placed centrally on a short, well-laminated core, and not touching a mass of iron or steel at either end, but always well polarised, the power of the high frequency but minute undulatory currents is exceptionally well conserved and reconverted into the form of energy required. This receiver is, therefore, especially adapted for long-distance work. In conjunction with a Brown transmitter, also owned by the same Company, excellent results have been obtained. As showing one of many instances where the receiver has been found superior to others, the owners state that all the best receivers to be obtained have been tried by Mr. Pocklington, representative of Callender's Company at Liverpool, for detecting faults in electric light leads. He says : "In my opinion your telephone receivers are by far the best I have yet tried for localising faults on underground mains, such as those in Liverpool. My experience extends over some seven years, and I have never been so certain of localisation with any other make." The combined Collier receiver and Brown transmitter telephone set is supplied by the Company specially made for warehouse, factory, and office requirements. The usual bell is dispensed with, and its place taken by the spoken word—a very useful and compact arrangement, requiring only very simple connections and minimising the cost of wiring.

Cable-Making and Wire-Covering Machinery.—Messrs. Johnson and Phillips have wisely entered at Stationers' Hall a very complete catalogue of machinery for sheathing, armouring and serving submarine cables, and also machinery for wire-winding, stranding, and closing work for electric light cables. The catalogue is very fully illustrated, and is undoubtedly the completest of the kind yet published by manufacturers of this class of machinery. The illustrations are taken from photographs of the actual machines which are the outcome of long experience in this special department. The firm are not only manufacturers but users of these machines, and the experience gained, therefore, is first hand. Accompanying the particulars are what may be termed guarantees of the output of the machines. The particulars given are very full and complete, and comprise the sizes, capacity and dimensions over all in English and in metrical measurements. The makers especially call attention to the machine illustrated on page 2, which is for sheathing "shore-ends," and is probably the largest of its kind in existence. It will armour the heaviest types of submarine cables, and at the same operation will sheath with tapes and "compound," or can be made to sheath with steel tapes or hemp yarns. This particular machine has been in work in the factory of one of the chief Continental manufacturing firms for several years, and has given every satisfaction. Messrs. Johnson and Phillips refer with some pride to the capacity of their works at Old Charlton for turning out machines in cases of emergency, a case in point being the execution of an order for 25 machines, illustrated on page 16 of the catalogue, in the short time of seven weeks. The capacity of these machines was 750 miles of covered wires per day. Many of the machines illustrated in the catalogue are of novel design, and no previous particulars have appeared regarding them. A further catalogue is in course of preparation, and will comprise machines for core taping, core vulcanising, cotton covering, indiarubber covering, silk coverings. The firm offer copies of the catalogues, compounding, &c. to any responsible applicant. It should be added that a comprehensive index, and the notes concerning the use of the machinery, make the catalogue unusually compact and complete.

College Calendars.—We have received from Messrs. Whittaker and Co. a copy of the "Programme of the Technological Examinations of the City and Guilds of London Institute" for the Session 1895-6." The price of the programme is 10d. net. Very full particulars will be found, in some places illustrated, of the subjects to be taken during the ensuing session. From the Durham College of Science we have received a calendar for the session 1895-6, together with prospectuses of the day and evening classes. Connected with this College there is also special Saturday classes for the benefit of artisans. The Secretary of University College, Bristol, forwards a copy of the calendar for the coming session, in which all particulars relating to the classes will be found. Copies of this Calendar can be obtained of Messrs. Whittaker & Co.

Barnet.—A belated attempt by Mr. Bampfield to infuse interest into the electric lighting question in this town, has signally failed—for the want of a seconder. The question arose on the discussion of correspondence between the District Council and Messrs. Vaughan and Brown.

Birmingham.—Col. W. L. Coke, M.I.C.E., held a Local Government Board inquiry on Tuesday into an application by the City Council to borrow £27,420 for technical education purposes. It was stated that the Council had already expended over £61,000 in purchasing a site for the technical school, erecting buildings, &c. The school was now nearing completion, and £14,000 of the loan was required for fitting up 116 rooms, laboratories, &c. The contract for supplying the fittings had been placed with Thomas Parker (Limited) for £13,227, and this work was in progress, because the Committee considered it desirable that the new session should be commenced next month. There was also a sum of £6,080 wanted for lighting the school by electricity, and for providing electric motive power in the laboratories. There was no opposition to the application.——The electric light is making steady progress in this city. The Birmingham Electrical Supply Company are laying mains in Broad-street and Hagley-road. Several residences in the Edgbaston district are being wired and fitted, and it is stated that current will be available by the end of next month. It is also stated that in order to cope with the growing demand for current in Newhall-street, the centre of the jewellery trade, the Company are building another supply station in that street.

Blackpool.—The Electric Lighting Committee of the Town Council, at their meeting on Saturday last, decided to recommend the Council to spend £30,000 in extending the Corporation electricity works before next season. Two new boilers and two 300-kilowatt machines will be erected. This addition to the plant will involve large extensions of the buildings. The question of transferring the tramway generating plant to the new buildings has been deferred. If the recommendation of the Committee be adopted the total expenditure on the electricity works will amount

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to nearly £90,000, but the Committee think the demand for current amply justifies the new expenditure. This demand continues to grow by leaps and bounds, and there is already considerable difficulty in complying with customers' requirements.

Bristol.—At the last meeting of the Electrical Committee it was decided to recommend the extension of the electric light mains from the corner of Regent-street to Victoria-square; from the end of West-street, St. Philip's, along Trinity-road to supply the new free library and St. Philip's police station; a short distance in Redcliff-street; from Redland Park-road to a part of Hampton-road, and a short distance in St. Paul's-road. The consideration of a proposal to include Cotham in the present extension scheme was postponed, as the Committee have already practically expended the money at their disposal. The demand for current continues to increase in a most satisfactory manner. The Guildhall and the Prince's Theatre are being wired and fitted for the electric light.

Bromley (Kent).—The District Council some time ago received an offer to purchase their Provisional Electric Lighting Order, and at the last meeting the Chairman (Mr. W. H. Bosanquet), in reply to a question as to what progress had been made, said that the Committee dealing with the question were making inquiries as to the ability of those who proposed to purchase the Order to carry out its provisions, and when this point had been satisfactorily settled the Committee would present a report to the Council.

Cambridge.—The present contract with the local gas company for lighting the streets expires in June, 1896, and, on the recommendation of the Paving, Drainage and Lighting Committee, the Town Council have decided to give the Cambridge Electric Supply Company an opportunity of tendering for the lighting of the town.

Cheltenham.—The Public Library is now lighted by electricity, the current having been switched on for the first time on Monday last. The work of wiring and fitting up the library has been carried out by Messrs. R. E. and C. Marshall to the specification of the borough electrical engineer, Mr. Hamilton Kilgour; 141 incandescents, with a total of 2,712 c.p. are used.

Church Lighting.—Lindley Parish Church, Huddersfield, and Zion Chapel, Lindley, are to be lighted electrically.—It has been decided to light the Congregational Church, Buckley (North Wales), electrically.

Club Lighting.—The West and Pellon Wards Liberal Club, Halifax, is now lighted electrically. The work of installation has been carried out by Messrs. Nunn and Sykes, of Halifax.

Dundalk.—The Electric Lighting Committee have just presented a report on the question of the introduction of the electric light into the town. The report recommends that in order to comply with the Provisional Order (which expires in July, 1896) the Council should invite electric lighting contractors to tender for the lighting of the town under licence, failing which steps should be taken in November next to give more extensive powers than a licence to the proposed contractors. The report was unanimously adopted.

Durban.—The Town Council have unanimously decided to adopt the recommendations contained in the report of Mr. W. H. Preece and Mr. James Fletcher (borough engineer) on the question of the electric lighting of Durban. The cost of the initial installation is not to exceed £25,000, and it was also decided to prepare specifications and invite tenders from the principal British manufacturing firms for the supply and erection of the necessary plant. An abstract of the report appeared in our issue of May 31st last.

Electric Traction in Egypt.—In reference to our Note on this subject in our last issue, we now learn that the Société Anonyme des Tramways du Caire, the company which was recently formed to take over the concession for the erection of electric tramways in Cairo, has given the contract for the construction and equipment of the line to the Union Elektricitäts Gesellschaft of Berlin.

Electric Railways.—Mr. Charles Rettie, of Liverpool, communicates to the *Journal of Commerce* of the 27th inst. on the subject of electric railways in general, and in connection with the application of electricity to the Mersey Company's line in particular. In taking a survey of the applications of the electric system to railways, Mr. Rettie observes that there is a splendid opening on the Lancashire and Yorkshire Company's 18-mile run to Southport for the application of the electric system.

Exeter.—A special meeting of the City Council was held on Wednesday to consider the advisability of negotiating with the Exeter Electric Light Company (Limited) for the acquisition of the Company's undertaking. A letter received by the Town Clerk from the solicitors to the Company stated that the County of London and Brush Provincial Company had offered £7,000 for their undertaking, and a syndicate of local gentlemen offered to give over £8,000. The critical condition of the Company rendered it necessary that an immediate decision should be come to, and if the Council were willing to purchase for £10,000, the Directors would recommend the proprietors to accept that amount. A memorial from the principal tradesmen in High-street, Fore-street, and Queen-street had also been received in favour of the acquisition of the works by the Council, and the Deputy-Mayor (Mr. E. J. Domville) said that he called the meeting in response to an urgent requisition. After referring to the position of the Company, he moved that the whole matter be referred to a special committee, but this motion was withdrawn in favour of a resolution by Mr. W. Wreford declaring it to be expedient that the control and supply of the electric light should be in the hands of the Council. A long discussion on this proposition took place. Mr. Penny thought if the Council let the present opportunity of purchasing the Electric Light Company's works pass by they would be making a mistake. The motion was unanimously adopted, and a further resolution by Mr. Wreford, authorising the Council to enter into negotiations with the Company for the acquisition of their undertaking, was also adopted. The further consideration of the matter was then referred to a committee of the whole Council, with power to appoint a special committee to decide points of detail.

Faraday.—An excellent portrait of Michael Faraday is published with the *Electrical Journal* of Chicago, U.S.A., for August 15th.

German Foresight.—At the instigation of the German Envoy at Tokyo and of the Prussian Minister of Commerce, a committee of German manufacturers have resolved to publish a periodical in the Japanese language, with the object of bringing prominently before Japanese buyers the goods of German firms. It has also been decided to publish a similar periodical in Chinese, and it is probable that the necessary translations will be made by the teachers of Japanese and Chinese in the Oriental Seminary at Berlin.

Hampstead.—The Electric Lighting Committee of the Vestry have recently presented a report, in which they review the past history of the station in Lithos-road, the foundation stone of which was laid in May, 1894. Reference is made to hitches which have from time to time occurred, but which have been overcome. Until now the lighting is a complete success. This is especially the case with private lighting, which in March last reached the equivalent of 6,500 8 c.p. incandescents. Since March the number of customers has risen to 116, with an equivalent of 11,879 8 c.p. lamps connected. Considerable additions are being carried out, and applications for current justify the Committee in seriously considering still further extensions. Rebates to large consumers from 3 to 20 per cent. have been agreed upon, to be made on the Christmas quarter accounts. A report is to be issued at Christmas on the general working of the station from the opening up till that time, to be published with the usual accounts of the Vestry's electric lighting undertaking.

Hull.—At the last meeting of the Electric Lighting Committee of the Town Council the Sub-committee recently appointed to consider the question of the appointment of a Borough Electrical Engineer in place of Mr. A. H. Gibbings, who has been appointed to Bradford, reported that they had interviewed Mr. Gibbings and Mr. Bastow (assistant engineer) in reference to filling up the vacancy. Mr. Gibbings' view was that Mr. Bastow had not had sufficient experience to justify his appointment to take charge of the station. A discussion on this report followed, and Mr. Holder (the Chairman of the Committee) moved "That the appointment of an electrical engineer be left open for four months beyond the termination of Mr. Gibbings' appointment, and that Mr. Bastow be asked to take charge of the station for that period." This resolution, however, was not seconded, and it was decided to adopt the Sub-Committee's recommendation to advertise for an engineer, whose salary has been fixed £250 per annum. Applications have to be sent in by the 19th September to Mr. R. Hill Dawe, Town Clerk. It has also been decided to allow Mr. Gibbings to go to Bradford two days a week, as the Hull station work would permit, subject to the Bradford Corporation paying the Committee his rate of remuneration up to the termination of his agreement with Hull or to Mr. Gibbings foregoing such payment—a truly involved arrangement, and hardly worthy of the high contracting parties.

Kingswood (Bristol).—The Town and Village Electric Light and Power Company, who have taken over the electric lighting of this district, have made proposals to the District Council as to public and private lighting, and at the last meeting of the Council a committee was appointed to consider and report on the matter.

London General Omnibus Company.—At the meeting of shareholders yesterday, the Chairman, Mr. Alderman Pound, who is not unknown in the City of London in connection with electric lighting enterprise, stated that the Directors were closely watching the development of electric and oil motors as compared with horse power.

Metropolitan Telephone Exchanges.—The new Gerard-street (Regent) Exchange of the National Telephone Company is, we understand, to be opened on October 14th. The new exchange is made up of the old Regent-street exchange and a portion of the Chancery-lane subscribers; the remaining portion of the subscribers of the latter exchange being transferred to Holborn. We are

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ourselves in the unsatisfactory predicament of having our telephone number changed, and can vouch for the inconvenience and expense which such a change involves. The National Company are face to face with a choice of evils, and have decided that the alteration of a great many subscribers' numbers is inevitable. It is to be hoped that arrangements are being made to obviate the necessity for any similar re-numbering in the future.

NEWPORT (MON.).—The Free Library Committee have referred the question of lighting the library by electricity to a Sub-Committee for consideration and report.

PORTSMOUTH.—The Town Council have decided to reduce the charge for electric current from 6d. to 5d. per unit, the reduction to take effect from September 29th. The Electric Lighting Committee are busily engaged in making extensions to the mains, and are introducing a new system of earthenware ducts, by means of which it is claimed the making of house connections can be effected at a cost of 1s. 6d., against 5s. previously.

THEATRE LIGHTING.—The new Empire Palace Theatre, Sheffield, is to be lighted throughout by electricity. The work of wiring and fitting has been entrusted to the Sheffield Electric Light and Power Company (Limited).

THE BERNE OFFICIAL VOCABULARY.—It is stated that the French Government has, on the representations of the London and Manchester Chambers of Commerce, suspended the order for the compulsory use from next New Year's Day of the Berne vocabulary for commercial telegrams. Previous protests from the Paris and Havre Chambers of Commerce had produced no results. It is also stated that the movement against the obligatory use of the vocabulary is rapidly spreading in other Continental countries.

THE LONDON TECHNICAL EDUCATION BOARD.—The issue of the *London Technical Education Gazette* for August contains particulars of the awards granted by the Board for the session 1894-95 to many of the schools of science, art or technology aided by the Board, and also the maintenance grants to the Polytechnics and to University College and Bedford College. The list of candidates who were recommended for evening exhibitions in science and technology contains a gratifying proportion of engineers' apprentices, draughtsmen, metal workers, and instrument makers. A list is given of 19 matriculation students of the Central Technical College of the City and Guilds of London Institute who have received the Board's diploma for applied physics and electrical engineering. The *Gazette* is a useful publication, and should become widely known.

WREXHAM.—The Board of Trade have decided to defer the consideration of the revocation of the Wrexham and District Electric Supply Company's Provisional Order for a further period of six months.

WORKS LIGHTING.—The extensive glass works of Messrs. Kilner Bros., at Conisborough, Yorks., are to be lighted throughout by electricity.

YORK.—The electric lighting question in this city has now taken a new turn. On the 12th inst. the Council referred back the whole question to the Streets and Building Committee, with instructions to select an expert to advise them as to the best system of electric lighting for the city, and the Committee have now resolved to invite Mr. Preece to become their adviser, and they have requested him to inform them what inclusive fee he would require to advise on the matter, and to support the application for the necessary borrowing powers, &c., to carry out the electric lighting scheme. It is to be hoped that Mr. Preece, if he accepts the position, will be successful in rescuing the electric lighting question from the involved condition in which it has been allowed to lapse by the combined action or inaction of the several committees who have in the past had the matter in hand.

OUTING.—The employés of the Edison and Swan Company's Ponder's End Works held their annual excursion at Brighton on Saturday last. The city offices and warehouses of the Company were closed for the occasion, and consequently many members of the City staff were enabled to join the party, which numbered upwards of 600. The excursionists were favoured with fine weather, and an enjoyable day was spent.

BOOKS RECEIVED.

Proceedings of the Royal Society. Vol. LVIII., No. 349. Price 4s.

"Polyphase Electric Currents." By Prof. Silvanus P. Thompson. (London: E. and F. N. Spon.) Price 12s. 6d.

Proceedings of the Royal Society of Victoria. Vol. VII. New Series. (Melbourne: Ford and Son.)

Transactions of the North-East Coast Institution of Engineers and Shipbuilders. Parts 9 and 10. Vol. XI. London: Andrew Reid and Co.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

August 19, 1895.

15,529. A. J. WHEATLEY. Harborne, near Birmingham. Improvements in electrical time switches.

15,547. J. A. KINGDON. London. An improved method of operating electric locomotives, tramcars, and the like, and apparatus therefor.

15,563. L. EPSTEIN. London. Improvements in the formation of the electrodes for use in primary and secondary batteries.

August 20, 1895.

15,664. SIEMENS BROS. AND CO. (LIMITED). London. Improvements in electrical apparatus for railway signals actuated by passing trains. (Messrs. Siemens and Halske, Germany.)

15,686. W. P. THOMPSON. Liverpool. Improvements in electric railways. (James Francis McLaughlin, United States.)*

15,695. E. J. CLUBBE and A. W. SOUTHEY. London. Improvements in electrically-propelled carriages.

15,703. G. G. M. HARDINGHAM. London. Improvements in electric cables. (The firm of Felten and Guilleaume, Germany.)

August 21, 1895.

15,722. W. THOMSON and W. ROUTLEDGE. Newcastle-on-Tyne. Improvements in the formation of thin plates intended to be subsequently assembled, as in certain electrical and like constructions.

15,736. W. PATTERSON. London. Improvements in insulating wire for electrical purposes.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

8,607. THOMPSON (KEITH). Electrical exchanges.

15,004. RITTER. Telephonic installations.

17,130. STOTZ and SCHINDLER-JENNY. Electrically heating liquids.

17,335. GRAHAM and CHAPMAN. Governing dynamos, &c.

1895.

7,458. KELLNER. Electrolysis of metallic salts.

10,445. STÖRMER. Electrolysis of alkali salts.

12,161. MOULART. Electric conductors.

12,468. MÜLLER. Electric railways.

NEW COMPANIES, STATUTORY RETURNS, &c.

In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1895, pages *304-332, &c. &c.*]

FIELDING AND PLATT (LIMITED).—This Company was registered on August 24th, with a capital of £50,000, in £10 shares, to purchase and take over the business carried on under the style of "Fielding and Platt," of the Atlas Iron Works, Gloucester, to enter into an agreement with Messrs. James Platt and James and John Fielding, engineers, of Gloucester, and to carry on the business of general engineers, gas and oil engine makers, metal workers, boiler makers, &c.

F. MADELEY AND CO. (LIMITED).—This Company has been registered, with a capital of £5,000, in £5 shares, to purchase the business of a tube manufacturer, carried on by F. Madeley, at Watery-lane, Birmingham, and to carry on the business of manufacturers of brass, copper and other tubes, metal workers, ironfounders and machinists.

PORTABLE ELECTRIC LAMP COMPANY (LIMITED).—This Company was registered on August 26th, with a capital of £50,000, in £1 shares, to acquire from William and Andrew P. Morrison the benefit of an invention entitled "improvements in portable primary batteries," and the letters patent granted in respect thereof (No. 9,826 of 1894), also the benefit of an invention of a composition suitable for the manufacture of the cases of the said batteries, and of a chemical compound known as "electric sand," suitable for the generation of electricity, for use with the said batteries, and to manufacture, provide, sell, deal in and let on hire steam, gas and other engines, dynamo machinery, cables, wires, batteries, electric motors, miners' electric safety lamps, meters, instruments, fittings, and other electrical apparatus and appliances. The subscribers, with one share each, are: E. S. Walmisley, F. H. Sanders, E. F. Grainge, R. G. Taylor, A. M. Forbes, L. White, and J. Seagrave.

ROAD VEHICLE STARTER SYNDICATE (LIMITED).—This Company has been registered with a capital of £18,000, in £1 shares, to carry on business as merchants, patentees, manufacturers, agents, contractors, &c.

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AFRICAN DIRECT TELEGRAPH COMPANY (LIMITED).—The annual return to August 7th has been filed. Out of a capital of £300,000, in £10 shares, 23,600 shares have been subscribed for and the full amount paid thereon.

ALTERNATE-CURRENT ELECTRO-MOTOR SYNDICATE (LIMITED).—The annual return to August 17th has been filed. The nominal capital is £6,000, in £1 shares; 5,037 shares have been taken up, and 2,000 have been issued as fully paid to Mr. W. Langdon-Davies electrical engineer. A call of 6s. per share on the remaining 3,037 shares has been made.

NEW ELECTRICITY SUPPLY COMPANY OF CROYDON (LIMITED).—The annual return for 1894 hast just been filed. The nominal capital is £40,000, in 100 Founders' and 7,900 Ordinary shares of £5 each; 29 of the former have been allotted.

PEARSON'S AUTOMATIC FIRE INDICATOR COMPANY (LIMITED).—The statutory return to July 12th has been filed. The nominal capital is £5,000, in £1 shares, of which 1,715 have been taken up; 1,000 fully-paid shares have been issued to Mr. Edward Mann, electrical engineer; 10s. per share has been called on 708 shares, but no calls have been made on the seven subscribers' shares.

RAND CENTRAL ELECTRIC WORKS (LIMITED).—The statutory return to August 13th has been filed. The nominal capital is £300,000, in £1 shares, of which 275,000 have been allotted, and a call of 5s. per share made.

READING ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return to July 1st has been filed. The nominal capital is £75,000, in £5 shares, and 2,819 of these have been allotted; 2,000 shares are held by Mr. J. C. Fiddler, merchant, Reading.

UNITED RIVER PLATE TELEPHONE COMPANY (LIMITED).—The annual return to July 23rd has been filed. Of a nominal capital of £500,000, in £5 shares, 58,000 shares have been taken up. 16,000 have been issued as fully paid, and the full amount has been called on the remaining 42,000 shares.

WESTERN COUNTIES ELECTRIC LIGHT AND POWER SYNDICATE (LIMITED).—The annual return to August 9th has been filed. The nominal capital of £25,000 is divided into 380 Ordinary and 120 Deferred shares, of £50 each. 85 of the former and all of the latter have been taken up. The Deferred shares have been issued as fully paid, and the full amount has been called on the Ordinary shares.

CITY NOTES.

MEMORANDA.—Bank rate, 2 per cent. (Feb. 22, 1894). Price of silver, 30½d. per oz. (Aug. 29th). Consols (2¾ per cent.) 107¾—107⅞ for money, 107⅞—107⅞ for September account (Aug. 29th); 2½ per cent. 106¼—106½. Stock Exchange Settling Days: Consols, Aug. 30th—Sept. 2nd; Stocks and Shares Continuation Day, Sept. 9th; Ticket Day, Sept. 10th; Pay Day, Sept. 11th; Mining Shares Carry-over Day, Sept. 7th; Railway and Foreign Stocks, &c., Sept. 10th—12th.

BRISTOL GAS COMPANY.—At the half-yearly meeting of this Company on Friday, the Chairman (Mr. J. W. S. Dix), in moving the adoption of the report and accounts, announced a further reduction of 2d. per 1,000 cubic feet in the price of gas. He said that the increase in their output (7½ per cent.), showed they were not much affected by their electrical friends, and the shareholders need not have any fear as to their not being able to maintain their present prosperous position. To properly appreciate the reduction and this heroic expression of opinion, our readers must remember that the Bristol Corporation are the owners of a thriving electricity supply station, and it will also be seen from another column that the Electrical Committee of the Corporation have decided to recommend considerable further extensions of the electric light mains.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended August 25th amounted to £875, and to £878 for the corresponding period of last year, a decrease of £3. The total receipts for the half-year were £6,883, and £6,941 for the corresponding period of last year, a decrease of £58.

CORK GAS CONSUMER'S COMPANY (LIMITED).—At the half-yearly meeting of the shareholders of this Company last week the Chairman (Mr. George Lynch) said that they had a considerable demand for gas from firms in the city who had private installations of the electric light, and he therefore thought that, instead of being a serious competitor, the electric light would prove of considerable service to them. This view was also echoed by Mr. S. H. Newsom. Answering a question as to the rumour of the formation of an electric light company, the Chairman said that the statutory notice of intention to apply for a Provisional Order had been given to the City Council. Mr. Denny Lane stated that similar notices had been served on three previous occasions, and added that he believed the Corporation were making inquiries from other Irish towns where the electric light has already been adopted as to the cost, &c., of an installation.

ELECTRIC CONSTRUCTION COMPANY (LIMITED).—The share transfer books of this Company will be closed to September 12th.

ELECTRIC TRACTION IN AMERICA.—It is stated that the Siemens and Halske Electric Company of America intend to form a combination with the Yerkes interest to fight the recently-formed Westinghouse-Baldwin combination. The Yerkes interests comprise the Widener-Elkins Syndicate, controlling many of the street car lines in New York, Philadelphia, Pittsburgh and Chicago. Mr. Yerkes, jun., was recently elected vice-president of the Siemens and Halske Company. Our readers will remember that in our issue of July 26th we gave particulars of the purchase of the plant of the Grant Locomotive Works in Cicero, Ill., by the Siemens and Halske Company, and at the same time the Siemens Company increased its capital from $1,000,000 to $2,000,000.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 25th inst. amounted to £1,318, and to £1,094 in the corresponding week last year, an increase of £224.

LONDON, DEPTFORD AND GREENWICH TRAMWAYS COMPANY (LIMITED).—At the half-yearly meeting of this Company on Tuesday the Chairman (Mr. W. J. Carruthers-Wain) very strongly condemned the action of the London County Council in connection with their treatment of the shareholders' interest. There was, he said, scarcely a project which the Council had formulated which would not in some way have damaged the interests of tramway companies, and he hoped that the Bill promoted by the Council to enable them to work all tramways (whether they leased the lines or not) would be strangled in the House of Lords.

NORTH STAFFORDSHIRE TRAMWAYS COMPANY (LIMITED).—The ordinary general meeting of this Company was held on Tuesday at the Guildhall Tavern, Gresham-street, London, E.C., Mr. W. J. Carruthers-Wain presiding. The Chairman said that not only would all obstacles to the working of the Longton lines be shortly removed, but the Longton Town Council are likely to make considerable extensions to the lines at their own expense. Their licence for working the tramways by steam expired in May, and it was suggested to them that they should take into consideration the question of the adoption of some improved motor. Having regard to the severe gradients in North Staffordshire, there could be no doubt that there were only two systems of traction that could possibly be adopted, and these were cable or electricity by means of overhead wires. The traffic was not great enough for the former system, and, in addition, the curves are tremendous. Consequently, the Directors have been compelled to consider the overhead system of electric traction, and therefore suggested to the Town Council that, if they desired them to adopt electricity, they should grant them an extension of their lease in order that they might be able to recoup themselves for the additional cost of introducing a new system of traction. The Town Council had replied that if the Company introduce electric traction they are prepared to considerably extend the present lease. The Chairman announced that a proper scheme for the working of the line by electricity had been prepared, and when all the necessary preliminary arrangements had been made by the local authority he would lay the details of the proposal before the shareholders.

PHOSPHOR BRONZE COMPANY (LIMITED AND REDUCED).—Notice is given that the Order of the Chancery Division of the High Court of Justice, dated July 20, 1895, confirming the reduction of the capital of this Company from £150,000 to £90,000 (in 15,000 Preference and 15,000 Ordinary shares of £3 each), and the Minute showing the several particulars respecting the altered capital were registered by the Registrar of Joint Stock Companies on August 17th inst. Only 8,375 Preference and 7,335 Ordinary shares have been issued, and on each £3 per share has been paid.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.—The annual meeting of this Company was held on Monday last at the Cannon-street Hotel, Mr. W. S. L. Schuster presiding. The Chairman said the present Directors were only responsible for the management of the Company's business for six weeks out of the period under review, and had repudiated the contract made with the Electric Construction Company by the late Directors, on the ground that it was not an equitable one, and that no Court would uphold it. This contract provided for a payment of 9d. per mile to the Electric Construction Company. The working expenses of the tramway amounted to about 2½d., which gave a total of 11½d. The receipts were, roughly, 10d., and therefore there would be an actual loss of 1½d. per mile, or £1,500 a year under that contract. Law proceedings with the Electric Construction Company in reference to the matter were still pending. He considered the contract meant absolute ruin to the South Staffordshire Company, and they were advised that its terms could not be enforced. The present Directors had resisted all attempts to break up their undertaking, and the Court had so far supported their action. As to the question of reorganisation, the Chairman said they had abolished the offices of traffic superintendent and draughtsman, while they had appointed Mr. Robins to the position of manager in place of Mr. A. Dickinson. In order to improve the service on the electrical section of the tramway the Company have decided to run trains every 15 minutes from Wednesbury to Bloxwich, and every half hour from Darlaston to Mellish-road, Walsall. After a long discussion the report and accounts were adopted.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation for 17,139 "A" shares (Nos. 01 to 05,800 and 05,802 to 017,140) of the Edison and Swan United Electric Light Company (Limited).

WEST AFRICAN TELEGRAPH COMPANY (LIMITED).—The half-yearly interest, due September 1st, on the Five per Cent. Mortgage Debentures of this Company, will be paid on and after Monday next by the National Bank of Scotland, 37, Nicholas-lane, London, E.C.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the week ended August 23rd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), amounted to £2,945.

WESTERN UNION TELEGRAPH COMPANY.—A Company with this title, and having a capital stock of $100,000, has recently been incorporated at Chicago. The promoters say it will be able to provide exchange connections for subscribers at $30 per annum.

.. CAMPBELL shows, by prope...

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, August 21.	Price Wednesday, August 28.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending August 28. Highest	Lowest
			TELEGRAPHS.			£ s. d.		Highest	Lowest
£1,012,880	Stock	11 0	Anglo-American	47 49	47 49	4 13 9	Jan., Apr., July, Oct	..	..
£2,993,560	Stock	2 2 0	Do. Preferred	88 89	89 90	5 8 0	" "	89½	88
£2,993,560	Stock	5/0	Do. Deferred	8½ 9	8½ 9	..	..	..	..
£184,500	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102 105	102 105	3 16 7	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	13¾ 14¼	13¾ 14¼	4 11 3	Mar., June, Oct., Dec	14¼	14
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111 115	111 115	4 7 6	June and December	..	..
10,000,000	$100	1¾%	Commercial Cable Capital Stock	160 165	160 165	4 4 10	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13 14	13 14	5 14 4	February and August	13½	..
6,000	10	10%	Do. Preference 10 per Cent.	20 21	20 21	3 16 2	" "	..	..
17,931	5	2/0	Direct Spanish (fully paid)	4 5	4 5	4 0 0	April and October	..	—
6,000	5	10%	Do. Preference 10 per Cent.	9¾ 10¼	9¾ 10¼	4 7 7	" "	..	—
£80,000	Stock	4½%	Do. 4½% Debentures of £50 each	103% 106%	103% 105%	4 4 11	" "	..	—
60,710	20	2/0	Direct United States Cable, 1877	9 9½	9 9½	4 4 3	Jan., Apr., July, Oct.	9 1/16	9
400,000	10	5/6	Eastern	17 17¼	17 17¼	3 15 4	" "	17¼	17¼
70,000	10	6%	Do. 6 per Cent. Preference	17¾ 18¼	17¾ 18¼	3 5 9	" "	18¼	17¾
£ 997,8[illegible]	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	127 130	127 130	3 1 7	May and November	128½	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105 108	105 108	4 13 0	February & August	..	..
250,000	10	2/6	Eastern Extension	17½ 17¾	17½ 17¾	3 18 4	Jan., Apr., July, Oct.	17¾	17½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125 129	125 129	3 2 0	February & August	..	..
£62,700	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103 106	102 106	4 15 0	January and July	..	..
£95,100	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103 106	102 106	4 15 0	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.) xd	105 108	106 108	3 1[illegible] 3	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	112% 115%	113% 116%	3 9 9	May and November	..	..
130,227	10	3 3	Globe Telegraph and Trust	10¼ 10⅝	10¼ 10⅝	3 19 6	Jan., Apr., July, Oct.	10⅝	10½
180,042	10	6%	Do. 6 per Cent. Preference	16¾ 17¼	16¾ 17¼	3 10 1	" "	17	16 15/16
150,000	10	5 0	Great Northern	21¾ 22¼	21¾ 22¼	3 16 8	Jan., April, and July	..	..
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105 108	105 108	4 12 10	March & September	..	..
17,000	25	37/6	Indo-European	50 53	50 53	4 14 4	May and November	..	..
37,548	10	2/6	London Platino-Brazilian	5 7	5 7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	107 111	107 111	5 11 1	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	107 110	107 110	3 13 1	..	—	..
11,839	8	4/0	Reuter's	3½ 4½	3½ 4½	..	April and October	..	..
8,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	127 132	127 132	4 12 2	" "	..	..
15,608	10	2/0	West African Telegraph	5½ 6½	5½ 6½	..	January and July	..	—
£149,900	100	5%	* Do. 5 per Cent. Debentures (red.)	105 108	105 108	4 11 9	March & September	..	—
30,000	10	2/0	West Coast of America	1½ 2½	1½ 2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99 104	99 104	7 13 10	June and December	..	..
88,321	10	6d.	West India and Panama	¾ 1	¾ 1	..	..	⅞	⅞
34,563	10	6%	Do. 6 per Cent. 1st Preference	10 10½	10 10½	5 14 3	May and November	10 7/16	..
4,661	10	6%	Do. 6 per Cent. 2nd Preference	8½ 9½	8½ 9½	6 3 4	" "	8¾	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110 113	110 113	4 9 1	June and December	..	..
64,242	15	6/0	Western and Brazilian	10¼ 10¾	10¼ 10¾	3 4 4	May and November	10¾	10 5/16
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½ 7	6½ 7	..	—	6½	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4¼ 4¾	4¼ 4¾	..	—	..	..
£171,900	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101 105	101 105	5 14 10	February & August	—	—
£214,800	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101 105	101 105	5 14 10	" "	..	—
$1,211,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113 118	113 118	6 0 11	May and November	..	—
£166,900	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	102 104	102 104	5 18 10	March & September	..	—
			TELEPHONES.						
44,000	5	2/6	Chili Telephone (fully paid)	3 3½	3 3½	..	..	—	—
£24,850	10/0	1½d.	Consolidated Telephone Const. & Maintenance	1/16 1/8	1/16 1/8	—	May and November	..	—
171,504	£1	3·2 5d.	Oriental Telephone and Electric (fully paid)	1/16 1/8	1/16 1/8	..	Yearly	..	..
184,597	5	2/6	National	5¾ 6¼	6 6¼	4 0 0	June and December	6 3/16	5 15/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	16 18	16 18	3 6 8	" "	15½	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15 16	15 16	3 15 0	" "	15¾	15¾
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	6 6½	6 6½	4 0 0	—	6 1/16	6 1/16
1,000,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	106 108	106 108	3 5 1	January and July	107¼	106¼
58,000	5	3 0	United River Plate	2½ 3	2½ 3	..	" "	..	..
£ 46,735	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	92 97	92 97	5 3 1	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.						
40,000	£10	5/0	City of London Electric Lighting (fully paid)	14½ 15½	14½ 15½	1 12 3	—	15½	15
10,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15½ 16½	15½ 16½	3 12 9	—	16	15¾
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	131 134	131 134	3 12 9	June and December	132	..
19,900	£5	..	Electricity Supply Co. for Spain	..	..	..	—	..	..
£30,000	£5	2 0	Charing Cross and Strand Electricity Supply Corp.	5¼ 5¾	5¼ 5¾	..	—	5 9/16	—
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..	..	..	—	..	—
8,322	£5	..	House-to-House Electric	—	—	..	—	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	—	—	..	—	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..	..	..	January and July	..	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7¾ 8¼	7¾ 8¼	..	—	..	..
111,000	5	..	London Electric Supply	..	..	..	—	..	..
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	11 11½	11½ 12½	2 8 0	..	11¾	11 1/4
£ 50,000	Stock	4½%	* Do. 4½% Debs.	117 119	117 119	3 16 1	June and December	..	..
6,452	£10	2 0	Notting Hill Electric	8½ 9	8½ 9	..	—	8 13/16	—
19,950	£5	2 0	St. James and Pall Mall	8¼ 8¾	8¼ 8¾	..	—	8½	—
20,000	£5	7%	Do. 7 per Cent. Preference	9 10	9 10	3 10 10	—	..	..
59,900	5	2 6	Westminster Electric Supply (fully paid)	8½ 8¾	8½ 9	3 1 1	—	8¾	8½
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	3	1/6	Brush Electrical Engineering	2 2½	2 2½	6 11 7	—	2½	2 1/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2 2½	2 2½	5 6 8	—	..	..
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures	112 115	113 116	3 19 1	March & September	..	..
20 000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1 2	1 2	..	January and July	..	—
12,139	5	1/6	Edison and Swan United	2 2½	2 2½	..	..	..	..
£1[illegible],000	Stock	4½%	Do. 4½% Mortgage Debenture Stock	104 107	104 107	4 4 1	..	104	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..	—	..	..	..	..
120,000	2	..	Electric Construction	¾ 1	⅝ ⅞	..	..	..	..
12,845	2	2 9¾	Do. 7 per Cent. Cumulative Pref.	2 2½	2 2½	..	..	—	..
91,195	2	10/0	Elmore's Patent Copper Depositing	¾ 1	¾ 1	..	..	—	—
20,000	5	..	Fowler-Waring Cables (fully paid)	¼ ¾	¼ ¾	..	..	—	—
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	19 21	19 21	4 15 3	February & August	19¾	..
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102 104	102 104	4 8 3	March & September	..	..
15,895	£10	..	International Okonite Ordinary	..	..	..	—	..	..
16,000	£10	..	Do. 8 per Cent. Preference	..	—	..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	⅛ ⅜	⅛ ⅜	..	..	..	..
37,370	12	12/0	Telegraph Construction and Maintenance	43 45	43 45	4 0 0	March and July	44¾	43¾
£150,000	100	5%	Do. 5 per Cent. Bonds	104 107	104 107	4 13 6	January and July	..	—
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..	..	..	..	..	—
41,098	£5	..	Do. Preference (fully paid)	..	..	..	..	..	—
£ [illegible]	10	6/0	W. T. Henley's Telegraph Works Ordinary	11 11½	11 11½	..	..	11½	—
£30,000	10	..	Do. 7 per Cent. Preference	15 15½	15 15½	4 10 4	..	..	..
£[illegible]	Stock	..	Do. 4½% Mortgage Debenture Stock	103 109	106 109	4 2 7	..	..	..
			RAILWAYS AND TRAMWAYS.						
£630,000	Stock	1½%	City and South London Railway	41 43	38 40	3 2 6	May and November	39 7/16	39
7,000	10	5%	Do. 5% Perpetual Preference	14 15	14½ 15½	3 4 6	..	..	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	133 136	134 136	2 18 10	May and November	..	..
87,500	£10	2½%	Liverpool Overhead Railway	10⅝ 10⅞	10⅞ 11	2 0 11	—	—	—
6,296	10	5%	Do. 5% Preference	15 15½	15 15½	3 4 6	..	..	—
25,000	Stock	4%	Do. 4% Debenture	111 113	111 113	3 10 10	January and July	—	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 903. [No. 19. Vol. XXXV.] FRIDAY, SEPTEMBER 6, 1895. PRICE SIXPENCE.

NOTES.

THOUGH Ipswich is, of British Association centres, an unusually small town; and has the distinction of being the place at which the smallest meeting of the Association has ever been held, save that at the start at York; we may expect that the activity at Ipswich during the forthcoming meeting will be little if any below the average. The interests of electrical men centre in the Mechanical, Physical and Chemical Sections, and in the combined meetings of these Sections which at Oxford proved so successful.

IN Section A, which is devoted to mathematics and physics, a good initial interest will be created for theorists by the presidential address from Prof. W. M. HICKS, on the present development of the vortex atom theory and kindred hypotheses of an elastic fluid ether. On the following day this same Section will conjoin with Section B, the province of which is Chemistry, to consider the relation between the elementary state of a molecule and the complexities of its spectrum, a subject to which we made some reference last week. Another discussion, on the adoption of a new unit of heat—do we want one? we wonder—has been arranged, and will be opened by a Paper from Mr. E. H. GRIFFITHS. Sectional Papers on a diversity of topics will be brought forward by a great many well-known men, and particulars of these will be found in our news "Notes" this week.

THERE is an unusually large number of electrical Papers in Section G, the engineering coterie. After the conclusion of the presidential address, in which Prof. L. F. VERNON HARCOURT will call attention to the mutual relations of science and engineering, Major-Gen. WEBBER will open a discussion on "Light Railways in Agricultural Districts." Mr. PREECE, in conjunction with Mr. A. P. TROTTER, will describe a "New Portable Photometer." The chloride battery will be described by Mr. W. H. EARLE, and the Hermite sewage process by Mr. J. NAPIER, the borough analyst. We may mention that the Hermite process is in use at Ipswich. The subject of "Telephony" will be broached, in some of its recent aspects, by Mr. A. R. BENNETT, and the progress made in "Induction Telegraphy" will be reported by Mr. PREECE. Most of these electrical Papers in Section G will be brought forward on "electrical day," which this year falls upon Monday, the 16th.

IN our "Correspondence" columns this week will be found several additional contributions to the Magnetic Unit controversy. Dr. LODGE does not hold that the statement $\mathbf{N} = 10$ is sufficient; but, as Mr. W. B. SAYERS points out, "if only the C.G.S. system is taken for granted, nothing more is required than the number expressing the quantity of the thing in question." Dr. LODGE makes a good point when he urges that "those who hold that no simple multiples are of any use ought to speak of an event as going to occur in 15,834,000 seconds, instead of in three weeks. . . ." To this we venture to reply that no one does hold that simple multiples are in no case useful. The total flux in big dynamos measured in *lines* certainly runs into very big figures, but what of that? Dynamo designers, who alone experience the alleged awkwardness of these large totals, do not appear to feel any inconvenience. Moreover, *lines* hold the field, and "megalines," &c., do not. No doubt if every schoolboy had to handle *lines* in large quantities, the "megaline" would be needed; although even then frequent usage would, perhaps, soon accustom him to deal airily and easily in millions of lines. Dr. SUMPNER's wish that the names of units used by practical men should be allowed to evolve themselves, and his preference for names that are self-explanatory, is, we feel sure, largely shared by others. The drawback to this process, however, is that it tends to the evolution of different compound names in each country, and, in some degree, to the evolution of different units. The disadvantage would not, perhaps, be so formidable in fact as it is in imagination. Neither the French nor the German rendering of ampere-turn, secohm, or volt-line would be unrecognisable to Englishmen. The difficulty lies in securing the adoption of the same word-mixture in every country.

THERE is considerable ingenuity in the general principle of the methods by which Mr. ALBERT CAMPBELL proposes to obtain a constant potential difference, under varying temperature, at the terminals of a Clark standard cell; and the methods themselves appear to be quite practicable for commercial use, where this form of cell is employed during testing operations. If a Clark cell is circuited through a high resistance of any metal possessing a positive temperature coefficient, a rise in temperature will cause the resistance to increase while the electromotive force of the cell will diminish. As a result, the potential difference at the ends of the wire will tend to become constant. As Mr. CAMPBELL shows, by properly choosing the

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material and magnitude of the resistance, and by arranging a number of these resistances in shunt and in series with the cell, the tendencies to change of the difference of potential between two given points may be set off against one another so as to cancel out completely.

THE net result, so far, of the indefatigable researches of Profs. DEWAR and FLEMING on the electrical behaviour of bismuth at low temperatures cannot be summed up more accurately than in their own words:—"These investigations indicate that the electrical behaviour of bismuth in certain states at and below particular temperatures is irregular, and that further study is necessary to arrive at a complete explanation of the facts." As, however, the further study stated to be necessary for the evolution of this much-to-be-desired complete explanation is—so the authors tell us in their Paper, which will be found elsewhere in the present issue—now actually in progress, and as revelations with regard to the conduct and character of electrolytic bismuth are promised shortly, we, in our turn, may hope that this decidedly inconclusive conclusion may prove but a temporary one.

THE general behaviour of bismuth is indeed indifferent, and when we come to its electrical resistance and thermo-electric power it is hopelessly vicious. The curves giving the specific resistance of this eccentric substance in relation to temperature all possess at least one bend, and some possess two. Had it been possible to lay the blame of the double bend upon impurities, something approximating to order might have been evolved out of chaos, and the physicist might have concentrated his explanatory powers upon the single-bend type of curve. Alas! 'twas not to be. A specimen of pure (?) bismuth prepared from the oxide by Mr. GEORGE MATTHEY yielded a single-bend curve, but then a specimen of pure (?) bismuth reduced from the oxychloride by Mr. EDWARD MATTHEY very inconsiderately gave a two-bend curve; whether by reason of its different origin or owing to the difference in the christian name of its preparer has not up to the present been definitely settled. An interesting discovery of Profs. DEWAR and FLEMING is that the sensitiveness of the electrical resistance of bismuth to a magnetic field is enormously increased at low temperatures; but as only one specimen was examined for this purpose, who can say whether this property is common to the substance called bismuth, or is merely peculiar to this particular specimen of it?

IT seems reasonable to anticipate that the so-called anomalous behaviour of bodies like bismuth will some day reward those who are now so patiently unravelling the tangle of observed facts, by revealing to them the meaning of the more decorous deportment of ordinary bodies. Eccentricity in the physical world is quite as trying to one's patience as it is when met with in the social world, and one can only hope it will perform as useful a function in the one as in the other.

THE British public is constantly being reminded, that as there are more things in heaven and earth than in orthodox philosophy, the chance that the inventor of a new (?) primary battery has been successful in bringing one of those things to light is not one to be laughed at. If every new name signifies a new thing, two of these inventors have got the latter in the "electric sand," with which it is proposed, firstly, to raise a capital of £50,000 in small-size shares, and afterwards to set about the "generation of electricity." But, the promises of "electric sand" are as nothing beside the promises of Mr. HYMEN LEVETUS. That gentleman has been proclaiming from the housetops the wonderful properties of the Milver Portable Electric Battery; and if one-half of these are to be relied upon, it is time for the horse and the dynamo builder to adjourn to the museum. The "Milver" battery does not, we are told, consume anything so expensive as zinc; it makes a daily 10-minutes meal on that wonderful material, "a substitute," and then it develops marvellous power for ten long hours. If you have a cathedral, Mr. HYMEN LEVETUS can give you a "Milver" battery that will light it; or if you merely want a glimmer to guide you to bed, it is not more difficult for the "Milver" to accomplish that than the lighting of St. Paul's. You need not live in England to enjoy these great benefits; for "arrangements have been made to secure the patent rights in fifteen countries." But, should it chance that you neither want to light your cathedral, nor in the small hours of the morning your staircase; nor yet to run a "produce wagon along the roads at the highest rate of speed"; there is still an advantage to be derived. For, if you put your money into this primary battery you will, so says that prophet, Mr. HYMEN LEVETUS, get back "twenty times the money invested."

The Theric-Oblasser Accumulator.—A company, with a capital of £30,000, has been formed in Germany to exploit the Theric-Oblatter patents in that country.

Cable Interruptions and Repair:—

	Date of Interruption.	Date of Repair.
Accra-Lagos	August 12th.	August 23rd.
Aden-Zanzibar	September 2nd.	—

Glasgow and West of Scotland Technical College.—The session for 1895-6 commences on Tuesday, October 1st. The entrance examination begins on Tuesday, the 24th inst. The Calendar for 1895-6 gives very complete particulars of the course of instruction in the day and evening classes.

Our Electrical Defences.—Operations have now been started for connecting Lavernock, the Flat Holm and Steep Holm, and Brean Down by an electric cable for the purposes of the Severn defence. The cable will be also connected with the Royal Engineers' offices in Canton and the Submarine Mining establishment at the docks, Cardiff.

Electric Motors and Cable Traction.—The cables on a three-mile section of the Chicago and City Railway Company are now being driven by means of a 700 H.P. Westinghouse continuous-current motor supplied with current from the mains. It is stated that the variations in load on this line are much more violent than would be the case with an electric tramway consuming about the same amount of power, the ammeter pointer rising and falling between 200 and 300 amperes within one-third of a minute.

Proposed Waterloo-City Overhead Railway.—It is rumoured that a project is on foot for the construction of an overhead railway from Waterloo Station to the City. All the necessary surveys have been made, and the Bill authorising the undertaking will be promoted in the next Session of Parliament by the South-Eastern Railway Company. The new line will compete with the underground electric railway now in process of completion connecting the South-Western Railway with the City at an almost identical point.

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Electric Elevators.—The electric elevator is rapidly coming into general use in the United States. At first, says the *Western Electrician* of Chicago, central station managers were rather dubious of the effect upon their lighting circuits of the sudden and heavy demands for starting currents for the elevator motors; but they have found that this service forms a safe and desirable addition to their business. Probably 30 or 40 electric elevators have been installed in Chicago within the last year, and the business is also growing rapidly in the large eastern cities.

Expiry of a Secondary Battery Patent.—On Tuesday next will expire the secondary Patent No. 3926, granted September 10, 1881, to Mr. J. S. Sellon. The patentee expressly disclaims the use of spongy lead, &c., *per se*, and the use of corrugated or grooved plates "unperforated for the retention of such substances." His claim is: The use in the construction of secondary batteries of *perforated* plates or sheets, roughened, serrated, or indented, composed of lead, platinum, or carbon, upon, in, or against which plates, spongy or finely divided lead, or oxides or other salts, or compounds of lead or other suitable substances or compounds, are or may be held or retained substantially as and for the purposes hereinbefore described.

The Electric Conductivity of Heated Gases.—At a recent meeting of the Physical Society of Berlin, Dr. Pringsheim gave an account of his experiments on the electric conductivity of heated gases. In a Chamotte tube closed by brass caps the various gases, such as air, hydrogen, and carbon dioxide, were heated to a temperature of 700°C to 900°C. The electrodes consisted of circular discs of platinum capable of being placed at varying distances from each other. All the results obtained by Becquerel in 1853 were confirmed. As the electrodes were separated from each other the deflection of the galvanometer became less, and with constant distance between the electrodes the current became less the longer it flowed. This fact led to the suspicion, verified by experiment, that polarisation was here playing a part. On breaking the primary current, the polarisation of the electrodes was quite perceptible for fully a half-hour. The author concluded from the above that conduction in heated gases is an electrolytic phenomenon.

Obituary.—We regret to have to announce the death, on August 30th, of Mr. H. C. Hart, one of the first-class technical officers of the Engineer-in-chief's Office, Post Office Telegraphs. Mr. Hart joined the Telegraph Department in June, 1870, shortly after the transfer of the Company's business to the State. He has throughout his official career taken a keen interest in the great developments of the telegraph and telephone industries and in Post Office work generally. He was a Director of several of the mutual associations started and managed by Post Office men for the benefit of their brother officers. His loss will be deeply deplored by all with whom he was brought into contact. The interment took place on Monday, the 2nd inst., at Elmer's End Cemetery. Among those present to render a last tribute of respect to their late colleague were Mr. J. Hookey, assistant engineer-in-chief, Messrs. J. B. Chapman, T. H. Stockwell, P. Ennis, J. W. Curra, R. C. Leversedge, T. Reid and J. Ward of the Engineer-in-Chief's Office, and many representatives of other branches of the Post Office. The deceased was only 49 years of age.

Atmospheric Electricity.—The *Sitzungsberichte* of the Vienna Academy of Sciences (Vol. CIV.), says *Nature*, contains a discussion of the observations of atmospheric electricity and St. Elmo's Fire on the Sonnblick by Messrs. J. Elster and H. Geitel, being a continuation of the observations to the time of the change of the former observer. The results confirm those previously obtained, and show that the yearly variation of the electrical energy at the summit is small, compared to that at the base, and that the summit of the mountain projects above those strata of the atmosphere in which electrical processes mostly occur. During the fall of fine snow the St. Elmo's Fire is mostly negative, but positive when large flakes of snow and hail are falling. Dr. J. Hann has recently published a Paper on the conditions of atmospheric electricity on the summit of the Sonnblick. The discussion, says *Nature*, is one of much importance, and the subject is treated by Dr. Hann in a very thorough manner.

British Association, Section A.—The proceedings this year of the Mathematical and Physical Section of the British Association, so far as they are of electrical or allied interest, comprise the following Papers:—Prof. O. Henrici will read a Paper in this Section "On the Teaching of Geometrical Drawing in Schools," with a view to the appointment of a committee. Lord Kelvin and Messrs. M. Maclean and A. Galt will contribute a Paper "On the Electrification and Diselectrification of Gases;" Prof. A. W. Rücker will propose the question, "Do Vertical (Earth-Air) Electrical Currents exist in the United Kingdom?"; Messrs. Edier and Starling will discuss researches "On the Velocity of Light in a Rarefied Gas through which a Current is Passing"; Dr. G. J. Johnstone Stoney has a Paper "On the Events that go on within Molecules"; and Mr. W. H. Wheeler will report on Reduction of Magnetic Observations and on Electrical Standards. This Section will meet daily at 10·30 a.m., except on Saturday, when the proceedings will commence at 10 o'clock.

A Case of Globular Lightning.—In *The Times* of Tuesday Sir Charles S. King gives the following quotation from a memoir of the Rev. Dr. William Henry, F.R.S., a very close and careful observer, in which he describes an accident to Belturbet Castle, the then seat of Viscount Lanesborough, caused by globular lightning:—

> "About 20 years ago (1719), this castle was struck in an extraordinary manner with lightning, the traces of which are preserved to this day, and seem to confirm that philosophical opinion that what the vulgar call the thunderbolt is only the focus of that stream of liquid fire which is then discharged. This thunder struck the top of the castle close by the stack of chimneys, from which it shot down perpendicular to the bottom. The hole it made in the garret ceiling through which it darted is scarce 3in. diameter. This seems to be the very focus; from thence diffusing it knocked to pieces the stone of the hearth, and cut to itself a circular passage about 3ft. diameter; descending to the next floor, and growing more diffused, it cut through the hearth and floor a passage of about 8ft. diameter; from thence descending into the hall, and spreading wide, it, by the violent concussion of the air, dashed down two stands of arms hung round the hall, and broke out of the door, tearing down one side of it. Two women were in the hall—the one who stood on the further side, near the arms, was struck down, astonished but not hurt; the other, who was that instant shutting the door, was struck half dead; that side of her next the lightning was left all black, the other not in the least discoloured; she in a few days recovered, and attended me at the time I observed this progress of the thunder."

Water Power Station on the Sihl, near Zurich.—The water power station on the Sihl, near Zurich, of which some mention has been previously made in these columns, came into operation on the first of this month. The entire water of the river is retained by a dam, and the water is led along a canal about a mile and a-half long to a reservoir which has been excavated to a capacity of 48½ millions gallons. From the reservoir the water is led by an iron pipe, 4½ft. in diameter, to the turbines. A sluice valve is inserted at the opening of the pipe, by means of which the entire water can be kept back without the aid of sluice gates. The average rate of flow through the pipe is 350 gallons per second. Before the water begins to descend it flows a distance of some 70 yards, thence the pipe leads the water to the turbine house 160 yards off with a fall of 63 per cent. The pipe is made from rolled sheet, which is 0·2in. thick from the reservoir to the beginning of the drop, and thence 0·44in. thick. At the turbine house there are at present three 500 H.P. turbines, to which later on two more will be added. The plant is designed to generate a total of 1,800 H.P., of which 1,000 H.P. will be devoted to lighting and the rest to power purposes. At the present moment agreements to take power for several years are in view, a total of 500 H.P. being required. As soon as the station commences work, some 4,400 8 c.p. lamps will require current, and 1,000 more are expected to be connected up shortly. The engineer of the station is Herr Wissling, previously head of the municipal electrical plant at Zurich.

Wiring Rules of the Paris Municipality.—The Paris Municipal Council has recently published a set of wiring rules, which will apply not only to installations connected to the municipal mains, but also to those connected to the mains of the various electric lighting companies of Paris. Rule 2 lays down that the copper conductors shall have a resistance of not more than 1·8 microhms per cubic centimetre at 20°C.—that is to say, they are to be of about 97 per cent. conductivity. Rule 3 lays

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down that the cross-section of the conductors is to be such that in the event of the accidental passage of a current of twice the normal amount, it shall not heat up more than 40°C. The maximum permitted current densities are as follows: 1,935 amperes per square inch for wires between Nos. 18 and 13 B.W.G., 1,290 amperes per square inch for wires between Nos. 13 and 1 B.W.G., and 645 amperes per square inch for larger conductors. The permissible density is double this when bare conductors are used. No single wire conductor of less than No. 20 B.W.G. is permitted. Rule 5 states that fuses must melt for currents equal to not more than three times the normal amount. Rule 7 states that a special tablet is to be placed upon houses which are electrically lit. By Rule 12 casing is permitted. With regard to arc lamps it is stated that the wires of the rheostats in connection with them are to be so arranged as not to attain a higher temperature than 200°C, and the resistance wires of the rheostat are to be separated from the base of the apparatus by at least 2in. of air. By Rule 15 all fixtures serving both for gas or electricity are to be mounted on insulated bases, having a resistance of at least half a megohm. Rule 16 reads as follows: "Every conductor which can be separated from the general network by the movement of a switch or the taking out of a fuse shall have an insulation resistance either with regard to earth or to its neighbouring conductor, which, expressed in ohms, shall not be lower than 5,000 E/2, E being the potential difference in volts measured at the terminals of the generator or transformer. In insulation tests the difference of potential employed shall be equal to E, not, however, exceeding 500 volts, nor going below 100."

The Telephotograph.—The telephotograph is the name of a new Swedish invention, which, according to *Engineering*, claims to do for the eye something like what the telephone does for the ear. It is based upon the peculiarity of selenium, that its resistance to the transmission of electricity depends to a great extent upon the strength of the light to which it is exposed. The construction of the telephotograph is simple enough, but it is not so evident that it would work as described. A fine point of selenium is made to move in a plane by a mechanical arrangement in such a manner that, moving repeatedly forward and backwards, within a limited compass of this plane, it describes a spiral consisting of very close windings. An electric current passes through the selenium point, and the power of this current will vary according to the light to which the point at any given moment is exposed. The receiver is constructed in a similar manner to the above, except that a very susceptible incandescent light has been substituted for the selenium point. The intensity of this light will, it is said, vary in harmony with the light to which the selenium point is exposed, though we should have thought there would be a perceptible lag and damping effect, considering the speed with which the lamp must be moved in its cycle. When the light is made to move in a similar manner to the movements of the selenium point, it will produce lights and shadows on the plane. The despatching apparatus is inclosed in a case, something like a photographic camera, fitted with an objective, which can be so adjusted that the picture of the subject to be telephotographed is formed in the movement plane of the selenium point. The lights and shadows produced by the incandescent light of the receiving apparatus will then, so it is said, produce a picture identical with the one at the despatching station. The rapidity of the movements of the selenium point through any one point of the picture must not allow of a greater interval than about one-eighth of a second, so that the corresponding impressions upon the eye of the beholder form a continuous complete picture.

African Telegraph Rates.—In the House of Commons on Wednesday Mr. Hanbury moved that the agreements (1) dated July 9, 1895, between the Treasury, the Colonial Governments of the Cape of Good Hope and Natal, and the British South Africa Company respectively, and the Eastern and South African Telegraph Company; (2) dated July 10, 1895, between the Treasury and the same Telegraph Company, providing for a reduction in the charges for telegrams between South Africa, certain places on the East Coast of Africa, Mauritius, and Seychelles on the one hand, and Europe on the other, be approved. Agreed to.—— The agreements referred to above are embodied in a Parliamentary Paper just published. The agreements provide for a reduction, now in force, in the charges for telegrams between South Africa, certain places on the East Coast of Africa, Mauritius and Seychelles on the one hand, and Europe. The rates per word previously varied from 7s. 6d. to 8s. 11d. for ordinary telegrams, and from 5s. 9d. to 6s. 4d. in the case of Government telegrams, and the Telegraph Company has undertaken to reduce the rates in the case of South African traffic by both the East and West Coast routes to rates which are approximately 5s. a word for ordinary and 2s. 6d. a word for Government telegrams. The Home Government and the contracting colonies have undertaken, by the first agreement, to grant, as from December, 1899, a subsidy of £17,000 per annum for 10 years, in the following proportions: By Her Majesty's Treasury, £8,750 per annum; by the Government of the Cape Colony, £6,000 (in the event of the Orange Free State paying to the Telegraph Company the sum of £200 per annum, this sum to be reduced to £5,800); by the Government of Natal £1,650, and by the British South Africa Company £600. Provision is made for a rebate in the subsidy if, during the last five years of the period of 10 years mentioned, the net receipts of the Telegraph Company exceed £180,000 in any one year. Under a second agreement the Home Government undertake to grant to the Telegraph Company an annual subsidy of £3,500, payable for 10 years as from January 1, 1900.

The Institution of Civil Engineers.—Subjects for Papers.—The Council of the Institution of Civil Engineers invites original communications on the subjects included in the following list, as well as on any other questions of professional interest. This list is to be taken merely as suggestive, and not in any sense as exhaustive. For approved Papers the Council has the power to award premiums, arising out of special funds bequeathed for the purpose. The following is a list of the subjects of electrical engineering interest suggested: The Purification of Sewage by Precipitation, Filtration, Electrolytic, Bacteriological and Chemical Processes—The Use of Ash-bin Refuse in Towns for the Production of Steam—The Methods of Condensing Steam by the Use of Moderate Quantities of Water—The Methods of Removing Moisture from Steam, and of Reducing Losses by Radiation from Steam Pipes—The Production and Use of Super-heated Steam—The Theory and Development of the Compound Steam Turbine—The Recent Developments in Gas Engines and Oil Engines, including a comparison of the relative merits of the several Cycles, with reference to "after-burning"—The Design and Construction of Large Turbines—The Magnetic Properties of Iron and Steel—The Extraction of Metals from their Ores by Electrolytic Processes—The most suitable Steam-power Equipments for Electric Light Stations—The Utilisation of Electric Lighting Plant during hours of small demand—The Utilisation of Electrical Energy in the form of Heat—The Regulation of Electric Pressure in large lighting circuits as carried out at the engine, the dynamo or the exciter—The Theory and Practice of the Transmission of Power by Alternating Currents—The Use of Electrical Motors for Driving Machines in textile factories and in engineering workshops—The first cost, facility and economy of operation of Electrical Traction on Railways with heavy trains and on Tramways—The Construction and Working of Electrical Lifts and Cranes—The Electrolytic Action of Return Currents in Electrical Tramways on Gas and Water Mains, and the best means of providing against Electrical Disturbances—The Use of Electrical Machinery for Lighting and the Transmission of Power in Warships and in the Mercantile Marine. In writing these essays the use of the first person should be avoided. They should be legibly transcribed on foolscap paper, on one side only, leaving a margin on the left side, in order that the sheets may be bound. Every Paper must be prefaced by an abstract of its contents not exceeding 1,500 words in length. Illustrations, when necessary, should be drawn on tracing paper, to as small a scale as is consistent with distinctness, but in no case should any figure exceed 6½in. in height. When an illustrated communication is accepted for reading, a series of diagrams will be required so drawn and coloured as to be clearly visible at a distance of 60ft. These diagrams will be returned.

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ON SELF-ACTING COMPENSATION FOR TEMPERATURE IN STANDARD CELLS.

BY ALBERT CAMPBELL.

In accurate testing work, when a standard cell is used, in most cases it is necessary to observe the exact temperature of the cell and to make a correction for it. In the case of the Clark cell the temperature coefficient is commonly given $= -0{\cdot}077$ per cent. per degree C. Dr. Kahle (*Wied. Ann.*, p. 174, No. 1, 1894) gives it a little higher, viz. $= -0{\cdot}083$ per cent. per degree C. Carhart's one-volt standard cell, in which calomel paste and solution of zinc chloride replace the corresponding sulphates, is stated to have a coefficient as small as $+0{\cdot}0097$ per cent. per degree C., and Weston's cadmium cell seems almost as invariable. But whatever be the merits of the two last-named cells, the Clark cell is at present the most widely received standard, and therefore any simple arrangement which gets rid of the correction for temperature must be of distinct advantage. Below are three methods which I propose for this purpose; as far as I know, they are novel.

The principle used in all of these is to make the variations in resistance of metallic conductors counterbalance the changes of E.M.F. in the standard cell. Since the amount of compensation *required* is approximately proportional to the variation of temperature, it is only necessary (*a*) to make the *applied* compensation also proportional to that variation, and (*b*) to ensure that the compensation acts correctly for a temperature rise of 1 degree.

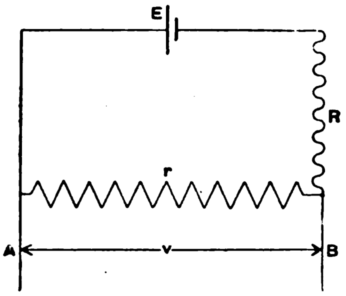

FIG. 1.— ⁀⁀⁀ = Manganin. /\/\/\/\ = Copper or Nickel.

Method 1.—In this the standard cell is placed in series with two high resistances of materials having different resistance temperature coefficients. As will be shown below, by properly choosing the materials and the magnitudes of these resistances the potential difference on one of these resistances can be rendered nearly independent of temperature.

In Fig. 1 let E be the E.M.F. of the standard cell and R, r the resistances in series with it, all being at the normal temperature.

Also let η, a, and β be the temperature coefficients of E, r, and R respectively. Let the potential difference between A and $B = v_0$ at the normal temperature and v_1 when the temperature rises 1°C. Take r and R so high that the resistance of the cell may be neglected.

Then $$v_0 = \frac{r\mathrm{E}}{r+\mathrm{R}}$$

and $$v_1 = \frac{\mathrm{E}(1+\eta)}{1+\frac{\mathrm{R}}{r}\left(\frac{1+\beta}{1+a}\right)} = \frac{\mathrm{E}(1+\eta)}{1+\frac{\mathrm{R}}{r}(1+\beta-a)}$$

$$= \frac{\mathrm{E}(1+\eta)}{\frac{r+\mathrm{R}}{r}\left[1+\frac{\mathrm{R}}{r+\mathrm{R}}(\beta-a)\right]}$$

$$= \frac{r\mathrm{E}}{r+\mathrm{R}}\left[1+\eta-\frac{\mathrm{R}}{r+\mathrm{R}}(\beta-a)\right].$$

Now, if v is to be constant, $v_1 = v_0$, and we must have

$$\eta = \frac{\mathrm{R}}{r+\mathrm{R}}(\beta-a).$$

This condition is easily satisfied if

r be of copper and $\therefore a = 0{\cdot}0040$,
R of German silver and $\beta = 0{\cdot}0004$,
E a Clark cell and $\eta = -0{\cdot}0008$.

So $$\frac{\mathrm{R}}{r+\mathrm{R}} = \frac{0{\cdot}08}{0{\cdot}36} = \frac{2}{9};$$

hence $$\frac{r}{\mathrm{R}} = \frac{7}{2}.$$

We can therefore make $r = 70{,}000$ ohms and $\mathrm{R} = 20{,}000$ ohms, in which case we shall have a constant voltage of about 1·115 volts from B to A.

Instead of making the coil r of copper, which is not a suitable material for high resistances, *nickel* might be used. According to Dewar and Fleming, pure nickel has a resistance temperature coefficient of 0·0062 per degree C.; according to my own experiments (*Proc. Roy. Soc., Edin.*, July, 1887) the coefficient for ordinary commercial nickel is sometimes as low as 0·0040. In any case, if annealed nickel be found to undergo no sensible change as it ages (a point which is yet doubtful), it would, from its higher resistivity, be preferable to copper in all the arrangements here described.

To the above method, however, there is the serious objection that, unless very high resistances are employed, the internal resistance of the cell will not be negligible, and, besides, the cell will polarise. The other two methods which I now proceed to describe are quite free from these defects.

Method 2.—The second way might be called the *auxiliary cell method*, for in it the small variations in E.M.F. of the standard cell are compensated by adding or subtracting a small fraction of the E.M.F. of an auxiliary cell, the magnitude of this added part being automatically regulated by the temperature.

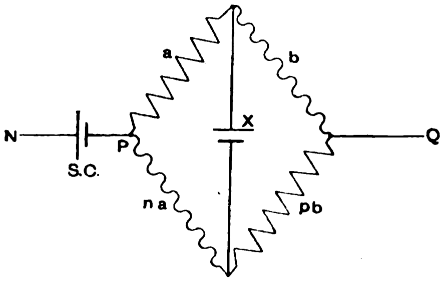

FIG. 2.—S.C. = Standard Cell. X = Auxiliary Cell.
/\/\/\/\ = Copper or Nickel. ⁀⁀⁀ = Manganin.

The arrangement will be seen from Fig. 2, in which the auxiliary cell (X) is shown connected up as in a Wheatstone's bridge, the resistances a and $p\,b$ varying with temperature, while the other arms $n\,a$ and b are practically constant. The auxiliary cell may be a Daniell, Leclanché, or other battery, whose E.M.F. is known to within about 5 per cent., and which will keep fairly constant when run on high resistance.

It is clear from the figure that, if the bridge resistances balance, the voltage from P to Q will = 0, and therefore the voltage from N to Q will be only the E.M.F. of the standard cell. If, however, the bridge, by change of temperature or otherwise, is not in balance, the voltage from N to Q will = E.M.F. of standard ± some fraction of E.M.F. of auxiliary. Let us now investigate if a, b, n, and p can be chosen so as to keep the voltage from N to P constant while temperature varies.

Let a and 0 be the temperature coefficients of a and b respectively, and let η, as before, equal that of the standard cell. To simplify matters, let the cell X be the only resistance in the cross circuit, and let its resistance be small compared with $a + n\,a$ and $b + p\,b$.

Let X = E.M.F. of the auxiliary cell;

V_0 and V_1 = potential rise from P to Q at the normal temperature and at 1°C. above it, respectively.

Then $$\mathrm{V}_0 = \mathrm{X}\left[\frac{p}{1+p} - \frac{n}{1+n}\right]; \quad \ldots \ldots \quad (1)$$

$$\mathrm{V}_1 = \mathrm{X}\left[\frac{p(1+a)}{1+p(1+a)} - \frac{n}{1+a+n}\right];$$

$$\therefore \mathrm{V}_1 - \mathrm{V}_0 = \mathrm{X}\left[\frac{ap}{(1+p)(1+p+ap)} + \frac{an}{(1+n)(1+a+n)}\right]$$

$$= \mathrm{X}a\left[\frac{p}{(1+p)^2} + \frac{n}{(1+n)^2}\right]$$

if neither p nor n is much greater than unity.

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$$\therefore V_1 = X\left[\frac{p}{1+p} - \frac{n}{1+n}\right] + X\,a\left[\frac{p}{(1+p)^2} + \frac{n}{(1+n)^2}\right]. \quad . \quad (2)$$

This equation will now enable us to choose suitable values for p and n. If the values of X and a be fixed, the maximum possible variation of V is when $\frac{p}{(1+p)^2} + \frac{n}{(1+n)^2}$ is a maximum. Now, since both p and n must be positive, each term in this expression must be a maximum, and it is easy to show that the condition for this is $p = n = 1$. Thus the maximum variation $= X\frac{a}{2}$.

If $X = 1{\cdot}5$ volts and $a = 0{\cdot}0040$, the variation in the auxiliary volts cannot exceed 0·003 volt per degree C. Accordingly a single Leclanché cell at X is more than sufficient if the standard is a Clark cell, for in it the variation to be compensated is only 0·0011 volt per degree C. Let us now find what values of p and n will give good compensation. Putting in the above values of X and a, equation (2) becomes

$$V_1 = 1{\cdot}5\left[\frac{p}{1+p} - \frac{n}{1+n}\right] + 0{\cdot}006\left[\frac{p}{(1+p)^2} + \frac{n}{(1+n)^2}\right]. (3)$$

Case I.—Let $p = n$. In this case the auxiliary volts (V) vanish at the normal temperature.

Equation (3) becomes

$$V_1 = \frac{0{\cdot}012\,n}{(1+n)^2}.$$

Now $V_1 = 0{\cdot}0011$ volt for correct compensation; hence $p = n = \frac{49 \pm 47{\cdot}75}{11} = 8{\cdot}795$ or $0{\cdot}123$. With either of these values the volts from N to Q (Fig. 2) for all ordinary temperatures will keep steadily equal to the E.M.F. of the standard cell at the temperature at which the bridge arms are adjusted to balance. The final adjustment can be made by connecting a sensitive galvanometer to P and Q and adjusting one arm of the bridge until a balance is obtained.

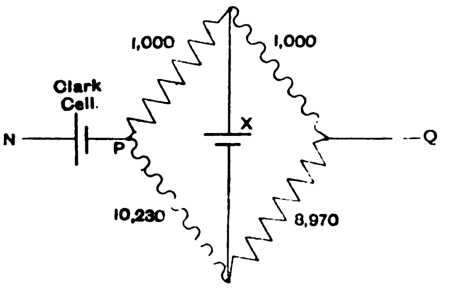

FIG. 3.—[zigzag line] = Copper or Nickel. [wavy line] = Manganin.

Case II.—Let p be not equal to n. When this is the case the first part of V_1 in equation (3) does not vanish, and this gives, in addition to the second term, which forms the temperature compensation, a small constant voltage to be added or subtracted. We can, therefore, choose n and p, so as to have correct compensation, and at the same time to bring the total voltage to an even figure, say 1·400, at all temperatures.

To investigate the general case, let

$$\frac{p}{1+p} - \frac{n}{1+n} = k \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and

$$\frac{p}{(1+p)^2} + \frac{n}{(1+n)^2} = m. \quad . \quad . \quad . \quad . \quad (5)$$

From (4)

$$p = \frac{n(1-k) - k}{nk + k + 1} \quad . \quad . \quad . \quad . \quad (6)$$

Substituting this in (5), and reducing, we have

$$(k + k^2 + m)\,n^2 - 2\,(1 - k^2 - m)\,n - k + k^2 - m = 0. \quad . \quad (7)$$

Equations (7) and (6) give the values of p and n for any desired values of k and m.

For example, let us aim at $V = 1{\cdot}400$ volts.

Here $$k = \frac{1{\cdot}400 - 1{\cdot}434}{1{\cdot}5} = -0{\cdot}02265,$$

and $$m = \frac{0{\cdot}0011}{0{\cdot}0060} = 0{\cdot}1833.$$

Hence $n \doteqdot 10{\cdot}23$, and $p \doteqdot 8{\cdot}97$.

Thus, if the resistances in Fig. 3 are right at 15°C, and $X = 1{\cdot}5$ volts, the voltage from N to Q will be 1·400 volts at all temperatures near 15°C.

In practice it would be safer (after the coils have been arranged approximately, as in Fig. 3) to observe the temperature of the whole, and then, by means of a potentiometer, comparing V_{NQ} with the E.M.F. of the Clark cell alone, to adjust one of the arms slightly, so as to bring V_{NQ} to 1·400 volt. This final adjustment would not sensibly interfere with the temperature compensation. Introducing resistance in branch X would afford another means of adjustment. For cells (like Carhart's) in which the E.M.F. increases with temperature, the auxiliary cell would merely have to be reversed.

Method 3.—To make this method clear let us consider Fig. 4.

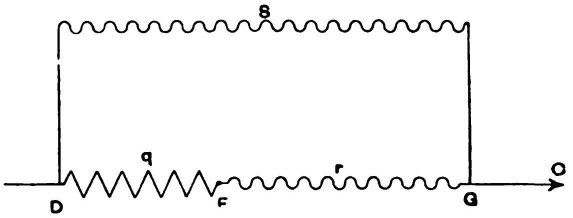

FIG. 4.—[zigzag line] = Copper or Nickel. [wavy line] = Manganin.

A current C from an outside source flows from D to G through the resistances q, r, and s, arranged as in the figure. Let q be more variable with temperature than r and s. Now it is possible to choose the values of q, r and s so that *C can remain absolutely invariable* and yet produce from F to G a potential difference exactly equal to the E.M.F. of a Clark cell *and having the same temperature variation.*

Let C be constant and let U_0 and U_1 = potential differences from F to G at the normal temperature and at 1°C. above it, respectively; also let a be the temperature coefficient of q, β that of r and s, and η that of the Clark cell.

Then $$U_0 = \frac{r}{q+r} \times \frac{(q+r)\,s}{q+r+s}\,C = \frac{C\,r\,s}{q+r+s};$$

$$\therefore \quad U_1 = C\frac{r\,s\,(1+\beta)^2}{q + q\,a + r + r\beta + s + s\beta}$$

$$\doteqdot C\frac{r\,s}{q+r+s}(1 + 2\,\beta)\left(1 + \frac{q\,a + r\,\beta + s\,\beta}{q+r+s}\right)$$

$$\doteqdot \frac{C\,r\,s}{q+r+s}\left[1 + \frac{(2\,q + r + s)\,\beta - q\,a}{q+r+s}\right].$$

Since U is to have the same variation as the Clark cell we must have

$$\eta = \frac{(2\,q + r + s)\,\beta - q\,a}{q+r+s}. \quad . \quad . \quad . \quad . \quad . \quad (8)$$

The simplest solution is to make r and s of manganin, so that $\beta = 0$, and the equation becomes

$$\frac{a}{\eta} = -\frac{q+r+s}{q} = -1 - \frac{r+s}{q}. \quad . \quad . \quad . \quad (9)$$

If q be of copper, $\frac{a}{\eta} = 5$;

$\therefore$ (9) becomes $r + s = 4q$. . . . . (10)

This is the required condition.

The method is best employed along with a potentiometer, as shown in Fig. 5. Here G H K are the potentiometer wires. The absolute values of q, r, and s are to be chosen to fulfil the condition in equation (10), and so that when the potential difference between F and G is just balanced by the Clark cell, the current through G H K will be just the right strength to make the potentiometer read directly in volts. The final adjustment can be made once for all as follows:—Observe the temperature and let the corresponding E.M.F. of the Clark cell $= E_t$. Adjust the current until the Clark cell balances when in position L′ with a potentiometer reading $= E_t$. Then slightly alter the position of the junction at F until the cell balances when shifted to position L. After this the Clark cell

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is kept permanently in position L. To use the potentiometer now it is only necessary to adjust the current until the Clark cell balances (at F and G). The potentiometer will then read directly in volts and be independent of temperature to the third place of decimals.

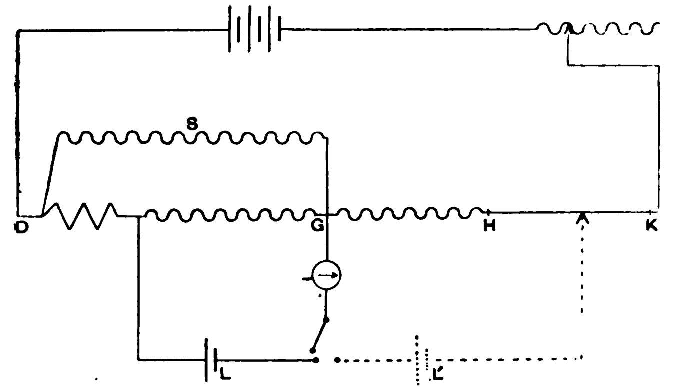

FIG. 5.— ∿∿∿∿ = Manganin. ∧∧∧∧∧∧ = Copper or Nickel.

In conclusion, two practical points should be noted: firstly, that the standard cell should be in the same case, if possible, as the compensating coils to ensure all being at the same temperature; and, secondly, that the copper or nickel resistances must be of such mass as not to be appreciably heated by the currents used.

THE MAGNETIC FIELD OF A RECTANGULAR CURRENT.

BY PROF. G. M. MINCHIN, M.A., F.R.S.

In the following Paper is given the expression for the magnetic force per unit pole at any point in the plane of a given rectangle when this rectangle is traversed by an electric current.

Let A B C D (Fig. 1) be a wire bent into the form of a rectangle and traversed by a current of strength i, and let P be any point whatever in space. From P let fall P Q perpendicular to the plane of the current; through Q draw L Q N and

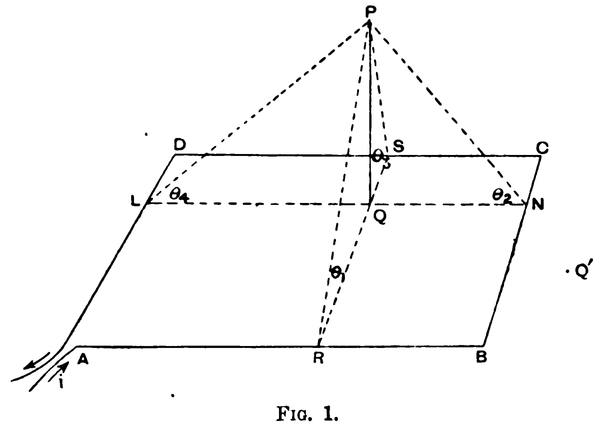

FIG. 1.

R Q S parallel to the sides of the rectangle. Now, if Ω is the conical angle subtended at P by the rectangular contour, we know that the magnetic potential at P due to the current i is $i\Omega$. This conical (usually called "solid") angle is thus defined: Round P as centre describe a sphere of any radius, r, and from P draw lines to all points on the contour A B C D; then these lines will cut the surface of the sphere in a spherical quadrilateral, the area of which, divided by r^2, is the conical angle. We have, then, to consider the quadrilateral in which the sphere is intersected by the four planes P A B, P B C, P C D, P D A.

Now, if the internal angles of *any* polygon formed by great circles of a sphere are (in circular measure) $A_1, A_2, A_3, \ldots$, the area of the polygon is

$$\{A_1 + A_2 + A_3 + \ldots - (n-2)\pi\} r^2, \quad . \quad . \quad (1)$$

n being the number of sides of the polygon; so that in the present case the conical angle subtended at P by A B C D is

$$A_1 + A_2 + A_3 + A_4 - 2\pi. \quad . \quad . \quad . \quad . \quad (2)$$

[Every polygon, or closed curve, on a sphere must, of course, be considered as having *two* areas, according to the portion of the spherical surface which we consider as *inside* or *outside* the contour of the curve. In this case it is the portion of the sphere which faces the circuit A B C D that we consider to be the area.]

The angles, $A_1, A_2, \ldots$, of the spherical quadrilateral are, of course, those between the planes P A B, P B C, . . . ; and it is easily proved either by spherical trigonometry or by analytical geometry that if the angles P R S, P N L, P S R, P L N are denoted by $\theta_1, \theta_2, \theta_3, \theta_4$, the angle between the planes P A B, P B C is $\pi - \cos^{-1}(\cos\theta_1 \cos\theta_2)$, with similar expressions for the angles between the other planes.

Hence, then, we have

$$\Omega + 2\pi = A_1 + A_2 + A_3 + A_4$$
$$= 4\pi - \cos^{-1}(\cos\theta_1 \cos\theta_2) - \cos^{-1}(\cos\theta_2 \cos\theta_3) \ldots; \quad (3)$$

so that if $\cos\theta_1, \cos\theta_2, \ldots$ are denoted by $c_1, c_2, \ldots$, we have finally

$$\Omega = 2\pi - \cos^{-1}(c_1 c_2) - \cos^{-1}(c_2 c_3) - \cos^{-1}(c_3 c_4) - \cos^{-1}(c_4 c_1). \; (4)$$

The most simple way to find the value of the magnetic force at any point, Q, in the plane of the rectangle is to take P indefinitely close to Q in Fig. 1, and to take the difference between the value of Ω for Q and the value of Ω for P, and divide this difference by the length P Q; for the force at P in any direction is the differential coefficient of Ω in that direction, multiplied by i.

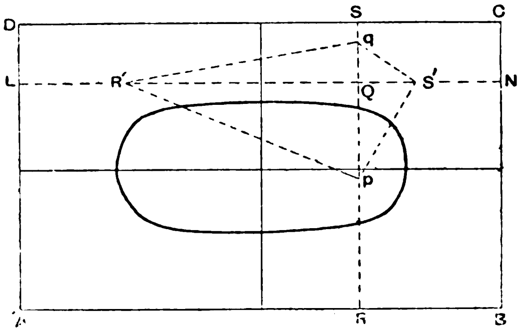

FIG. 2.

Now Ω at Q and at all points in the plane of A B C D *within* the contour is 2π, as is well known, while Ω at all points in the plane and *outside* the contour is 0. Suppose P very close to Q; let $PQ = z$, $RQ = l$, $QN = m$; then $\cos\theta_1 = 1 - \frac{z^2}{2l^2}$, nearly, and $\cos\theta_1 \cos\theta_2 = 1 - \frac{z^2}{2}\frac{l^2 + m^2}{l^2 m^2} = 1 - \frac{z^2}{2}\frac{RN^2}{l^2 m^2}$; so that the circular measure of the angle whose cosine is $\cos\theta_1 \cos\theta_2$ is $\frac{z \, . \, RN}{lm}$, or $\frac{z}{p_1}$, where p_1 is the perpendicular from Q (or from B) on R N.

Hence, then, if p_1, p_2, p_3, p_4 are the lengths of the perpendiculars from Q on the lines R N, N S, S L, L R, the value of Ω at P is

$$2\pi - z\left(\frac{1}{p_1} + \frac{1}{p_2} + \frac{1}{p_3} + \frac{1}{p_4}\right),$$

and hence the value of the magnetic force intensity at Q is

$$i\left(\frac{1}{p_1} + \frac{1}{p_2} + \frac{1}{p_3} + \frac{1}{p_4}\right), \quad . \quad . \quad . \quad . \quad (5)$$

which is a simple result, published now for the first time, so far as I am aware. Of course for a point, such as Q', in the plane of the rectangle, but outside its area, a similar result holds with the proviso that two of the perpendiculars (p_1, p_2) become negative. We must observe also that such a result as (5) obviously supposes that the point Q is not near any side of the rectangle—or, at least, is so distant that the diameter of the cross-section of the wire may be neglected and the wire still considered to be a mere *line*.

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There is a practical way of using the result (5) which will assist graphic construction. In practice it is difficult, or troublesome, to measure reciprocals, $\frac{1}{p_1}$, &c., so that we must endeavour to get an expression depending on the measurement of *direct* lengths. This can be done as follows :—

Let Q, Fig. 2, be the point at which the magnetic force is required ; draw L Q N, R Q S, parallel to the sides ; on Q N) take S′ such that Q S′ = Q S, and R′ such that Q R′ = Q R ; from S′ draw S′ q and S′ p parallel, respectively, to L R and R N ; draw R′ q, R′ p. [Of course, it is easy to see that R′ q, R′ p are parallel to L S, S N.] Then (5) is equivalent to

$$i \cdot \frac{\text{length of contour } p\,S'\,q\,R'}{Q\,R\,.\,Q\,S}, \quad . \quad . \quad . \quad (6)$$

in which, then, the only reciprocal that has to be taken is that of the product Q R . Q S ; but this is always easily at our disposal if the drawing is made on section-paper. There is no difficulty in verifying the equivalence of (5) and (6), so that it is not worth while to occupy space with the proof.

The oval curve contains on its contour all points at which the magnetic force has a certain constant value, chosen arbitrarily, and it was constructed with considerable ease and rapidity by the rule contained in (6). It may be observed that there is a tendency to corners, or abrupt change of curvature, in such curves.

The case in which the point Q, at which the value of the force is required, lies very close to some part of the current remains for investigation.

NOTES ON SOME EXPERIMENTS WITH ELECTRO-MAGNETIC MECHANISM.

BY P. V. McMAHON.

(Concluded from page 587.)

The last and not least important set of observations are plotted on Fig. 29, and are the results of experiments with the 14in. double-taper core, with the second spring, the different curves being obtained by altering the initial tension of the spring and also the position of the point of the core with respect to the outside edge of the coil at starting. The variation of excitation was maintained the same, viz., 280 ampere-turns for all the curves, *i.e.*, *a* to *f*. Starting with *a* the travel for the above-named variation is only 1·4in. Here, before the current was switched on, the point of the core was 3·25in. outside the coil, and the spring had no initial tension. The first reading (or the first point of balance between ampere-turns and spring) was obtained when the core point was 7·4in. outside the coil. It is thus evident that the core passed rapidly over the first part of the scale. These first points on the curve were not observed, as the object of this experiment was to find the difference between the curves when the core started under different conditions for the same ampere-turns at start and finish. Consequently, the first and last points on the curve must correspond with those of curve *f*. This first curve *a*, in addition to having the shortest travel, is also the worst curve, being nearly part of a semicircle.

The second curve, *b*, was obtained under the following conditions : The point of the core was flush with the outside edge of the coil before the current was switched on, or 3·25in. of core less through the coil than in *a*. For the minimum excitation (580 ampere-turns) the point of the core settled down 5·5in. outside the coil, the travel in this case being 2·45in. The shape of the curve is much better than *a*, although it bends over a little towards the end of the travel.

The spring was arranged as in *a*—*i.e.*, it had no initial tension at the start.

In the third curve, *c*, the point of the core was 3·25in. outside the coil, as in *a*, but here the spring had an initial tension corresponding to a torque of 0·99 inch-ounces. With minimum excitation the core point stood 5·05in. outside the coil, or 0·45in. less than in *b* ; the travel in this case was 2·8in. The curve is somewhat similar in shape to those obtained with the two 8in. cores, only the deviation from a straight line is not so marked.

Coming to the fourth curve, *d*, the point of the core was flush with the outside of the coil, as in *b*, but the spring had an initial tension corresponding to a torque of 0·99 inch-ounces ; with minimum excitation the core point took up a position 2·6in. outside the coil, and the travel was 4·35in. The curve, as will be apparent on inspection, is a perfectly straight line.

The next curve, marked *e*, was arranged under similar conditions to *d*, with the exception that the spring was given an initial tension corresponding to 1·21 inch-ounces torque ; with minimum excitation the point of the core stood 1·35in. outside the coil, and the travel is just the same as in *d*, viz., 4·35in. This curve is not quite straight, but bends slightly at the beginning.

The sixth and last curve, *f*, was arranged so that the core point was flush with the edge of the coil, without the current flowing, and with the minimum excitation the core remained in

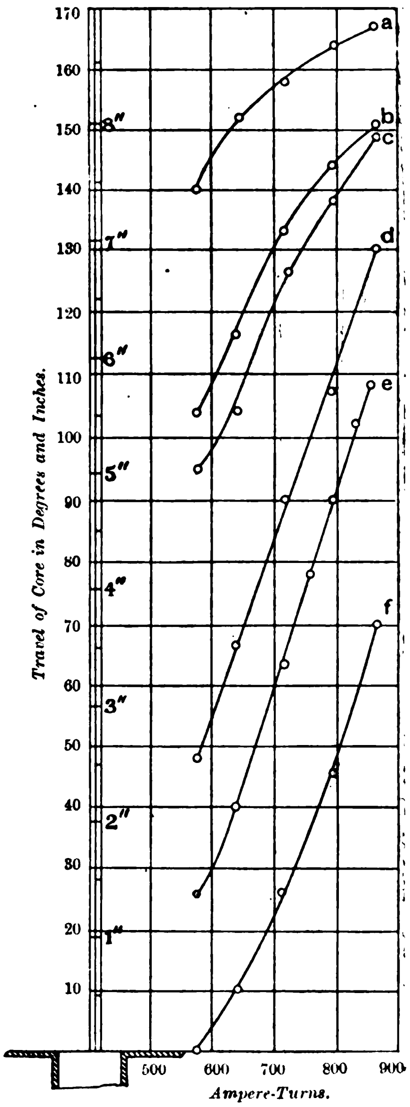

FIG. 29.

the same position. The spring had an initial tension corresponding to a torque of 1·32 inch-ounces. The travel was 3·7in., and the curve not so good as *d* or *e*.

The set of curves given above clearly show how it is possible to vary not only the shape of the curve, but also its travel, by adjusting the spring and the position of the coil with respect to the core.

Here we start under conditions giving a short travel and a bad curve, and gradually come to a maximum travel and a perfectly straight line ; altering the condition still further by increasing the resistance to the movement of the core, the travel becomes small, and the curve deviates again from a straight line. Another noteworthy point about these curves is that each curve becomes straighter until a perfectly straight

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line is reached; then the curves gradually bend in the reverse direction.

Owing to the initial tension of the spring being altered several times it is not possible to give a scale for the torque exerted. However, it can be found by multiplying the travel in degrees by 0·011 (the torque in inch-ounces per degree as found from calibration of the spring) and adding the value of the torque in inch-ounces corresponding to the initial tension, thus:—

—	Travel in degrees.	Torque in inch-ounces.
a..................	140—167	1·54—1·83
b..................	110—151	1·14—1·66
c..................	95—149	2·03—2·62
d..................	48—130	1·51—2·42
e..................	26—108	1·49—2·39
f..................	0— 70	1·32—2·09

Table V.

References to curves.	Travel of core in inches.	Variation of ampere turns.	Description of cross-piece.	—
Fig.				
26 *a*...	2·5	200	½in. sq. iron	14in. core single taper.
b...	2·5	200	½in. sq. iron	14in. core double taper.
c...	2·5	200	½in. sq. iron	5in. core taper bent arm.
27 *a*...	1·1	120	½in.sq.brass	5in. core (quick taper).
b...	2·3	120	½in. sq. iron	5in. core (quick taper).
28 *a*...	2·8	200	½in. sq. iron	5in. core (quick taper). [base.
b...	2·6	200	½in. sq. iron	5in. core (quick taper) with iron disc on
c...	2·7	200	½in. sq. iron	5in. core (slow taper). [excitation.
29 *a*...	1·4	280	½in. sq. iron	Point of core 7·4in. outside coil with min.
b...	2·45	280	½in. sq. iron	" 5·5in. " "
c...	2·8	280	½in. sq. iron	" 5·05in. " "
d...	4·35	280	½in. sq. iron	" 2·6in. " "
e...	4·35	280	½in. sq. iron	" 1·35in. " "
f...	3·7	280	½in. sq. iron	" 0in. " "

The latter experiments with cores and solenoids may be said to be successful as regards sensitiveness, range and shape of curve, but weak as regards the turning moment. It appeared as if this weakness was due to the fact that the return path for the lines of force was through air and not iron.

To try the effect of a closed magnetic circuit, several experiments were made with an electro-magnet, resembling the field-magnet of a dynamo in appearance, and various shaped armatures. In all cases with an iron return in the magnetic circuit the mechanism was very sluggish; most of the armatures tried gave no movement at all for a considerable variation of the excitation, but in all cases the mechanism was infinitely stronger than when no iron return was provided.

It would seem as though this sluggishness was due to the fact that the air gap used was in all cases very short, and on the whole the magnetic circuit was short and of large cross-section, thus resembling a closed magnetic circuit, and consequently the variation in the lines did not follow the variation or excitation in anything like the same relation as in the earlier experiments with solenoids and core.

The truth of this statement is borne out by the experiments that followed, in which large pole-pieces were used, and the return magnetic circuit through air. Here the mechanism was not so strong for the same weight of material (copper and iron) and expenditure of energy as with the preceding arrangement, but it was stronger than the solenoid and even more sensitive.

The results and curves (where obtainable) with the closed magnetic circuit are given, not on account of their success, but rather on account of their failure, to comply with the required conditions set forth in the commencement. Although not satisfactory from this point of view, the experiment with the shuttle-wound armature and large pole-pieces forms an excellent piece of mechanism, where on switching on the current a very large movement or range and a strong pull or turning movement is required, as in the case of automatic signals, &c., for railway working.

Fig. 30 is a half-size drawing of field-magnets used in all experiments with a return magnetic circuit. The limbs and yoke are built of charcoal iron plates like transformer stampings No. 20 B.W.G., with a thin layer of varnished paper between each plate. The different pole-pieces were held in position by brass clips and wooden wedges, and the joints between the pole-

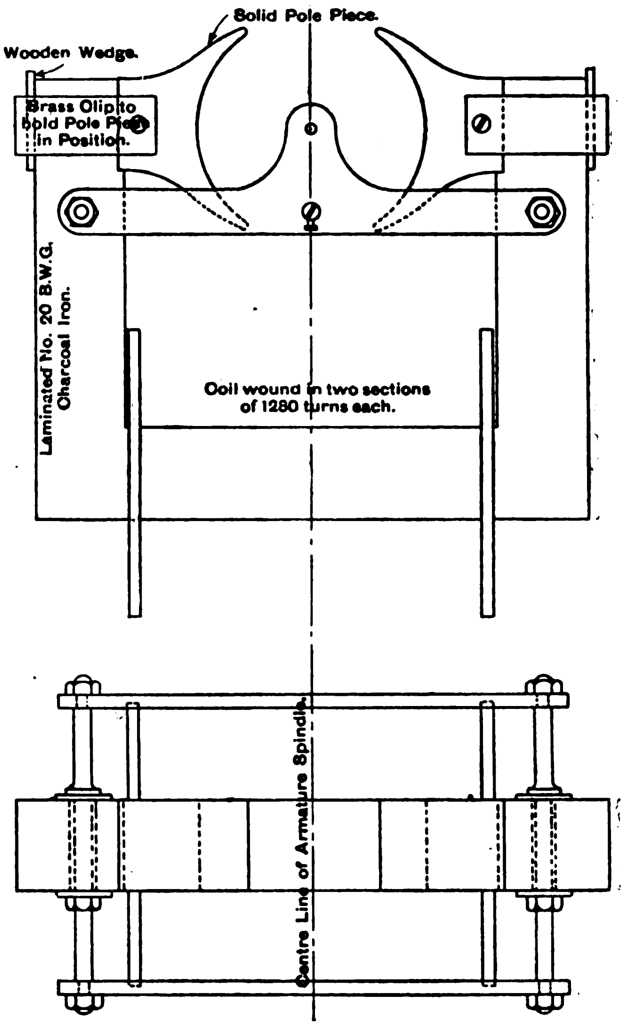
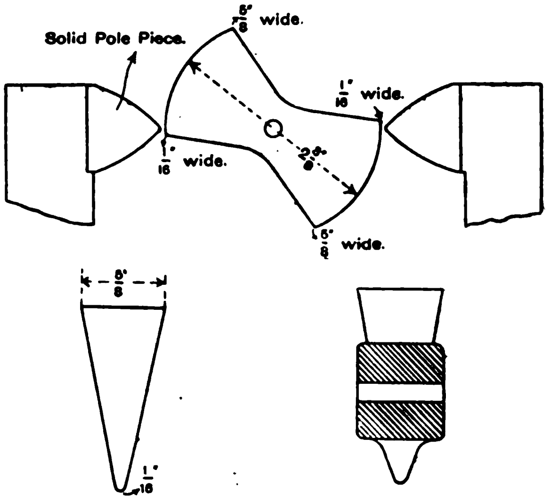


Fig. 30.

pieces and magnet limbs were carefully faced to insure good contact. The large pole-piece is shown in position in the drawing, and the remaining pole-pieces are shown in Figs. 31 and 32.



Surface of end of Armature. Section through centre of Armature.

Fig. 31.—Knife Edge Pole Pieces and Small Solid Iron Armature.

Two coils were wound on the yoke, each containing 1,280 turns No. 26 d.c.c. copper wire. It was found necessary to use one coil only, as when the two coils were coupled in series there were too many ampere-turns, consequently the inner coil,

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of 18 ω resistance, was used in all experiments. The armature bearings were carried by the bolts passing through and insulated from the limbs, and were made of brass.

The result of the first experiment is plotted on Fig. 33, curve *a*, and was obtained with the small solid iron armature and knife-edge pole-pieces. The armature was in the position

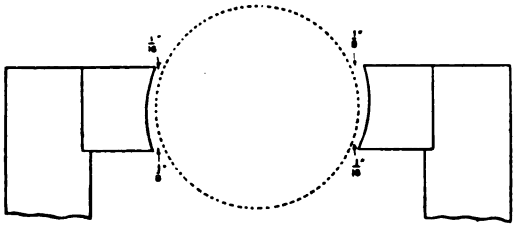


FIG. 32.—Oblique Approach Pole Piece.

shown in Fig. 31 when the pointer stood at zero. This relative position of armature and pole-pieces with the small and large armatures gave the best results, several other positions being tried. The spring in this position had an initial tension of 180deg., corresponding to a torque of 1·98 inch-ounces. Curve *b* (Fig. 33) is that obtained with the large solid armature under the same conditions as in curve *a*. The travel for a variation of

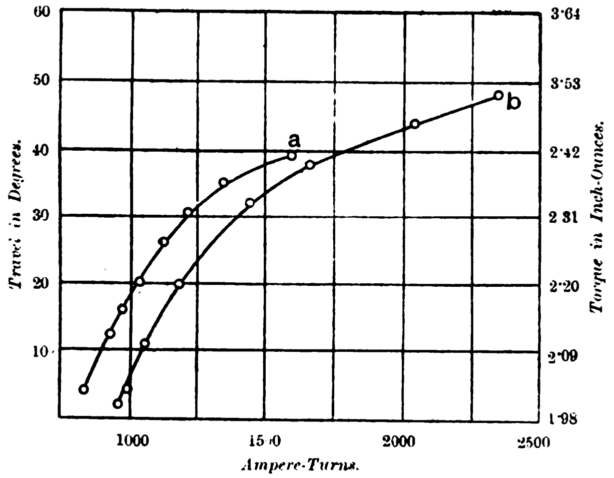
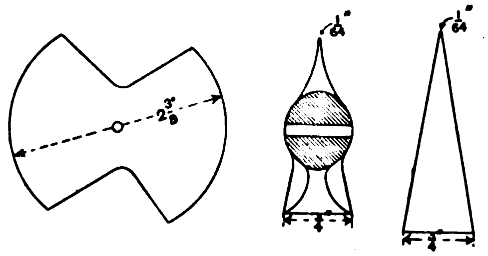


FIG. 33.

500 ampere-turns on the straightest part of the curve is 31deg. for both armatures; the maximum travel corresponding to maximum variation of excitation is 35deg. and 750 ampere-turns for the small, and 46deg. and 1,400 ampere-turns for the large armature. It would seem as if the travel of the armature was directly proportional to the length of the end surface of the armature. Of course, this is what one would expect, and it is fairly borne out by the above experiment.



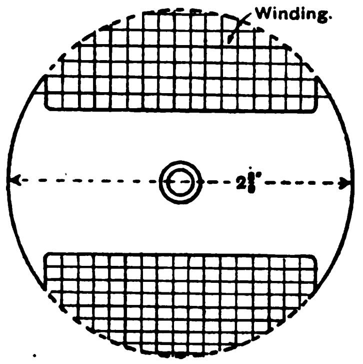
Section through centre. End surface of Armature.

FIG. 34.—Large Solid Iron Armature.

The armature used in the next set of experiments and shown in Fig. 35 was built up in a similar manner to the field-magnets, and had 500 turns of No. 26 d.c.c. wire wound in the space shown; the resistance of the winding was 6·5 ohms. The armature winding was coupled in series with the field-magnet coil, as in a series dynamo. The flat spiral spring used in the former experiments was used as a controlling force, and had an initial tension corresponding to a torque of 1·98 inch-ounces.

This armature was first tried with the knife-edge pole-pieces, and the curve obtained is given in Fig. 37A. The maximum travel for a variation of 1,500 ampere-turns was 25deg., and the curve is a fair approximation to a straight line.

The position of armature with respect to the poles is shown in accompanying sketch (Fig. 38). This position was found to give the best result.



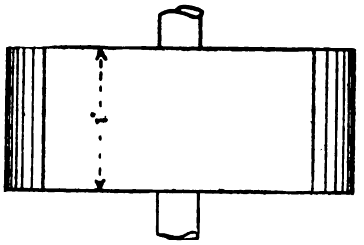
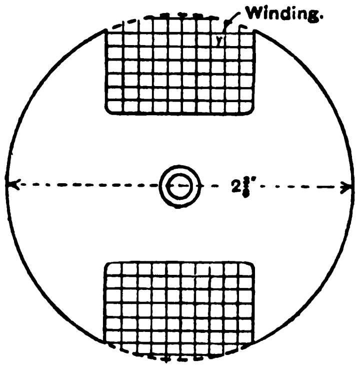


FIG. 35.—Wound Armature on Laminated Iron Core.

Next, the circular pole-pieces were used, and the two curves obtained are shown on Fig. 37, *b* and *c*. Inspection of these curves makes it apparent that the apparatus thus arranged is quite unsuitable for the purpose in view. Several positions of the armature with respect to the poles were tried, but that sketched (Fig. 39) gave the best results.



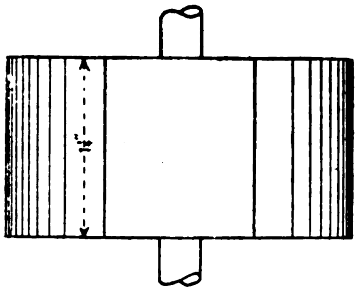


FIG. 36.—Wound Armature on Wooden Core.

In curve *b* the spring had the same tension as in *a*, and in *c* the tension was increased to give a torque of 3·96 inch-ounces at the start. In the curve *b*, for a maximum variation of 1,780 ampere-turns the travel was 77deg., while the useful or straight part is only 11deg. for a variation of 1,500 ampere-turns. The respective maximum values for *c* were 1,800 ampere-turns and

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74deg., while the useful travel was 6deg. for 1,500 ampere-turns variation.

Although this piece of mechanism is not suitable for our present purpose, it is obviously useful where on closing the circuit a long travel, combined with strength and quickness, is

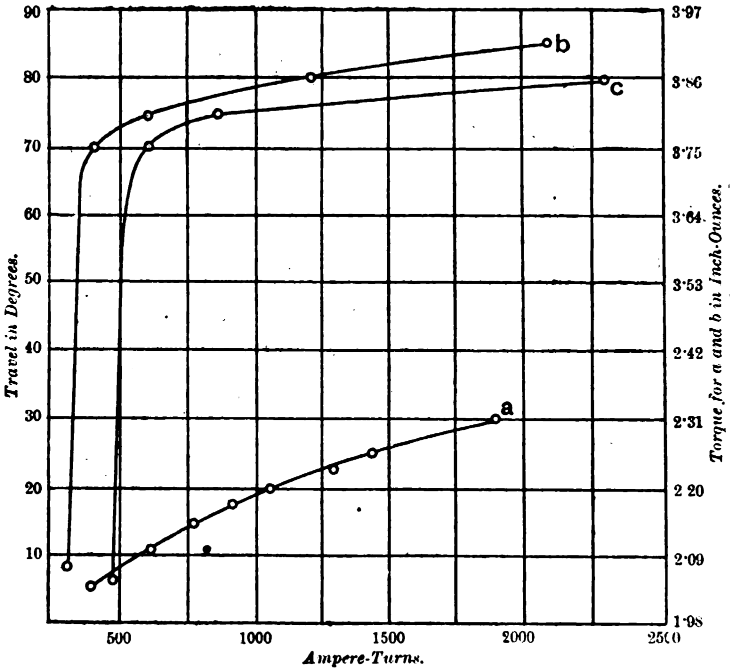

Fig. 37.

desired. The first part of both *b* and *c* curves makes this apparent, as a movement of 60deg. is obtained for a variation of 100 ampere-turns.

While experimenting with this armature and pole-pieces several positions were tried to obtain the best result as regards a rapid travel for minimum variation irrespective of the shape

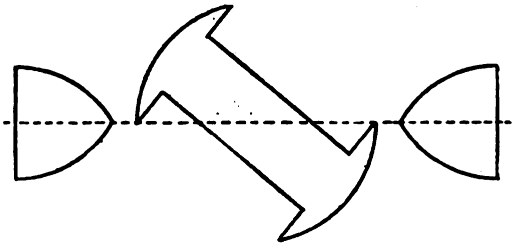

Fig. 38.—Position of Armature with respect to pole pieces when pointer was at 0.

of the curve; that sketched (Fig. 40) gave the best result with this particular armature and poles. With an initial tension corresponding to a torque of 1·98 inch-ounces the travel for a variation of 34 ampere-turns was 90deg.

In the last experiments made with this return magnetic circuit mechanism the wound armature with wooden core

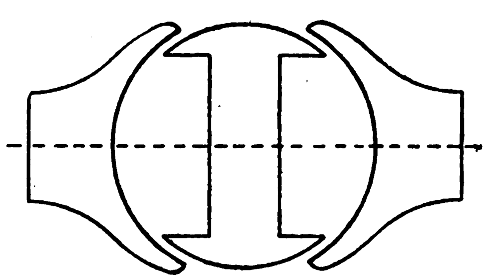

Fig. 39.—Position of Armature with pointer at Zero.

(shown on Fig. 36) was used. This armature was very similar to the last, but had not quite so much winding, having 500 turns of No. 26 d.c.c. copper wire and 6 ohms resistance. With the pointer at zero the spring had no initial tension, as experiment proved that the mechanism with this armature was not as strong as when the iron-cored armature was used. The curves obtained are given on Fig. 41, *a* and *b*; in *a* the knife-edge poles were used, and for a maximum variation of 1,700 ampere-turns the travel was 43deg.; in *b* with the circular poles the travel for the maximum of 1,750 ampere-turns was 96deg.

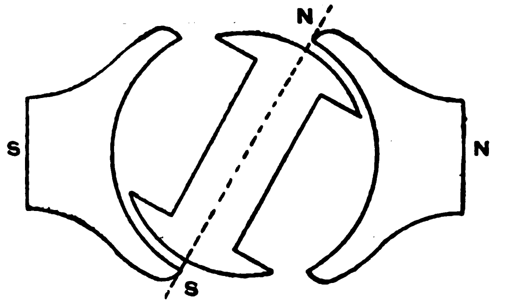

Fig. 40.

The useful travel in this case was 68deg. for a variation of 850 ampere-turns, as against 29deg. for the same variation in *a*.

The pole-pieces shown (Fig. 32) were tried, but the results were of no value, as the travel was insignificant. Mention is

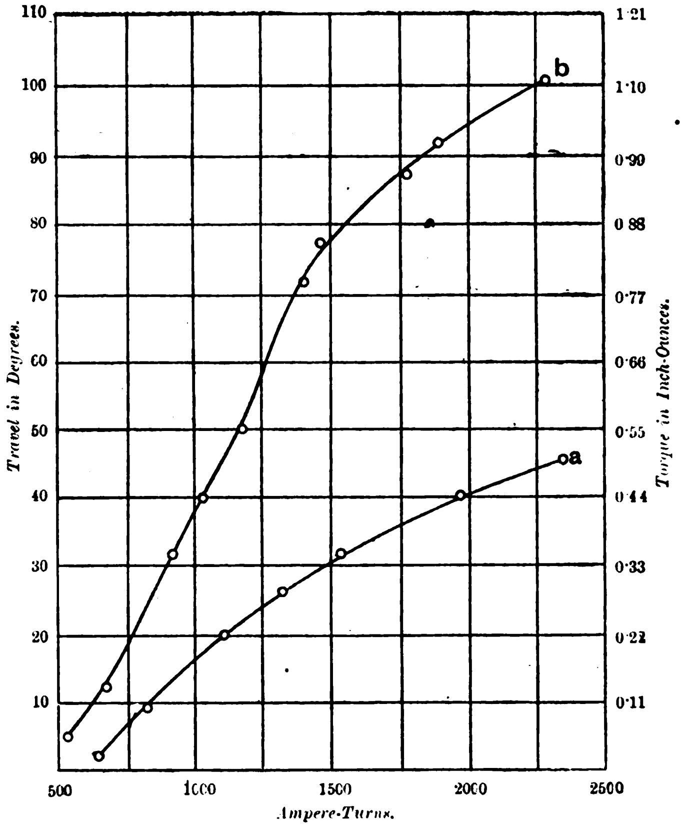

Fig. 41.

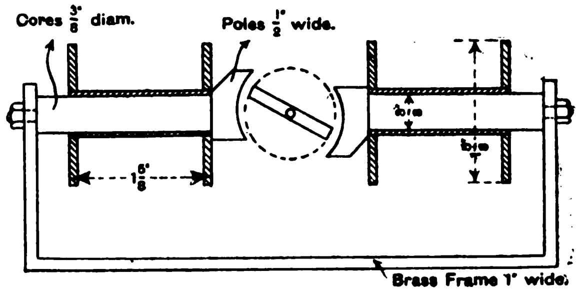

Fig. 42.

made of these poles, as the best results were obtained with the same shape without a return magnetic circuit.

In all the experiments with a return magnetic circuit the mechanism was very sluggish—*i.e.*, it did not respond to the alteration in the ampere-turns—and as this was one of the chief objects in view, the experiments that follow with an open

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magnetic were tried, and were, on the whole, the most successful from every point of view.

The first experiment tried was with the mechanism shown (Fig. 42), and needs very little explanation. Two round cores

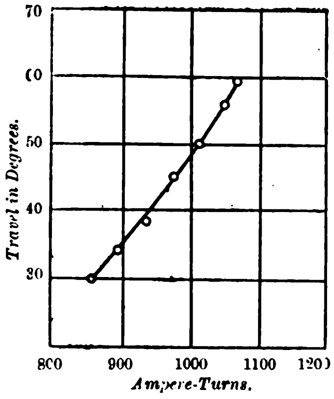
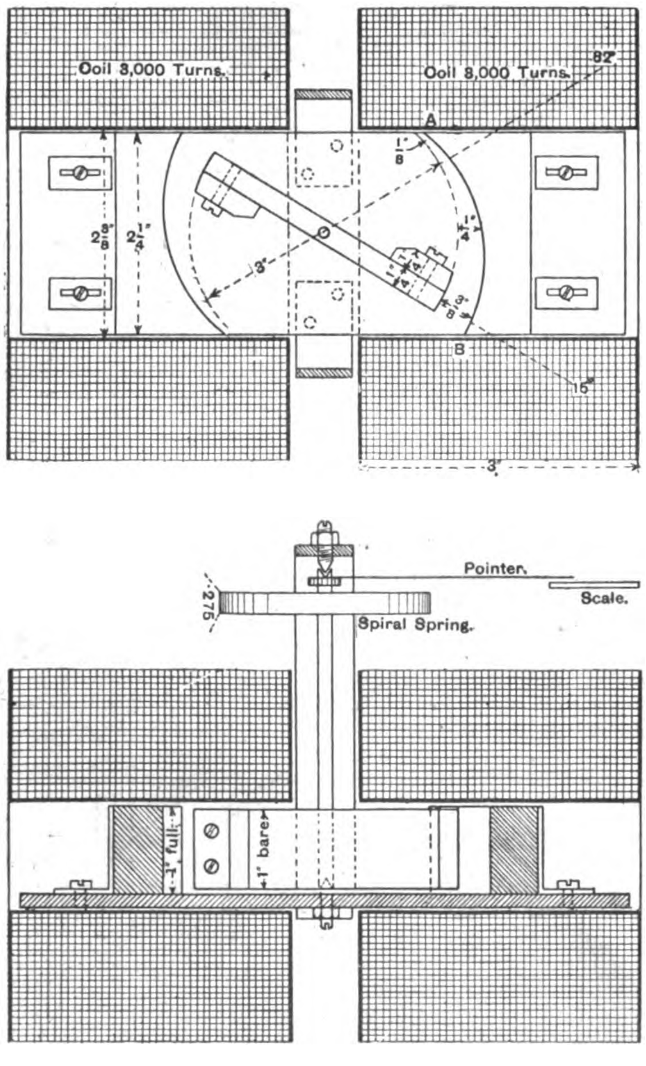


FIG. 43.

of Lowmoor iron $\frac{5}{8}$in. diameter had pole-pieces screwed on the ends, and were supported at the other ends by the brass bracket shown 1in. wide by $\frac{1}{8}$in. thick. To this bracket was screwed, at right angles, a smaller ⊔ bracket, having pivots which formed



Section through Centre.

FIG. 44.

the bearings for the armature spindle. The coils were slipped over the cores, and were wound with No. 32 platinoid wire, double-silk covered; each coil had 3,100 turns, and a resistance of 1,300 ohms. The controlling spring was arranged as in the last-mentioned experiments, and was very weak, being the mainspring of an ordinary lever watch. The pole-pieces were $\frac{1}{2}$in. wide by $\frac{3}{4}$in. long, and were bored out eccentrically to the centre of the armature spindle. The dotted circle (Fig. 42) is the path of the armature; the smallest air gap between the end of the armature and the pole was $\frac{1}{16}$in., gradually increasing to $\frac{1}{8}$in. at each side. It is evident that the mechanism worked on the principle of decreasing the air gap, and consequently the pole-pieces were so shaped that for each degree moved through by the armature the length of the air gap was decreased a proportionate amount. The armature was simply a piece of soft iron, $\frac{1}{2}$in. wide and $\frac{1}{8}$in. thick, with a spindle $\frac{1}{16}$in. diameter passing through, to which the pointer and spring were attached.

The curve obtained with this apparatus is given in Fig 43, and is almost a straight line; in fact, if the pole-pieces had been more accurately shaped on the lines laid down above, the curve would have been a perfectly straight line. For a variation of 210 ampere-turns the travel was 30deg., which is a far better result than any of the preceding. As to sensitiveness, the mechanism was as sensitive as the voltmeter.

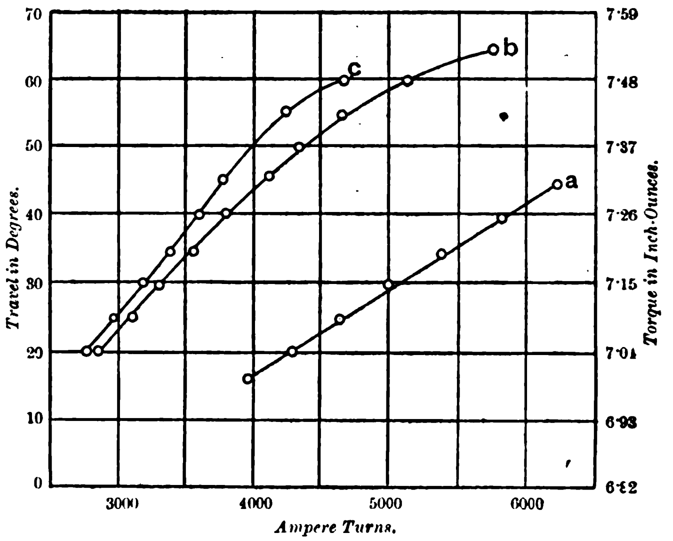


FIG. 45.

The result of this experiment was so encouraging that a much larger apparatus was made upon exactly similar lines, but the coils, instead of being wound on cores, were wound over the pole-pieces to save space.

The large open magnetic circuit mechanism is shown in plan and section through centre of the polar faces (Fig. 44). The armature was made of Lowmoor iron 1in. (bare) wide, $\frac{1}{4}$in. thick and 3in. diameter. The thickness of the armature could be increased to half-an-inch by the piece of iron shown held in position by brass screws. The armature was fixed to a spindle $\frac{3}{16}$in. diameter and supported vertically on pivots, as shown. The bottom pivot went through the brass base plate and the top through the brass bracket, to which the free end of the spiral spring was also secured. The pole-pieces were secured to the brass base plate by brass knees with slots to allow the length of the air gap to be varied. The poles were $2\frac{1}{4}$in. and 1in. (full) wide, and were bored out from two different centres, chosen so that the length of the air gap at A was $\frac{1}{8}$in. long and at B $\frac{3}{8}$in. long. Thus the length of the gap decreased in a ratio directly proportional to the angle turned through by the armature; the polar faces embraced an arc of 67deg., and in the middle, or 33·5deg. from B, the length of the air gap was $\frac{1}{4}$in. The coils were wound on copper bobbins, had an oblong hole $2\frac{3}{8}$in. by $1\frac{3}{16}$in. in the centre, and were slipped over the pole-pieces, the distance between the two coils being only $\frac{3}{4}$in. In this way the armature and poles were completely covered by the coils, and the waste lines of force were reduced to a minimum. Each coil had 3,000 turns No. 26 d.c.c. wire, and the total resistance warm was 143 ohms. When the outside edge of the armature was in line with the edge of the pole-piece at B the pointer stood at 82deg.; this enables the

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position of the armature to be followed in its course on reference to the respective curves.

The result of the first set of experiments with this piece of mechanism is given on Fig. 45, curves *a*, *b*, and *c*, and shows the effect of using different springs, also increasing the thickness of the armature at the extremities. In *a* the spring was ·183in. × ·0145in. × 24in. long, and in *b* the spring used before (·275in. × ·013in. × 36in.); in the former a maximum travel of 29 deg. for 2,200 ampere-turns, and for 2,000 ampere-turns the travel 26deg., the curve being a perfectly straight line; in *b* the maximum travel was 45deg. for 2,900 ampere-turns, and for 2,000 ampere-turns variation the travel was 38deg. (straight part of the curve). Increasing the width of the armature, as shown Fig. 44, and under exactly similar conditions to *b*, the travel in *c* was 40deg. for the same variation. Thus a better result was obtained by increasing the thickness of the armature.

The next and final experiment with this piece of apparatus was made with a view to determine the best degree of eccentricity of the air gap. The curves are given on Fig. 46, *a* and *b*, and are similar to *b* and *c*, Fig. 45, but the slightly longer travel is due to the curve starting earlier.

In *a* the maximum travel is 40deg. for a variation of 2,900 ampere-turns, and in *b*, for a variation of 2,400 ampere-turns, the travel is 40deg.; this increased travel is due to the armature

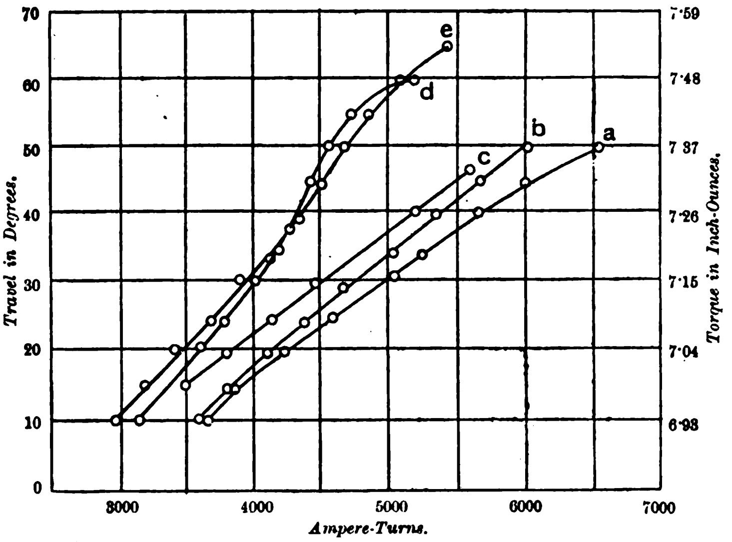

FIG. 46

being thicker. Taking the straightest part of the curve in both cases, for a variation of 2,200 ampere-turns the travel was 31deg. in *a* and 35deg. in *b*; from this it would seem that the thick armature was better suited for the purpose than the thin one.

In the curves *c*, *d*, and *e* the thick armature was used, and the distance between the armature and the pole-pieces was varied (at A and B, Fig. 44). In *c* the gap was $\frac{1}{8}$in. long at A and $\frac{3}{8}$in. at B. Here the travel was 31deg. for a variation of 2,100 ampere-turns, and the curve is a perfectly straight line. Changing the length to $\frac{1}{16}$in. at A and $\frac{5}{16}$in. at B, the travel was 50deg.; these lengths were then altered to $\frac{5}{16}$in. at A and $\frac{5}{16}$in. at B, and the travel was exactly the same for the 2,100 ampere-turns variation. Comparing the curves in *d* and *e*, we see that the curve *d* rises rather quickly when the armature is about the middle of its path; this seems to be due to the fact that the decrease in the length of the air gap was not proportional over the whole length of the travel, it being proportionately shorter at this point. The curve *e* is not quite a straight line, and the slight rise is due to the same cause. The length of the air gap was designed to proportionately decrease when it was $\frac{1}{8}$in. at A and $\frac{3}{8}$in. at B, and in this instance the curve is straight, although the travel is somewhat shorter.

It seems that by decreasing the length at A and increasing it at B, being careful that a proportionate increase was maintained from A to B, that a longer range and a perfectly straight line could be obtained. However, this was not tried, and the experiments here came to a close.

The results are tabulated (Table VI.), and require no further comment:—

Table VI.

Reference to curve.	Maximum travel in degrees	Maximum variation in amp.-turns.	Comparative travel and corresponding variation in ampere-turns.		Remarks.
			Travel.	Variat'n.	
Fig. 33 *a*...	35	750	31	500	Small solid armature and knife-edge pole-pieces.
b...	46	1,400	31	500	Large solid armature and knife-edge pole-pieces.
37 *a*...	25	1,500	25	1,500	Wound armature (iron core) and knife-edge pole-pieces.
b.	77	1,780	11	1,500	Wound armature (iron core) and circular-edge pole-pieces.
c...	74	1,800	6	1,500	Wound armature (iron core) and circular-edge pole-pieces (stronger spring).
41 *a*...	43	1,700	29	850	Wound armature (wooden core) knife-edge pole-pieces.
b..	96	1,750	68	850	Wound armature (wooden core) circular-edge pole-pieces.
43......	30	210	30	210	Open magnetic circuit eccentric pole-pieces (small apparatus).
45 *a*...	29	2,200	26	2,000	Open magnetic circuit eccentric pole-pieces (large apparatus).
b...	45	2,900	28	2,000	Open magnetic circuit eccentric pole-pieces (large apparatus).
c...	40	2,000	40	2,000	Open magnetic circuit eccentric pole-pieces (thick armature).
46 *a*...	40	2,900	31	2,200	Open magnetic circuit eccentric pole-pieces.
b...	40	2,400	35	2,200	Open magnetic circuit eccentric pole-pieces (thick armature).
c...	31	2,100	31	2,100	Open magnetic circuit eccentric pole-pieces, air gap $\frac{1}{8}$in. at A & $\frac{3}{8}$in. at B.
d...	50	2,100	50	2,100	Open magnetic circuit eccentric pole-pieces, air gap $\frac{1}{16}$in. at A & $\frac{5}{16}$in. at B.
e...	55	2,450	50	2,100	Open magnetic circuit eccentric pole-pieces, air gap $\frac{5}{64}$in. at A & $\frac{5}{16}$in. at B.

In conclusion, it may be said that the simple core and solenoid as arranged in the first experiment is not at all suitable where long range combined with strength and sensitiveness are required. There the weight of the core is supported by the magnetic field. This weight takes away a certain amount of the strength of the arrangement. It may be argued that the core could be supported and pull against a spring, but this arrangement makes the mechanism too bulky for most purposes. If a core and solenoid is used at all it seems from the results of the experiments on the circular-shaped cores and short coils that this form is more satisfactory, but to obtain a long range it is necessary to use a long core, and to keep the size of the mechanism within reasonable limits it is necessary to make the core embrace an arc of about 300deg.; then it acts like a heavy flywheel, and gives the arrangement so much inertia that it is not the least dead-beat, and although it may be sensitive to the variations in the excitation, the core does not settle down in its new position before another change in the ampere-turn takes place.

Coming to the arrangement with a return magnetic circuit, although possessing great strength for its size, the sluggishness of the mechanism makes it quite unsuitable for the purpose in view. The mechanism that embodies all the conditions laid down in the commencement, viz., maximum range, strength, and sensitiveness, for a minimum variation of excitation, is that with an open magnetic circuit and eccentric pole-pieces. In addition to the above this apparatus has the advantage of occupying less space,

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The Oldest Electrical Journal, 1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices.*

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NIAGARA.

The flow of verbiage that has signalised the electrical utilisation of the Falls of Ni-a-gá-ra has been in keeping with the proportions of the biggest cataract on earth; would that the word-fall were as impressive as the water-fall. The English tongue gave way beneath the strain, and many effusions that were meant to be choice specimens of declamatory rhetoric resembled nothing so much as the mouthings of a foreigner in the throes of a new language. "I sometimes think," remarked a *Fortnightly* reviewer some ten or twelve years ago, "this nineteenth century, with its material progress and its mechanical inventions, its steam and its electricity, gas and patents, is being treated by the Press and its other public admirers much as the chamberlains in *Zadig* treated the Satrap. The century is hardly awake of a morning before thousands of newspapers, speeches, lectures and essays appear at its bedside, or its breakfast table, repeating as in chorus: 'Que son mérite est extrême! Que de graces! que de grandeur!' Surely no century in all human history was ever so much praised to its face for its wonderful achievements, its wealth and its power, its unparalleled ingenuity. . . . . . ." It was into some such frame of mind as this that the perpetual cataract of congratulation anent the engineering feat performed at Niagara had worked us, when we found our table groaning one morning beneath the weight of the Niagara Power Number of *Cassier's Magazine*, and with visions of yet another wearisome "cantata in honour of the age of progress," envied the table the freedom with which it could give vent to its feelings. The very first paragraph on the very first page confirmed our worst fears. "To souls sensitive to the beautiful and the sublime the plunging torrent," says Mr. FRANCIS LYNDE STETSON, "has appealed, by the stateliness of its stream, the brilliance of its boisterous rapids, and the deep glassy green of its silent foreboding brink, as well as by its drop into the seemingly infinite depth, from which there comes to him who listens the note of the welcoming abyss, deeper than the diapason of any organ's pipe."

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The conception of an engineering magazine—at any rate the successful execution of the idea—must be placed to the credit of our good friends across the Atlantic. We all read nowadays—even the most rigid of "practicians"; and the generality of engineers like to know something of what is going on in those branches of the profession of which they have no special knowledge. And this not necessarily with a view of immediately or ultimately converting even light reading into hard cash, but mainly to keep in touch with the advance of each division of the Grand Army of Engineers—a touch which it is extremely difficult to maintain in these busy days, with observations accumulating like cinder heaps in the Black Country, and each man fencing in his little field of knowledge like a workman's allotment, and sticking up a notice to warn off intruders. To assist in keeping up this touch the engineering magazine has been evolved, and if the Niagara Power Number of *Cassier's* be a criterion, right well is the purpose answered. The purveyors of popular science and the writers of scientific romances are ever in danger of missing the mark either by writing far over the heads of those whom they propose to instruct or interest, or by wearying with prolix and unnecessary exposition. The difficulty experienced by the ancients in steering between Scylla and Charybdis is as nothing to that experienced by would-be popularisers of science. On the whole, we would advise them to err, if err they must, on the side of assuming a too considerable learning on the part of their prospective readers. It is flattering to one's self-esteem to be thought capable of understanding an argument or description, not a line of which is in truth comprehended. As an eminent transatlantic inventor and enthusiast once said of the, to him and to most of us, quite unintelligible lucubrations of a famous English mathematical physicist: "It does one good to be seen in their company." On the other hand, except it be a feeble and obvious witticism laboriously explained, we cannot imagine a greater insult to human intelligence than an elaborate explanation which could only have been offered on the assumption that the recipient thereof was devoid not only of understanding (that might pass), but of an elementary scientific education (that is unpardonable). Now in this matter writers in engineering magazines possess a decided advantage. They can gauge with the accuracy of a Whitworth machine the receptive capacities of their probable readers. All engineers—electrical, mechanical, civil, hydraulic and marine—at any rate start in life with much the same educational equipment; possessing some acquaintance with physical science and mathematics, and some years' experience of the workshop and drawing office. This much assumed, and the further assumption made that an article in an engineering magazine will not usually be read by experts in the particular subject treated of, but will be read by engineers of another branch, or by well-informed engineering amateurs, it would argue considerable mental myopia if the mark were often missed. In the special number to which we have alluded, the mark has been hit with unusual frequency. With scarcely an exception, the ten articles here offered up on the altar of Ni-a-gá-ra are restrained in tone, lucid in language, coherent in treatment, and illustrated, for the most part, by illustrations that illustrate. Benthamite principles have prevailed in the composition of this cantata of congratulation; the financial engineer, the hydraulic engineer, the electrical engineer, the sanitary engineer, not to mention the historically-inclined engineer, has each his allotted section; the greatest happiness of the greatest number has evidently been kept in view. The longest and by far the most interesting contribution is that by Mr. L. B. STILLWELL, of the Westinghouse Company. It is a model of what such an article should be, and, moreover, gives due recognition to the fact that the Niagara electrical plant did not spring full-matured and freshly-original from the brain of the great Pittsburg concern. There are, no doubt, many details which electrical engineers must have wished rather than have expected to see; but notwithstanding the omission of these, with the possible exception of one or two experts in big dynamo design, all electrical engineers may glean much valuable information from Mr. STILLWELL's excellent account of the plant he played such a prominent part in constructing.

Criticism of a *fait accompli*, especially when it is of an engineering order, is somewhat futile, and we do not propose to indulge in it. The Cataract Construction Company is composed of shrewd capitalists, who had the best engineering advice,—indeed, it was a matter of reproach against them that they sucked the engineering brain of Europe,—the whole work has been carried out by the best firms in the United States. It were best, therefore, to leave it to Time to justify or to condemn the general principle and engineering details of a scheme upon which such an array of talent has been concentrated. Evident it is, however, that extreme forethought characterised the general plan of the Cataract Construction Company, and extreme care and skill characterised all constructional details. Success has been deserved, even if it has not been attained.

Speculation as to what will be is perhaps scarcely more to be commended than criticism of what has been accomplished; but the revolutionary potentialities revealed by the electrical utilisation of Niagara, and the vein of five-per-cent. philanthropy running through so much of the literature concerning it, make it impossible to avoid at least a glance at the future. At the first annual dinner of the Institution of Electrical Engineers, in November of 1889, the Marquis of SALISBURY, in the course of a speech full of wit and wisdom, expressed a hope that electrical engineers, by their discovery of the electrical transmission of power, would do something towards scattering those "unnatural and often unwholesome aggregations of humanity" brought about by the mechanical engineer's discovery of the steam engine. Should the Niagara scheme develop to the extent anticipated by sanguine, but sober practical engineers like Mr. S. DANA GREENE of the General Electric Company, and should small-scale reproductions of Niagara spring up wherever possible, Lord SALISBURY's vision of men and women pursuing in their own homes many industries now requiring the aggregation of the factory, might well be within measurable distance of of realisation. The long-headed founders of the Niagara Falls Power Company, however, contemplate no such contingency. They have indeed constructed a 20th-century Utopia out of very unpromising materials and called it Echota, which being interpreted means "Place of Refuge," but although they are prepared for such an innovation as a healthy, pretty, clean, clear-aired, industrial town, the factory system is still to be supreme. Electricity, if it succeeds in effecting even such a comparatively moderate improvement as this, will have done an appreciable something in redressing the evils brought about by steam. The interesting question is whether factories and factory towns, when deprived of their soot and squalor, may not prove sufficiently satisfactory to those gathered within them to exclude all wish for the realisation of Lord SALISBURY's dream. Its realisation would in any event prove economically difficult: without the motive power of misery it might be impossible. The half-way house will have been made so comfortable that no one will want to continue the journey.

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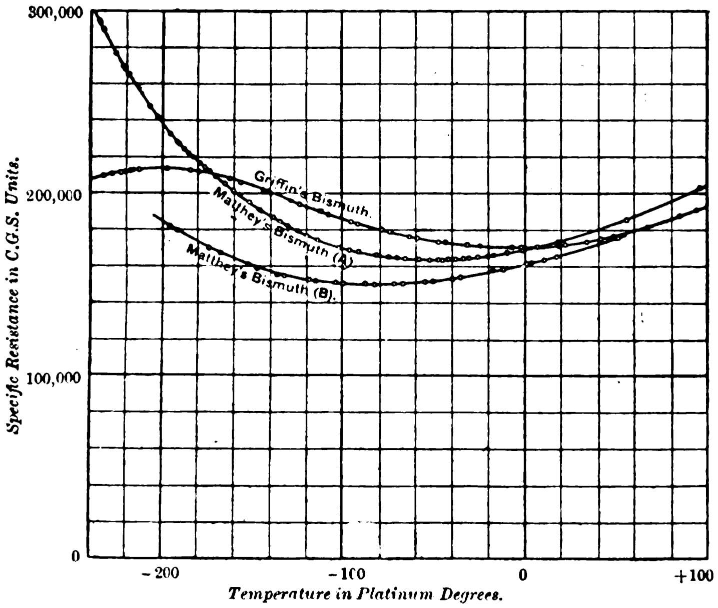
THE VARIATION IN THE ELECTRICAL RESISTANCE OF BISMUTH, WHEN COOLED TO THE TEMPERATURE OF SOLID AIR.*

BY PROF. JAMES DEWAR, F.R.S., AND PROF. J. A. FLEMING, M.A., D.SC., F.R.S.

In the course of investigations on the electrical resistance of pure metals and alloys at low temperatures made during the years 1892 and 1893, the results of which were communicated to the *Phil. Mag.*,† extensive examination was made by us of the variation in specific electrical resistance exhibited by most of the ordinary metals when cooled to temperatures approaching the absolute zero. In the course of this research the abnormal behaviour of bismuth with regard to its variation of specific resistance with temperature was noted, and in a further research on the thermo-electric powers of metals and alloys at low temperatures, the results of which were communicated to the *Phil. Mag.* recently,‡ it was noticed that the curves representing the thermo-electric power of bismuth, both for pure and for commercial specimens, presented a discontinuity at temperatures lying between about −70deg. and −100deg. We were therefore recently led to make a more careful examination of the variation of electrical resistance of bismuth when cooled down to the temperature of solid air, some of the results of which are of sufficient interest to communicate, although the investigation is still in progress, and much remains to be done to complete it.



The Variation of Electrical Resistance of Bismuth with Temperature.

A sample of very pure bismuth was kindly prepared for us by Mr. George Matthey, by the reduction of the oxide, an analysis of which showed very small traces of iron as the only impurity. This bismuth, which was the same as that used by us in our thermo-electric experiments, was pressed into wire by a steel press, two sizes of wire being prepared, one having a diameter of about 0·067cm., and the other a diameter of 0·049cm. Lengths of these wires were mounted up in an appropriate form for taking the electrical resistance when measured in liquid or in solid air, or at any other temperature up to +100°C.

Amongst other specimens a wire was pressed from some commercial bismuth, supposed to be fairly pure, which will be distinguished by being called Griffin's bismuth; the diameter of this last wire was about 0·066cm. The diameters of these wires were carefully measured with a microscope-micrometer in about twenty different places, the lengths of the wires used being about 30cm. or 60cm. The sample of pure bismuth prepared for us by Mr. George Matthey will be distinguished by speaking of it as Matthey's bismuth, the thicker of the two wires being called A and the thinner B. The dimensions and mean diameters of the pressed wires, which were used just as they came from the press, were as follows:—

Sample.	Length. Centimetres.	Mean diameter. Centimetres.
Matthey's bismuth (pure), A	61·25	0·06713
Matthey's bismuth (pure), B	32·70	0·04926
Griffin's bismuth	52·90	0·06625

In addition to these samples of pressed wires, other specimens were prepared by drawing melted bismuth up into fine glass tubes and making a suitable connection with the bismuth for the purpose of an electrical resistance measurement by means of tinned copper wires melted in to the ends of the bismuth specimen. These samples of bismuth then had their electrical resistance measured with a Wheatstone bridge in the usual way, the temperature of the specimen being taken at the same time by means of a platinum thermometer, consisting of a platinum wire closely in contact with the specimen of bismuth. All the temperatures which are given in the following paragraphs have been converted into platinum temperatures, taken in terms of our standard platinum thermometer P_1, the electrical constants of which were given by us in the Paper on the Thermo-electric Powers of Metals (see *Phil. Mag.* July, 1895). Temperatures so measured are distinguished by the letter P_1 placed after the number denoting the temperature. The electrical resistance of the bismuth specimens, all proper corrections being made for the resistance of the connecting wires, was taken at a large number of temperatures lying between the boiling-point of water (100°C.) down to the temperature of solid air, which, in terms of our standard platinum thermometer P_1 is about −233deg. P_1 to −235deg. P_1. From the known dimensions of the bismuth wires the volume specific resistance of the metal was calculated at these different temperatures.

The above numerical results are set out in the form of three curves. It will be seen that the specific electrical resistance of all the bismuth specimens taken from 100°C. downwards gradually diminishes to a point which, in the case of the specimen of pure bismuth "A" was about −50deg. P_1, and in the case of the specimen "B" about −83deg. P_1. After these temperatures had been reached, further cooling *increased* instead of diminishing the electrical resistance of the A and B bismuth, until, at the lowest temperature reached by the employment of large quantities of solid air, the electrical resistance of the specimen "A" had become increased by nearly 80 per cent. of its minimum resistance, and at the same time the mean temperature coefficient had become very large, and of course negative.

It may be noted that the melting point of solid air, as determined by our standard platinum thermometer, is −232·2deg. P_1, liquefaction taking place under a pressure of 14mm. of mercury. The boiling-point of liquid air under a presure of 746mm. is −209·75deg. P_1.

The same general facts were observed in the case of the specimen of pure bismuth "B," only in this instance the temperature was not taken below about −200deg. P_1. As regards the commercial bismuth (Griffin's) the curves show that after reaching a minimum point, which for that specimum appears to occur at about 0°C., there is another point of inflection in the resistance curve in the neighbourhood of −200deg. P_1, after which the resistance again diminishes.

In the case of each of these specimens the resistance measurements were repeated many times, and in both directions, to obtain an assurance that the relation of resistance and temperature was perfectly definite, and that proof might be obtained that all the three specimens of pressed bismuth wire, as well as the bismuth melted in the tubes, did not undergo any permanent change in their condition by the action of the low temperature, but that there was a definite relation between temperature and electrical resistance in the manner shown in the curves.

Similar experiments made with pure antimony drawn up into glass tubes did not show the appearance of any minimum resistance for any temperature between 0° and −200° P_1. In no other case amongst all the metals and alloys examined by us has any phenomenon presented itself similar to that shown by the above specimens of pure bismuth. So far, therefore, at these investigations have gone they show that the behaviour of bismuth at low temperatures in respect of electrical conductivity is anomalous. The temperature-resistance curves of these specimens are quite different to those of other pure metals.

In our first communication on the electrical resistance of metals (see *Phil. Mag.*, October, 1892), we showed that carbon taken in the form of a carbon filament from an incandescent lamp increases its resistance continuously when cooled down to the boiling point of oxygen, and we suggested that for pure non-metals continual lowering of the temperature towards the absolute zero would in all probability continually increase the specific electrical resistance. In

* From the *Phil. Mag.*, September [Abstract].

† *Phil. Mag.*, 1892, Vol. XXXIV., p. 326, "On the Electrical Resistance of Pure Metals, Alloys, and Non-Metals at the Boiling-point of Oxygen;" also *Phil. Mag.* 1893, Vol. XXXVI., p. 271, "The Electrical Resistance of Metals and Alloys at Temperatures approaching Absolute Zero." See also *The Electrician*, Vol. XXIX., p. 611, and Vol. XXXI., p. 529.

‡ *Phil. Mag.*, July, 1895. "Thermo-Electric Powers of Metals and Alloys between the Temperatures of the Boiling-point of Water and the Boiling-point of Liquid Air." See *The Electrician*, July 12, p. 365,

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the specimens of pure bismuth A and B there is no indication at the lowest temperature reached, - viz., 235° P_1, that the resistance lines for this pure bismuth would have another point of inflection. If, then, the specific resistance of these samples of pure bismuth goes on increasing continuously down to the absolute zero of temperature, as it would appear to do, in that respect they behave like a non-metal, having, however, a very much larger temperature coefficient than carbon.

The behaviour of bismuth in a magnetic field in regard to electrical resistance, and also the fact that different specimens of bismuth have in some cases positive and in other cases negative coefficients at temperatures above 0°C., has been examined by other observers. Without entering into any historical statement of the course of investigation in this matter, brief reference may be made to two Papers on this subject which have a bearing on the facts here described by us. In 1886 an experimental study of the influence of magnetism and temperature on the electrical resistance of bismuth, and also of its alloys with lead and tin, was described by M. von Aubel (see *Phil. Mag.*, 1888, 5th series, Vol. XXV., p. 191). He studied the electrical resistance of certain specimens of pure bismuth in the form of rods slowly cooled, and for temperatures between 17·2°C. and 70·8° C. found a negative coefficient for some of these specimens. In the case of rods of pure bismuth, which had been tempered between temperatures 15·2°C. and 69·7°C., he found a positive temperature coefficient within these limits; that is to say, in the first case heating the bismuth decreased its resistance, and in the second case heating the bismuth increased its resistance between the stated limits of temperature. In none of the samples of bismuth examined by us have we found a negative temperature coefficient for temperatures above 0°C. For a certain specimen of compressed bismuth wire M. von Aubel found the resistance practically constant between 16·8°C. and 76°C.; but on melting, cooling, and annealing the same specimen it acquired a positive temperature coefficient between these limits. M. von Aubel examined the electrical resistance of certain bismuth-lead-tin alloys, and he came to the conclusion that the cause of these anomalies in the temperature coefficient of bismuth was the varying physical condition of the bismuth, and not the presence of impurities.

In 1894 Mr. J. B. Henderson published a Paper on "The Effects of Magnetic Fields on the Electric Conductivity of Bismuth" (see *Phil. Mag.*, 1894, 5th series, p. 488), and he gives a series of curves showing the temperature variation of bismuth when taken in magnetic fields of different strengths. For a certain specimen of bismuth wire, and for a certain magnetic field strength of about 10,000 C.G.S. units, his curves indicate a point of minimum resistance for the bismuth. Taking the bismuth at a certain temperature, the temperature coefficient at that point in a zero magnetic field was found to be positive; but on gradually increasing the strength of the magnetic field in which the bismuth was immersed the temperature coefficient finally became negative.

One point of interest, then, in connection with these investigations is whether the specific resistance of bismuth always presents a minimum value, and whether the temperature at which this minimum value occurs depends upon the strength of the magnetic field in which the bismuth is immersed as well as upon the physical condition of the metal. In the case of the two wires of pure bismuth "A" and "B" used by us, the diameters of the wires were different, and the pressures under which they were formed, and therefore the physical condition in the interior of the wire was no doubt also different. Hence, although both these wires present a point of minimum electrical resistance, the temperature at which this occurs is not identically the same. Another point of interest is that the temperature at which a discontinuity was found by us in the thermo-electric line of the pure bismuth, and which was found to be about −80°C., is also approximately the point at which the resistance-temperature coefficient of the same bismuth becomes sensibly negative. It is therefore clear that at this temperature a critical point is reached for this particular sample of bismuth, and below this point the bismuth undergoes a physical change which affects its thermo-electric value as well as its resistance-temperature coefficient. These investigations indicate that the electrical behaviour of bismuth in certain states at and below particular temperatures is irregular, and that further study is necessary to arrive at a complete explanation of the facts. It has been pointed out by one of us (*see* Friday Evening Discourse at the Royal Institution, by Prof. Dewar, "On the Scientific Uses of Liquid Air," January 19, 1894; see also *The Electrician*, July 12, 1895, p. 361) that the tensile strength of very many metals is greatly increased by cooling them down to the temperature of liquid oxygen, but that there is a very marked decrease in the tensile strength of bismuth, as well as of antimony and some other metals when taken down to the same low temperature. It is interesting to note that bismuth, which, at any rate in certain states, presents the anomaly of a discontinuity in its curve of thermo-electromotive force at a certain low temperature, has also at about the same temperature a change of sign of the temperature coefficient, and becomes, in addition, exceedingly brittle below that temperature.

In an interesting Paper on "The Mechanism of Electrical Conduction" (see *Phil. Mag.*, Ser. 5, 1894, Vol. XXXVIII., p. 57), Dr. C. V. Burton makes reference to our former experiments on the resistance of pure metals, and states and proves a theorem to the effect that at the absolute zero of temperature every substance must have either infinite specific resistance or infinite conductivity. In the samples of bismuth A and B we have before us a material which exhibits, as far as we can judge, a tendency in its specific resistance to continually increase as it is cooled to temperatures lying below about − 80deg. In this respect it resembles a non-metal, and the question arises whether this is the proper characteristic behaviour of pure bismuth, or whether in any other physical condition it would show the normal quality of pure metals in decreasing its specific resistance regularly as it is cooled towards the absolute zero. With the object of ascertaining this we have also tested some very pure bismuth kindly sent to us by Mr. Edward Matthey, and which was prepared by the reduction of the oxychloride. This being pressed into wire was found to give a resistance-temperature curve very similar in general form to that marked Griffin's bismuth. The resistance decreased down to about 0°C., and then increased again when cooled to about −160°, and finally decreased again. It is clear, therefore, that the specimens of bismuth—viz., that prepared for us by Mr. George Matthey from the oxide, and that prepared by Mr. Edward Matthey from the oxychloride, and which are both very pure—behave quite differently at very low temperatures with regard to their electrical conductivity. We have also examined the variation of a sample of bismuth prepared electrolytically, but the result of this examination we reserve until the observations have been confirmed on other samples of electrolytic bismuth.

One fact of considerable interest has presented itself in studying the action of a magnetic field on the electrical resistance of bismuth cooled to low temperatures. It is well known that the electrical resistance of bismuth is increased by being immersed in a magnetic field. Taking a sample of the pure (Matthey) bismuth wire, we measured its electrical resistance at 18°C. in the earth's field, and when placed transversely in the field of an electromagnet, and found an increase of resistance due to the field in the ratio of 1·361 to 1·434, or about 5 per cent. The same sample was cooled in liquid oxygen, and measured again in the same fields. The resistances were then in the ratio of 1·478 to 1·858. The increase in resistance in this last case is nearly 25 per cent. Hence the cooling of the bismuth to − 182°C. increased the effect of a given magnetic field in altering its resistance about five times.

Another experiment was made to ascertain whether increased pressure on the surface of the bismuth affected its resistance. When a sample of pure bismuth wire was subjected to an external surface pressure of 300 atmospheres, a very slight but definite increase of resistance was found, which disappeared instantly on removing the pressure.

The above-described observations show that there is a very marked difference between different samples of bismuth as regards electrical resistance when subjected to very low temperatures, and that its behaviour at these temperatures in magnetic fields is also abnormal. We propose to reserve further remarks on this subject until we have completed the experiments in progress on electrolytic bismuth. We expect then to be able to state the results obtained for specimens of bismuth of known chemical purity, and to distinguish between those effects which are due to physical condition and those, if any, arising from the presence of minute traces of impurity.

ELECTRO-DEPOSITION OF BRASS.*

BY FRANK SUTTON.

The first part of the Paper deals with the general theoretical considerations involved in electro-deposition, and with the calculation of the E.M.F. required from thermo-chemical data. The author then proceeds to recount the experiments which were carried out in the electrical engineering department of the Columbia College, and gives the methods employed for determining the resistance of the baths. Tables and curves are given. The baths employed were as follows:—Mixtures of zinc sulphate and copper sulphate solutions in equal and unequal proportions, copper sulphate and zinc chloride in the proportion of 100 copper to 60 zinc, a solution of equal parts copper acetate and zinc chloride, and equal parts of copper acetate and zinc acetate. These baths were all composed of half saturated solutions, and the only one that gave a deposit looking like an alloy was the last. But the author points out that the heats of formation of the two acetates, although nearer than those of the other salts employed, were still too far apart. A saturated solution of the cyanides of copper and zinc was then tried, and gave good results, as the heats of formation of the two

* Abstract from *Electric Power* of New York.

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salts are very nearly the same. A cyanide brassing solution, used commercially, was also tried, and gave a good deposit, but not equal to that obtained from the solution prepared from pure material. The resistance of the latter was also lower.

With reference to the conditions under which copper and zinc will alloy, the author points out, in conclusion, that the local action, that is, back currents caused mainly by the counter E.M.F., tends to work towards the surface of the solution, and that this counter E.M.F. is different for alloys that are deposited from the solution, being higher for an alloy that contains more of that metal whose salt solution has the higher E.M.F. This counter E.M.F. not only depends on the solution, but also on the alloy. The alloy deposited depends upon the initial E.M.F. As the impressed E.M.F. is increased the alloy will change its proportions, these proportions depending on the velocities of the migration of ions in different salts. The amount of zinc increases directly with the initial E.M.F., and finally reaches a point where more of it is deposited than of copper. The best alloys are obtained when the initial E.M.F. exceeds the counter E.M.F. by a small amount. As the initial E.M.F. is increased the counter E.M.F. will increase, but at a much reduced rate, and this rate decreases so much that when the initial is very high the counter is negligible. Now this counter E.M.F., although it does cause a certain amount of energy to be lost, may be considered a help as far as electro-plating work is concerned, as it really throttles the current, and keeps the ions from combining too rapidly.

A THEORY OF THE SYNCHRONOUS MOTOR.*

BY W. G. RHODES, M.SC.

1. Several foreign writers, notably Steinmetz,† have given theories of the synchronous motor, but most of them, by failing to see how the analysis could be simplified, add to the difficulties of the theory by mathematical intricacies which are apparently quite unnecessary. The author offers the following attempt to present a theory of the synchronous motor in as simple a way as possible, and as the mathematics, for the most part, consist of simple algebra, the difficulties are reduced to a physical conception of the subject. Many of the results have already been obtained, and the part for which the author chiefly claims originality is the method of attacking the problem.

2. We consider the case of an alternating-current machine whose field is excited by a direct current, while a simple alternating current passes round the armature.

Let p = output of motor;
c = virtual value of armature current;
R = resistance of armature;
E = virtual value of impressed E.M.F.;
e = ,, ,, counter E.M.F. of motor;
L = coefficient of self-induction of armature;
n = frequency of armature current;
I = impedance of armature = $\{R^2+(2\pi n L)^2\}^{\frac{1}{2}}$;
S = reactance = $2\pi n L$;
ψ = phase difference between c and E;
ϕ = ,, ,, ,, c ,, e;
θ = ,, ,, ,, c ,, Ic.

Then the input $= p + c^2 R$;
and also $= c E \cos\psi$;
therefore $p + c^2 R = c E \cos\psi$.

Solving for c we get

$$c = \frac{E}{2R}\cos\psi \pm \frac{1}{2R}\sqrt{\{E^2\cos^2\psi - 4pR\}} \quad . \quad . \quad (1)$$

Since c is always real, we must have

$$E^2\cos^2\psi \geqq 4pR;$$

therefore the maximum value of p is

$$p = \frac{E^2}{4R} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This occurs when $\psi = 0$; that is, when the current and the impressed E.M.F. are in phase with each other.

We notice that the maximum output is the same as the maximum energy which can be given to an external circuit by a generator of constant E.M.F. E. From (1) we get the corresponding value of the current

$$c = \frac{E}{2R}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

3. To find the corresponding value of e we notice that E, e, Sc and Rc reversed are in equilibrium amongst themselves; so that taking components of these along and at right angles to the direction of E, we have

$$\left.\begin{aligned} e\cos\phi &= E - Rc \\ e\sin\phi &= Sc \end{aligned}\right\};$$

and

therefore

$$\left.\begin{aligned} e\cos\phi &= 2Rc - Rc = Rc \\ e\sin\phi &= Sc \end{aligned}\right\}, \text{ from (3).}$$

and

Squaring and adding, we get

$$e^2 = (R^2+S^2)c^2 = I^2c^2;$$

therefore

$$e = Ic = \frac{IE}{2R}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Also, by division,

$$\tan\phi = \frac{S}{R} = -\tan\theta \text{ (see Fig. 1).}$$

4. We thus find that when working at maximum output:—

(1) The impressed E.M.F. is in phase with the current in the armature.

(2) The maximum output is $p = \frac{E^2}{4R}$.

(3) The corresponding current in armature is $c = \frac{E}{2R}$.

(4) The corresponding counter E.M.F. is $e = \frac{IE}{2R}$.

(5) The angle of phase between the armature current and the E.M.F. necessary to overcome the resistance and self-induction of the armature is equal and opposite to the angle between the current and the counter E.M.F.

(6) Also from (4) we see that

$$e \gtreqless E \text{ according as } I \gtreqless 2R,$$

$$\text{that is, according as } (2\pi n L)^2 + R^2 \gtreqless 4R^2,$$

$$\text{,, \quad ,, \quad } L^2 \gtreqless \frac{3R^2}{4\pi^2 n^2},$$

$$\text{,, \quad ,, \quad } L \gtreqless \frac{R\sqrt{3}}{2\pi n}.$$

Running Light.

5. We have

$$\left.\begin{aligned} p + c^2 R &= cE\cos\psi \\ p &= ce\cos\phi \end{aligned}\right\}.$$

and

If we neglect the friction of the bearings, &c., we may, in this case, put $p = 0$; we then have

$$\phi = \pm\frac{\pi}{2}$$

and $cR = E\cos\psi$.

Hence the maximum value of c is (putting $\psi = 0$)

$$c = \frac{E}{R},$$

the same as would be produced by a constant E.M.F. E in a non-inductive circuit of resistance R.

Also, putting $\psi = \pm\frac{\pi}{2}$, the minimum current is zero.

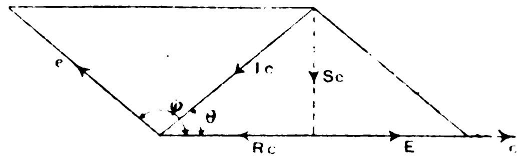

Fig. 1.

Now, from Fig. 1, we get (of course ψ is not now zero, nor does $e = Ic$)

$$E^2 = e^2 + I^2c^2 + 2Ice\cos(\phi - \theta);$$

when $\phi = \pm\frac{\pi}{2}$, this becomes

$$E^2 = e^2 + I^2c^2 \pm 2Ice\sin\theta$$
$$= e^2 + I^2c^2 \pm 2Sce, \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

since $\sin\theta = \frac{S}{I}$.

The upper sign in (5) corresponds to the machine running as a generator, and the lower as a motor.

We also see from (5) that, corresponding to $c = \frac{E}{R}$, we have

$$e = \mp\frac{ES}{R},$$

and, corresponding to $c = 0$, we have

$$e = \pm E.$$

* Paper read before the Physical Society.
† Trans. Am. Inst. Elec. Eng., December, 1894.

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Now, solving equation (5) as a quadratic in c, we get

$$c = \mp \frac{eS}{I^2} \pm \frac{1}{I^2}\sqrt{(I^2E^2 - R^2e^2)} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

and, as c is real, we must have

$$I^2E^2 \geqq R^2e^2$$

or

$$IE \geqq Re\,;$$

therefore the maximum value of e is given by

$$e = \pm \frac{IE}{R}$$

and the corresponding current is

$$c = \mp \frac{eS}{I^2}$$

$$= \mp \frac{SE}{RI}.$$

6. The equation $\quad e^2 - 2Sce + I^2c^2 = E^2$

is the characteristic curve of the motor running light. It may be written

$$e^2 - 2Sce + S^2c^2 + R^2c^2 = E^2,$$

or

$$(e - Sc)^2 + R^2c^2 = E^2,$$

or

$$\frac{(e - Sc)^2}{E^2} + \frac{c^2}{\frac{E^2}{R^2}} = 1,$$

which is the equation to an ellipse having as conjugate diameters the lines

$$e - Sc = 0 \text{ and } c = 0.$$

Similarly, the equation

$$e^2 + 2Sce + I^2c^2 = E^2,$$

which refers to the machine as a generator, may be written

$$\frac{(e + Sc)^2}{E^2} + \frac{c^2}{\frac{E^2}{R^2}} = 1,$$

also the equation to an ellipse. These ellipses are represented in Fig. 2.

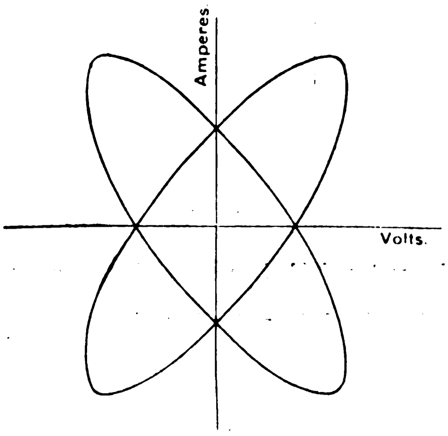

FIG. 2.

Minimum Current at Given Power.

7. We have

$$p + c^2R = cE\cos\psi.$$

The current is a minimum when $\frac{dc}{d\psi} = 0$. Now, differentiating with respect to ψ,

$$(2cR - E\cos\psi)\frac{dc}{d\psi} + cE\sin\psi = 0\,;$$

therefore, when

$$\frac{dc}{d\psi} = 0,$$

we have

$$\sin\psi = 0,$$

or

$$\psi = 0\,;$$

that is, the current is a minimum when in phase with the impressed E.M.F., as is otherwise obvious. Putting, therefore, $\psi = 0$, we have

$$p + c^2R = cE \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

This curve is of the second degree in c and p, and is satisfied by the following system of points:—

(a) $\left.\begin{array}{l} c = 0 \\ p = 0 \end{array}\right\}$ (b) $\left.\begin{array}{l} c = \frac{E}{2R} \\ p = \frac{E^2}{4R} \end{array}\right\}$ (c) $\left.\begin{array}{l} c = \frac{E}{R} \\ p = 0 \end{array}\right\}$.

That the equation is satisfied by (a) is obvious, and we see that it is satisfied by the points (b) and (c) by writing it in the form

$$\left(c - \frac{E}{2R}\right)^2 + \frac{p}{R} = \frac{E^2}{4R^2}.$$

8. Thus we see that the curve of minimum current at given power passes through the points of

(a) Zero current and zero power;
(b) Maximum power;
(c) Maximum current and zero power.

We notice that the maximum current at no load is $c = \frac{E}{R}$, whereas if the motor were at rest the current would be $c = \frac{E}{I}$; that is, the maximum current at no load is in all cases greater than the maximum current if the armature is at rest.

9. Again, from the equation

$$p + c^2R = cE\cos\psi,$$

we have

$$\psi = \cos^{-1}\frac{p + c^2R}{cE}\,;$$

therefore

$$\frac{d\psi}{dc} = \frac{c^2R - p}{c\sqrt{\{c^2E^2 - (p + c^2R)^2\}}} = 0,$$

when

$$p = c^2R.$$

ψ is then a maximum, and we see that the maximum difference of phase between the current and the impressed E.M.F. takes place when the electrical efficiency is $\frac{1}{2}$.

10. *Example.*—Suppose we have a 50-kilowatt motor driven by a 1,000-volt generator, and suppose that $R = 3$ ohms and $S = 4$ ohms, so that $I = 5$ ohms.

Then Maximum output $= \frac{10^6}{12} = 83{\cdot}3$ kilowatts;

Corresponding current $= \frac{1000}{6} = 166{\cdot}7$ amperes;

Corresponding counter E.M.F. $= \frac{5000}{6} = 833{\cdot}3$ volts;

Maximum current running light $= \frac{1000}{3} = 333{\cdot}3$ amperes;

Corresponding counter E.M.F. $= \frac{4000}{3} = 1{,}333{\cdot}3$ volts; &c.

11. To find the characteristic of the motor at any given load we must eliminate θ and ϕ between the equations

$$p = ce\cos\phi,$$

$$\sin\theta = \frac{S}{I},$$

and

$$E^2 = e^2 + I^2c^2 + 2Ice\cos(\phi - \theta).$$

The eliminant is

$$E^2 - e^2 - I^2c^2 - 2Rp = 2S\sqrt{c^2e^2 - p^2}, \quad . \quad . \quad . \quad (8)$$

which is the required general relation between e and c.

In the Paper referred to above, Steinmetz calls equation (8) the fundamental equation of the synchronous motor: the equation is there developed and plotted; results are obtained directly from equation (8), but the development is so cumbrous that the writer thinks that his simple treatment may benefit those interested in the subject of alternate-current motors.

Armature Reaction in a Single-phase Alternate-current Machine.

12. In the above analytical treatment the magnitudes only of θ, ϕ and ψ are considered. We proceed to investigate the signs of these angles in order to determine the lags or leads of the E.M.F.'s over the current, and to apply the results to find out whether the field excitation of generator and motor is strengthened or weakened by the reaction of the armature currents.

13. It will now be convenient to slightly alter the meanings of the symbols.

Let E = virtual value of generator E.M.F.;
e = ,, ,, counter E.M.F. of motor (as before);
R = total resistance in circuit consisting of generator motor and line;
L = sum of coefficients of self-induction of generator and motor armatures, or, if the line possesses self-induction, the coefficient of self-induction of the whole circuit;
I = impedance of the complete circuit;
S = reactance of the complete circuit.

14. The E.M.F. Rc, which drives the current, is the resultant of E, e and Sc; so that E, e, Sc and Rc reversed form a system of E.M.F.'s in equilibrium.

In Fig. 3 let the positive direction of rotation be counter-clockwise, and let Oc be the direction of the current. The instantaneous value of the current does not concern us at present. Take OR^1 equal to Rc reversed, and consequently opposing the current; let $OS^1 = Sc$, lagging behind the current by a quarter of a period. The resultant, OT^1, of OR^1 and OS^1 will then be equal and opposite

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to the resultant of E and e. If, therefore, we produce T^1 O to T and make O T = O T^1, O T will represent in magnitude and direction the resultant of E and e. If, now, we are given the magnitudes of E and e, we can find their directions by parallelogram law. Now two parallelograms can be constructed having O T as diagonal and E, e as adjacent sides, but, since E is the E.M.F. of the generator, we take that which gives the component of E along O c in the same sense as the current. The other parallelogram would make e the generator. We may notice that the possibility of constructing these two parallelograms affords a proof of the fact that, in general, either of two alternate current machines may be driven as a motor by the other, irrespective of their relative E.M.F.'s. An analytical proof of this is given by the energy equation

$$p + c^2 R = c E \cos \psi,$$

remembering that $\qquad p = c\, e \cos \phi,$

and that ϕ and ψ are independent.

The condition that E represents the generator E.M.F. limits our choice of the two parallelograms to O E T e (Fig. 3). We then have

$$\text{angle } c \text{ O E} = \psi,$$
$$\text{angle } c \text{ O } T^1 = \theta,$$
and $$\text{angle } c \text{ O } e = \phi.$$

15. Now through T draw P S T Q parallel to the line of current and draw P M, S O, T R and Q N through e, O, T and Q respectively, at right angles to the line of current. We have

$$\tan \theta = -\frac{S e}{R e} = -\frac{S}{R} = -\frac{2\pi n L}{R}; \quad . \quad . \quad . \quad (9)$$

that is, θ is independent of the current and O T is a fixed direction relative to O c so long that the speeds of the machines are kept constant, and L is considered constant.

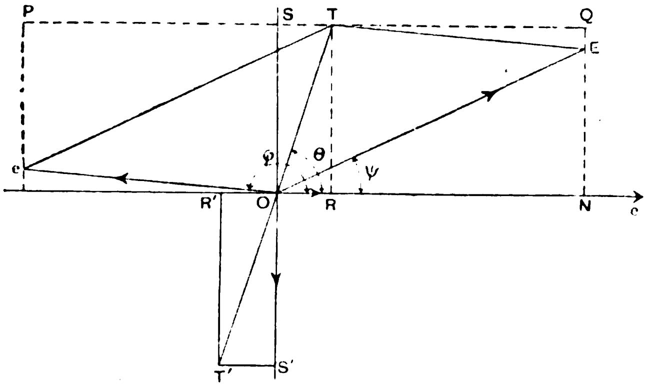

Fig. 3.

16. In Fig. 3,

O S (or P M) is proportional to the current [$= 2\pi n L c$],
O M is the component of e directly opposing c,
O R is the E.M.F. required to overcome resistance [$= R c$],
and O N is the component of E in the direction of c;

hence, rectangle P S O M is proportional to the output of the motor [p],
rectangle O S T R „ „ c^2 R losses,
and rectangle O S Q N „ „ output of generator [c E cos ψ].

From this, and the equation

$$p + c^2 R = c E \cos \psi,$$

it follows that the efficiency of transformation

$$= \frac{OM}{ON} = \frac{OM}{MR}.$$

17. If the output of the motor is kept constant, we have

$$\text{rectangle PSOM} = \text{constant},$$

and the locus of P is a rectangular hyperbola having O M and O S as asymptotes (Fig. 4).

Take any point P on this hyperbola.

We have seen (9) that O T has a fixed direction relative to O c, and the point T (Fig. 3) on this direction is found by drawing through P a line parallel to O c. Again, e lies on the line through P parallel to O S, and e T = E in magnitude.

Let the E.M.F. of the generator be kept constant and equal to E. With centre T and radius E describe a circle cutting P M in e and e^1; then the corresponding counter E.M.F. of the motor may be either O e or O e^1, and the current is represented by P M (in magnitude)—that is, corresponding to given values of E and c there are two values of e. The relative phases in the two cases are shown in parallelograms O e, T E and O e^1, T E^1 (Fig. 4).

18. To find the point P^1 on the hyperbola corresponding to minimum current (Fig. 4) we have to bring the points e and e^1 into coincidence. The point P^1 is obviously got by taking O $E_1{}^1$ equal to E and through $E_1{}^1$, drawing $E_1{}^1$ P parallel to O T. The resulting parallelogram O P^1 T_1 E_1 shows that the generator E.M.F. is in phase with the current.

19. Suppose now that the excitation of the generator field is kept constant, while that of the motor is varied.

When the motor excitation is small, as O e (Fig. 4), we see that the current leads over the motor E.M.F. and lags behind the generator E.M.F.

When e exactly opposes c, the latter lags behind E.

When E and c are in phase (minimum current) c lags behind e.

When e is still further increased, as O e^1, c leads before E, and lags behind e. This explains the condenser action of an over-excited synchronous motor noticed by Prof. S. P. Thompson and others.

20. It is known that a leading current strengthens the field of a generator and weakens that of a motor, while with a lagging current the reverse is the case.

We therefore conclude that when the excitation of the motor field is small armature reaction weakens the fields of both generator and motor, and when the motor is over-excited both machines have their fields strengthened. When working at minimum current armature reaction strengthens the motor field, and does not affect the field of the generator.

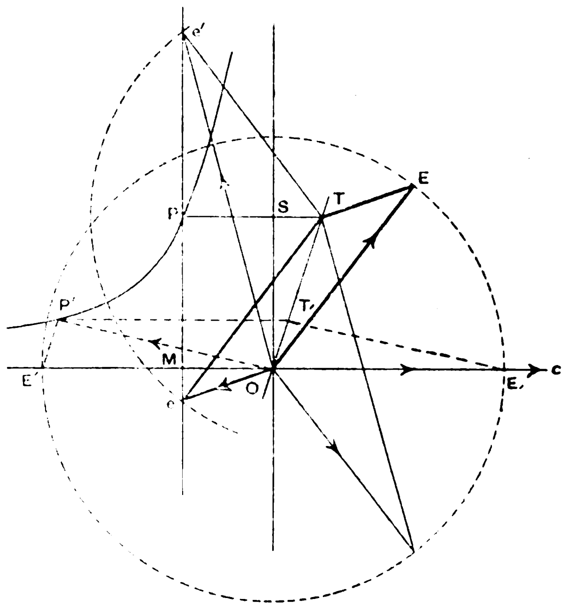

Fig. 4.

When the motor field is unaffected the generator field is weakened.

21. Now the field of the motor is, under ordinary working conditions, excited to a somewhat greater extent than is required to obtain minimum current; for, though the c^2 R losses are a minimum and the efficiency a maximum when the current is a minimum, it is advisable to increase the counter E.M.F. to a certain extent in order to cope with accidental variations of the load. Under ordinary working conditions, therefore, the effect of armature reaction is to strengthen the field of the motor and also of the generator, but to a less extent.

22. We now proceed to obtain an expression for the alteration in ampere-turns of the field excitation due to armature reaction.

Let ϕ be the displacement of phase of the current over the E.M.F. of the machine; n the number of turns of wire in one section of the armature; i the virtual current, and $i_0 \sin pt$ the instantaneous value of the current, so that i_0 is its maximum value.

It has hitherto been customary to assume that the alteration in the excitation is given by the expression

$$i\, n\, \phi, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

where ϕ is expressed in circular measure.

Now it is not the virtual current to which the armature reaction is due, but the *mean value of the current* through an angle ϕ on each side of its maximum value—that is, the proper value of the current is given by

$$I = \frac{p}{2\phi} \int_{\frac{\pi - 2\phi}{2p}}^{\frac{\pi + 2\phi}{2p}} i_0 \sin pt\, dt,$$

$$= \frac{i_0}{\phi} \sin \phi.$$

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And, remembering that $i_0 = \sqrt{2}\, i$, we get

$$I = \sqrt{2}.\, i \frac{\sin \phi}{\phi}.$$

Thus the proper expression for the alteration of the field excitation in ampere-turns is

$$2\, I\, n\, \phi,$$

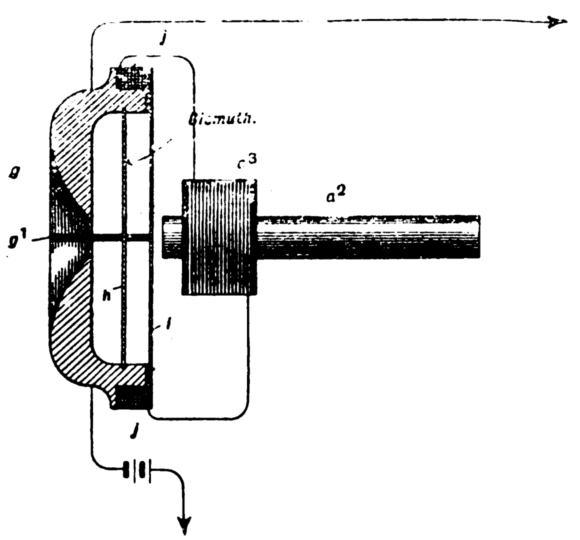
or $$2 \sqrt{2}\, .\, i\, n \sin \phi. \quad . \quad . \quad . \quad . \quad . \quad (11)$$

To find the total excitation of the field we must add expression (11) to, or subtract it from, the ampere-turns on the field, according as the current leads or lags in a generator, and lags or leads in a motor.

A BISMUTH MAGNETO TELEPHONE TRANSMITTER.*

It is well known that the electrical resistance of bismuth varies when this metal is subjected to the influence of a magnetic field, and the extent of the variation is, within limits, proportional to the strength of the field. This principle is employed in an instrument designed to determine the strength of magnetic fields, by measuring the resistance of a bismuth wire inserted therein.

The same idea has been embodied, though for a different purpose, in a telephone transmitter due to Mr. J. S. Biggar, of San Francisco, Cal. The instrument, which is illustrated in the accompanying engraving has a mouthpiece, *g*, divided into two parts, separated by insulating material *g*¹. There are two diaphragms, one *h* of bismuth and the other *i* of soft iron and of the usual construction, the latter insulated from the mouthpiece.



A Bismuth Magneto Telephone.

Between the two diaphragms is an air chamber which conducts the vibrations of one diaphragm to the other. Back of the iron diaphragm is placed the usual permanent magnet and coil. A coil of wire *j* is wound upon the mouthpiece of the instrument, and surrounds the bismuth diaphragm. This coil is in a closed circuit with the coil upon the permanent magnet. The two parts of the mouthpiece form the terminals of the main circuit, and they are bridged, as shown, by the bismuth diaphragm. It will be seen that the bismuth diaphragm is located in the magnetic circuit of the coil *j*, and that it is therefore subjected to the variations in magnetic force, which cause it to vary the flow of current in the main circuit.

EXPENDITURE OF ELECTROMOTIVE FORCE IN ELECTRO-CHEMICAL PROCESSES.†

The author points out that even after the corrections supplied by Helmholtz, Gibbs and Nernst have been applied, there is a wide discrepancy between the theoretical and the actual E.M.F. required in commercial electrolytic processes. In the electrolysis of sulphate of copper solution between copper electrodes we have an ideal case, but complications occur as soon as the extraction of copper from its ores by electrolysis is attempted. The ore may contain iron, and may be partially decomposed, so that sulphuric acid and oxygen are produced, and the current may not extract copper from the anode as rapidly as it is deposited on the cathode. Uncompensated losses occur from the oxidation of oxidisable salts; for instance, $FeSO_4$ is converted into $Fe_2(SO_4)_3$, and sulphuric acid which may be present is decomposed with the evolution of oxygen and hydrogen. Oettel has shown that even in the electrolysis of copper sulphate between copper electrodes as much as 20 per cent. of the current may be spent in producing persulphuric acid. The wasteful evolution of hydrogen constitutes the weak point in almost every electrolytic process. A comparison is made between the production of chlorine by the electrolysis of hydrochloric acid, and the decomposition of hydrochloric acid by air, aided by the contact action of copper. In the former process only 50 per cent. of the electrical energy is used, so that it requires 6½ times the weight of coal to produce the same quantity of chlorine that the Deacon process does. A great saving would be effected if the hydrogen evolved could be made to combine with oxygen and produce electrical energy which could be usefully employed. As long ago as 1839 Grove showed by his gas battery how this might be done, but the problem practically remains unsolved to this day as far as technical applications are concerned. Messrs. Mond and Langer's gas battery (*Proc.* Roy. Soc., 46, 296, 1889) is a great improvement, but the author states that it is liable to get out of order, and requires more skilled attention than can be expected from a workman. The author considers that the invention of a practical gas battery which could be fed with air and producer-gas would be a matter of great importance.

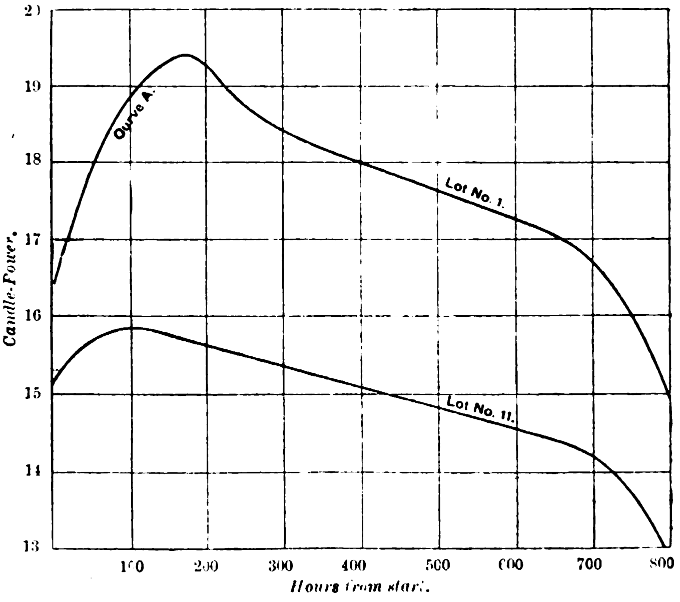
* From the *Electrical Engineer* of New York.

† F. Quincke, *Zeits.* der Vereines Deutscher Ingenieure, 39, 1-6.

TEST OF PACKARD LAMPS.

The *Electrical Engineer* of New York has recently published a report of an exhaustive test of Packard lamps, made by Prof. B. F. Thomas, of the Ohio University, which will prove of interest to all users of incandescent lamps.

In order to test the lamps under commercial rather than laboratory conditions, arrangements were made with the local Edison electric company to carry on the test on their regular circuit where the lamps would be subjected to the same variations in voltage that they ordinarily experience in practice.



Curve "A," showing Candle-Power.

Fifty 100-volt 16 c.p. lamps were tested in two lots of 25 each. The average voltage was about 99. The photometric readings were taken with a Lummer-Brodhun photometer. The values obtained are plotted in the accompanying diagram, curve A showing the candle-power and time; curve B the percentage of initial candle-power and time, and curve C the efficiency and time.

As shown by these curves, Lot I. shows a marked increase in candle-power on the start, reaching a maximum of 17·9 candles at about 175 hours, then decreases uniformly until 600 hours, when a more rapid decrease sets in. The candle-power does not fall to its initial value of 15·54 candles until over 700 hours from the start. Lot II. shows only a moderate rise in candle-power, with a maximum at about 150 hours, and then decreases uniformly to its initial value at 400 hours. It shows also a sharp increase in declining brightness at 600 hours. This change may have been produced by strain due to abnormally high voltage at soon after the 600-hour point. Such a high voltage was observed for some time during the day preceding the evening on which the readings at 696 hours were taken, and its effect on the candle-power of

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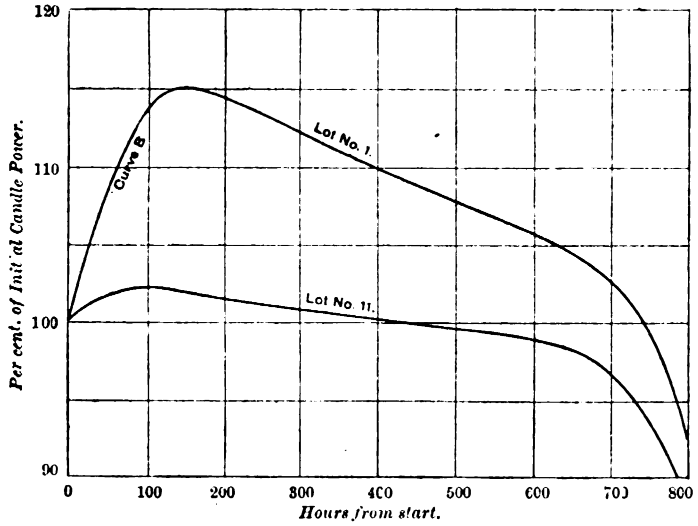
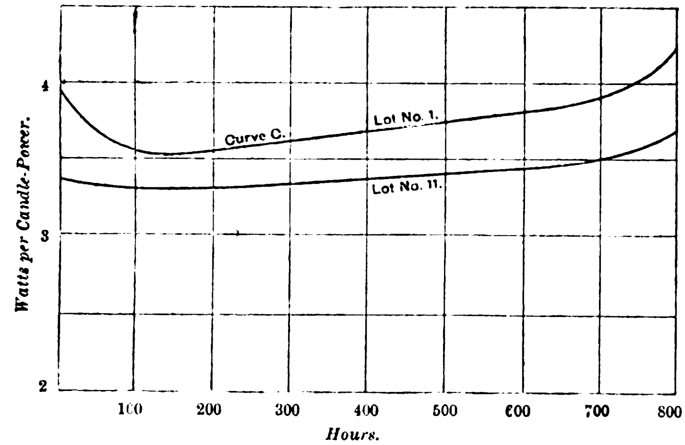
Lot I. was particularly marked, though less so than on Lot II. Curve B shows a rise of over 15 per cent. in the candle-power of Lot. I., with a final value only 6·5 per cent. below the initial value.



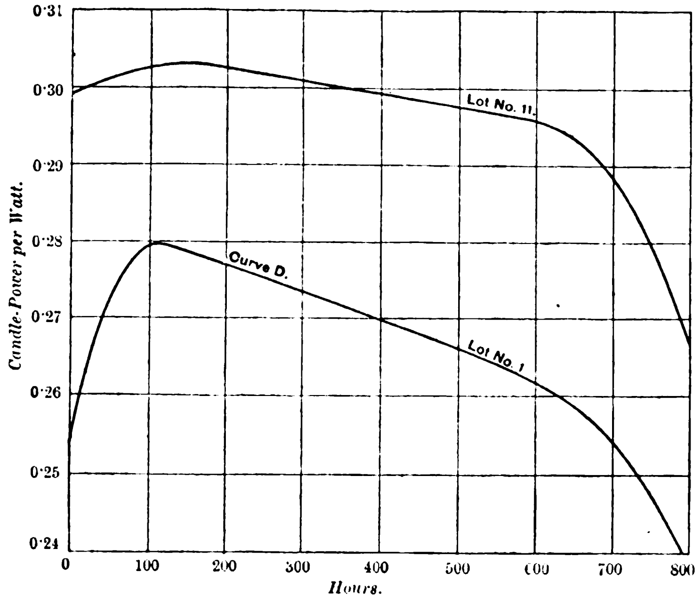
Curve "B," per cent. of Initial Candle-Power.

The total range in candle-power from beginning to end, is 22 per cent. for Lot I., and 14·5 per cent. for Lot II.



Curve "C," Watts per Candle-Power.

Curve C shows a marked increase in efficiency for Lot I. on the start, falling back to the initial value only after 600 hours. Lot II.



Curve "D," Candle-Power per Watt.

improves in efficiency also on the start, though to a smaller extent, and continues at a practically uniform figure for 600 hours. The decrease in efficiency of each lot after 600 hours is much less rapid than usual. Curve D shows the candle-power per watt.

With the tests as a basis, computations were made as to the economy of the lamps. For this purpose the cost of the lamp was assumed at 20 cents and that of the kilowatt-hour at 20 cents. Under the conditions assumed, the lamps in Lot I. show a minimum average cost of the light produced by them, under the conditions assumed, at about 450 hours. Lot II. shows a minimum, under the same conditions, at 650 hours. The difference in cost of light produced by the two lots, at the minimum point for each lot, is about 7 per cent. in favour of Lot II. The range in candle-power of Lot I., up to 450 hours, is about 15 per cent., while that of Lot II. is only 6½ per cent. up to 650 hours. Lot II. is better than Lot I. on this account also, as uniformity of candle-power is desirable, other things being equal.

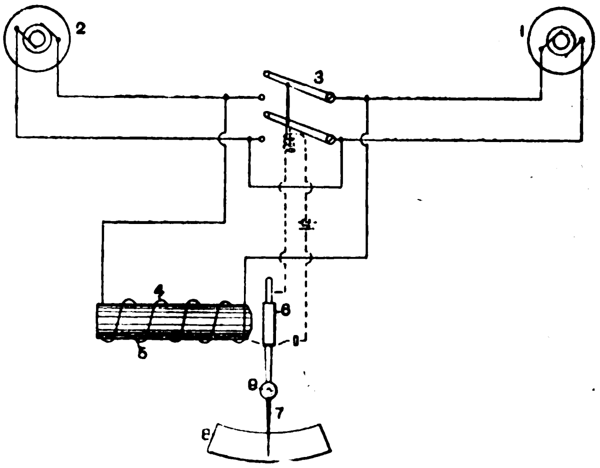
The prices used were chosen because they fairly represent lamp cost, and cost of energy as supplied by central lighting stations in this country to-day. Higher prices for lamps, or a lower price per kilowatt-hour, will bring the "smashing point" for either lot later than the times named, though no change in the relative value of the two lots will follow, if compared under like conditions.

For isolated plant work, the net cost of energy is considerably decreased, and may be taken at less than 10 cents per kilowatt-hour—in some cases as low as 6 cents. For such work, the computed cost will show a minimum at or beyond 800 hours. The "smashing point" will in some cases not be the question of cost of light produced, but the decrease in candle-power of the lamps being reached when the light produced by the lamps is no longer satisfactory. No lamp of either lot showed any serious blackening, and the majority of the lamps were scarcely blackened at all.

Taking economy, maintenance of candle-power and freedom from blackening into account, the results obtained from these lamps according to Prof. Thomas are much superior to any heretofore published.

THE MERSHON SYNCHRONISM INDICATOR.*

In order to connect alternating machines in parallel to the same circuit they must be at the same phase, or in synchronism, and in order to determine this point various devices have been employed. Thus in some cases an acoustic indicator is used, while in others an incandescent lamp placed across the terminals of the machines to be connected is observed, and when at its greatest brilliancy the switch is thrown. The point of greatest brilliancy in an incandescent lamp is somewhat difficult to determine, except by experience, and with the object of supplying a device which can be read off with accuracy by the ordinary station attendant, Mr. Ralph D. Mershon, of the Westinghouse Company, has devised the arrangement shown in the accompanying engraving.



Mershon Synchroniser.

This indicator has the advantage also of being equally well adapted for alternating circuits of high and low frequency, the acoustic indicator being unavailable for frequencies below a certain limit.

The indicator consists of a coil 4 connected to the machines, as shown, and acting upon an armature which carries a pointer passing over a scale. The armature may be either of iron or consist of a closed coil or a disc of non-magnetic material, in the latter case being acted on inductively. Assuming the coil 4 to be so connected in circuit that the electromotive forces therein will be in opposition when the machines are in the proper relation for closing the switch 3, the armature 6 will, in the absence of such relation, be moved either toward or away from the coil 4 and its core 5, the

* From the *Electrical Engineer* of New York.

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direction of such movement being dependent upon whether the armature be of magnetisable or non-magnetisable metal. As the two machines approach the same speed, and the electromotive forces come more nearly into opposition, the armature will tend to return to its original or zero position until the relation of the machines is such that they may properly be connected in circuit, when the armature and its pointer will be in approximately the position shown in Fig. 1.

If, on the other hand, coil 4 be so connected in circuit that there shall be a coincidence of the electromotive forces therein when the machines are in the proper relation for connecting them in circuit, the operation of the device will be the reverse of that above described—that is to say, if the armature be of magnetisable material its extreme left-hand position will indicate the time for closing the switch, and if of non-magnetisable material its extreme right-hand position will give the proper indication, the vertical or zero position, indicating the absence of the desired relation of the two machines.

Mr. Mershon prefers to so connect the coil in circuit that there shall be an opposition of electromotive forces therein at the proper time for throwing the switch and to employ a non-magnetic armature; but the other connection and variety of armature described are entirely practical and may be employed. It is obvious that the armature or its pointer may also serve, if desired, to close a circuit, which shall operate to effect the closing of the switch automatically.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

New York, *August 23, 1895.*

Extensive Consolidation.—An arrangement of considerable importance has been consummated between the three largest traction companies in Philadelphia, the basis of the arrangement being broadly as follows: A new corporation has been formed known as the Union Traction Company, which concern has purchased practically all of the shares of the Electric and People's Traction Companies, and has acquired, by lease and otherwise, the control of all the lines forming the system of the Philadelphia Traction Company. The new Company is capitalised at $30,000,000, about $24,000,000 of which will be absorbed in obtaining the control of the above-named Companies and $4,500,000 devoted to extensions and improvements now in hand and contemplated, leaving a margin of about $1,500,000. The deal has been approved by the directorates of all the Companies concerned, and a majority of the stockholders have filed their assents.

Long-Distance Power Transmission.—An unusually ambitious undertaking is in progress in the State of California. The scheme contemplates the transmission of 1,000 H.P. or more from a point on the San Joaquin river to the city of Fresno, Cal., a distance of 35 miles. The power station will be located at the foot of a mountain on the riverside, and will contain special water-wheels designed for abnormal heads and three three-phased alternating-current generators of 340 kilowatts each. On the mountain top, 1,500 feet above the station, a reservoir has been constructed which will hold enough water for several days' run in case of trouble with the prime water supply. A canal will bring the water from a point about seven miles up the river to the reservoir, and welded steel pipes will serve to convey the water from the reservoir down to the water-wheels in the station. The E.M.F. on the line will be 11,000 volts, which will be reduced by step-down transformers at a sub-station in the city of Fresno, from which current will be supplied for incandescent lights and stationary motors directly from the secondary mains. Rotary transforming sets will be located in the sub-station for the purpose of converting the alternating current into direct current for operating arc lamps and the street railway system of the city, the latter requiring about 300 H.P.

BOOKS RECEIVED.

"*Proceedings* of the Royal Society." Vol. LVIII. No. 350. Price 2s. 6d.

The Exchange Telegraph Company's Poll Book. 1885, 1886, 1892, 1895. Price 2s.

CORRESPONDENCE.

MAGNETIC UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The reluctance to extend to magnetic units the same sort of treatment as has proved successful with electric units is somewhat surprising. There are some who hold that such a statement as that $\mathsf{N} = 10$ is sufficient, but I hope that Prof. Ewing will, after consideration, dissociate himself from these, inasmuch as it could only be accurate if N were a pure number. As it stands it tells us nothing, any more than the statement that "the depth of the sea at a certain bar is 60" has any meaning unless we are told whether feet or fathoms are meant. It is true that a unit equal to 10^8 C.G.S. is large, but a unit of 1 C.G.S. is just as much too small, for dynamo purposes.

Those who hold that no simple multiples are of any use ought to speak of an event as going to occur in 15,834,000 seconds, instead of in three weeks; and they should express the distance from here to York in feet or inches.

There are certainly two quantities on which agreement is needed. If "lines" and "ampere-turns" respectively are held sufficient by a decided majority of those concerned, very good —let them be agreed upon; but it cannot be good for everyone to be devising a unit of his own. (And, by the way, I have nowhere urged people to make the henry of any size other than the secohm, as Prof. Ewing seems to imagine.)

The idea underlying my draft suggestions was mainly that it was well to consider the entire aspect of the question before finally deciding on the units for even these two essential quantities.—Yours, &c., Oliver J. Lodge.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Dr. Lodge's suggestions chiefly refer to three units for quantities intimately related to H, B and L.

First, as regards H. Since $\mathsf{B} = \mu\,\mathsf{H}$, the magnetism induced in a magnetic circuit easily follows from H. Considering an anchor ring of iron with n turns of wire round it carrying a current of A amperes, and supposing l is the circumferential length of the core,

then $$\mathsf{H} = \frac{4\pi}{10}\,\frac{n\,\mathrm{A}}{l}.$$

A being in amperes, and l in centimetres, $\frac{4\pi}{10} n\,\mathrm{A}$ is called the magnetomotive force = M.M.F., and total lines = $\mathsf{B} \times$ area $= \mu\,\mathsf{H} \times \text{area} = \dfrac{\text{M.M.F.}}{\dfrac{l}{\mu\,\text{area}}}$, and $\dfrac{l}{\mu\,\text{area}}$ is called the magnetic resistance.

Dr. Lodge suggests a name for the unit of M.M.F. But really there is *one in use*—viz., the ampere-turn, and M.M.F. $= \frac{4\pi}{10} \times$ ampere-turns.

The constant is of no importance to practical men, they are so used to them in their formulæ. The $\frac{4\pi}{10}$ cannot be got rid of. Mr. Heaviside proposes to alter the size of the ampere, so as to get rid of it in this equation (and this would involve changing either the ohm or the volt to correspond). Is it ever likely this suggestion will be adopted?

Then, as regards B, Dr. Lodge proposes a name not for B exactly, but for $\mathsf{B} \times \text{area} = \mathsf{N}$ = total number of lines. In this I quite agree, but the point is that with few exceptions everyone already uses the word *line* for this purpose, sometimes with the prefix "magnetic," sometimes with the affix "of force," and sometimes alone; but all use the word line, and, strange to say, nearly all people, practical and theoretical, use the C.G.S. unit for N, although when the density of lines is considered some use N per square centimetre (or B), others N per square inch, and others use the Kapp unit. Now it seems to me a pity to try to substitute any word for *line*. As regards the unit corresponding with the volt and ampere—*i.e.*, 10^8 lines, opinions differ as to whether the unit is wanted or not. Whenever I have had occasion to use it I have employed the word

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volt-line for the purpose. But I think the unit can very well be done without for the present.

Then as regards L; this only becomes of practical interest when iron is used, and then it is such a variable quantity that only by a stretch of the imagination can it be said to exist. Since L is only of importance as a means of calculating the number of lines N from the current strength, it is best when L is variable to calculate N by the ordinary method of the magnetic circuit, and to leave out L altogether.

Then as regards units generally, I disagree with the idea of naming units after celebrated men. First, one has to find a unit which is wanted, then to make successive international congresses agree to sink their national prejudices, and, finally, to make "practicians" adopt the name. Which task is most difficult is hard to say, but, having done all this, people have yet to be taught the meaning of the name. My own idea is that units should grow up themselves as they are wanted, in the manner exemplified by the word "ampere-turn." This has simply been compounded of the words which in the shortest way explain its meaning. It has not been authorised by any congress. It has simply grown up in a natural way, and in spite of congresses it will last. Another word like it is secohm. This word has been smashed, pulverised and destroyed by two or three scientific gatherings—the B.A., and the French, and the American Congresses. Yet where is the word "quadrant," and where is the word "henry?" No one seems quite certain what henry means, but the word secohm explains itself; and, in spite of the word secohm being thrown over three times, it is yet to be discussed at the next B.A. meeting. The reason is that the word is founded on a rational system, whereas henry has nothing but sentiment to recommend it. Though the term volt-line for 10^8 lines has, as far as I know, never been used, I cannot help thinking it a much better word than "weber," or "gauss," or any such name having no apparent connection with what it is supposed to represent.

If a unit is very badly wanted, of course people may agree on a name like ohm, ampere, or volt. But as a rule these units are *not* badly wanted, and it is best to let the names grow up by themselves in the way suggested. A "volt-line" is such that when a circuit loses lines of force at the rate of one "volt-line" per second, the E.M.F. generated in the circuit is one volt. Hence the name. One can easily imagine names being given in this way. There is no national jealousy to delay the adoption of a name founded in this manner, for it is chosen for convenience and explicitness merely.—Yours, &c.,

W. E. SUMPNER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Prof. Silvanus Thompson's letter in your issue of August 23rd leaves so little to be desired as a clear statement of the magnetic quantities with which electricians have to deal, and of the logical sequence in which they occur in matters of design, that, with one exception, it may, I think, be taken to express the feelings of those who have to practically use measurements in matters of construction. I refer to the omission of a unit coefficient of self-induction. It is true that from certain points of view it is an additional and unnecessary unit, but so saturated is the existing writing on electro-dynamics with the ideas and formulæ which embody its use that it really becomes a necessity.

Whether the C.G.S. system is the best or not is, I feel, a question which it is too late to discuss; it at least has the advantage of consistency and simplicity, and taking as it does three fundamental arbitrary quantities and choosing water for mechanical and thermal quantities and the ether or air in electro-magnetic quantities as the standard substances, the memory is burdened with few constants.

But when we come to the so-called practical system, this simplicity is at once lost. It is true that so long as we are dealing with some beaten path of design it is possible to keep straight, but I have found that in any new lines of design or investigation involving mechanical, electrical, and, perhaps, thermo-dynamical quantities, the practical units lead to hopeless muddle. The purpose, as I understand it, of the practical units is to provide that all ordinary measurements shall fall between the figures 1 and 1,000. If it effected this it might be an excuse; as it does not, I fail to see where the advantage comes in. Most designers use a slide rule, and in order to keep the decimal place (which is far more troublesome than 4π) under proper control many I know do as I do, and write every number down as an integer (under ten), with, say, two places of decimals, followed by 10^x, x being + or −. So that the only difference between the practical and absolute unit is the value of x.

But the objection to the practical unit is that you have to remember, if you can, or, if you cannot, use a table to find how many absolute units there are in a practical unit. We might as well have stuck to our pounds, and feet and bushels, and gills and perches, and the rest of them.

In a word, I regard all these practical units as an unmitigated nuisance, and therefore view the proposed augmentation of their number with alarm.

But, in addition, in order to avoid 4π in the expression for the line integral of magnetic force, we are threatened with another complication in the adoption of a system in which air or ether is not to be the standard substance. It appears to me it would be equally logical to have a special system of units for expressing the circumferences and areas of circles and volumes of spheres, in order to avoid π appearing in these space quantities.

Engineers find no difficulty in this case, nor will they in the case of the magnetic force if only they are left alone. Give names if you will to the absolute units, for by so doing statement of quantity is simplified, and let the units be of those quantities named by Prof. Thompson, with the addition I before mentioned; but do not let us be burdened with fresh arbitrary multiples under the name of practical units.—Yours, &c.,

LLEWELYN B. ATKINSON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is without doubt desirable that the relations between the magnetic units should be expressed in simple terms, avoiding the ambiguity which often exists at the present moment. If the Electrical Standards Committee of the British Association succeed in doing this the Ipswich meeting will have done good work.

Without presuming to discuss the theoretical difficulties in the way, perhaps I may be permitted to state how the matter strikes me as a practical man who has had to design many machines. The first quantity to be determined in designing dynamos is evidently the total quantity of magnetism in the induced circuit; its name is of little importance, much less that of the unit. I always think of this quantity as *lines*, and, following Prof. Silvanus P. Thompson, denote it by the symbol N; it has different values for different parts of the magnetic circuit, of course. The next quantity is found by dividing N by the effective area expressed in square inches or centimetres. This I denote by the symbol B″ or B, according to the unit of area. Its name is of no importance. I think of it as a density. Finally, the magnetomotive force required to produce N must be determined. This quantity is most readily and obviously, may I say, expressed in ampere-turns, because both the numbers of amperes and of turns of wire are so easily measured by shop methods. The relation between the ampere-turns per inch or per centimetre of circuit for a given value of B″ or B is taken from curves easily calculated within the required limits of accuracy. There is no substantial difficulty about the matter, except such as may lie in the uncertainty of the iron data.

If by changing the units of these quantities it were possible to make the reluctance vary as the magnetomotive divided by the total lines—*i.e.*, to follow a simple law like that connecting electromotive force, current and resistance—it would be worth while to make the change. But it appears to me that as the permeability of iron does not follow a straight line law, no equation can be of use in practice, except in conjunction with tables showing the variations of the permeability. In fact, it is necessary to resort to the usual curves of magnetism. In practice, I arrange things so that B″ is plotted in relation to

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ampere-turns per lineal inch (*see* p. 35, "Electric Motive Power").

The $4\pi/10$ difficulty is really of little importance in designing work, as it is easily included in the calculations for determining the tables or curves which are now used by every man who has to get his living at this branch of engineering.

In designing alternators the matter is more complicated owing to inductance. Yet it is possible to design very good alternators without a knowledge of the exact value of the *henry*, and I think that many designers build their machine first and determine this quantity afterwards. The unit of inductance should be defined in a simple manner which will lend itself to practice.—Yours, &c., ALBION T. SNELL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Like the bulk of your correspondents in last week's issue, I have not experienced any need for new names for magnetic units. To me $\mathsf{N} = 10,000,000$ is as convenient an expression as $\mathsf{N} = 10$ megalines. If only the C.G.S. system is taken for granted, nothing more is required than the number expressing the quantity of the thing in question. For example, when in steam engineering the question is asked, "What is the boiler pressure?" would it not be simpler to say 100 than to say 100lb. per square inch? Yet the only reason for adding "pounds per square inch" is the fact that in other countries "kilogrammes per square centimetre," for instance, are in use. If a coinage system were universal among civilised nations, and that coinage system were a decimal one, what need would there be for anything more than a plain number with a decimal point to express a given value? And if any name were given, would not this inevitably get dropped in time as a useless encumbrance? Engineers have been content to use the definition "pounds per square inch" instead of giving a name to a unit which would need defining, but if steam pressure was universally measured in pounds per square inch, or kilogrammes per square centimetre, it would be superfluous to write or speak either of these expressions. Now, I take it that, except for a few gentlemen, mostly in this country, who find it too much trouble to remember the multiplier 2·54, the C.G.S. system is universally adopted in electrical calculations. My view of the matter, then, is that every effort should be used by those engaged in electrical work to ensure that the unit for each thing to be measured shall have but one definition; then the only thing to be remembered would be the fundamental and unalterable physical relations between the things dealt with.

Supposing it is asked, "What is the unit of self-induction?" the reply sought for is invariably not the *name* of the unit, but the definition of it. If, then, there is but one definition, there is no need for a name.

I agree with Prof. S. P. Thompson that there should be no "academic fatuities" as to whether B stands for flux in air or in iron. The total flux is the same through all parts of a magnetic circuit, and its inductive effect when changing is the same whether it exists in air or in iron, and the fact that in air and most other substances $\mathsf{B} = \mathsf{H}$ should lead to no confusion, but rather towards clear relationship and simplicity.—Yours, &c., W. B. SAYERS.

Glenwood, Bearsden.

ELECTRICALLY DRIVEN ROAD CARRIAGES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On page 568 of the current issue you make the following editorial comment: "And yet, with the practical possibility of accumulator tramway traction still an open question, there are individuals who affect to believe in electric omnibuses." Perhaps you will have the kindness to spare me a few lines of your valuable space to reply somewhat briefly to the innuendo conveyed therein. As I had the privilege of running over 2,000 miles in the Ward Company's 1888 accumulator omnibus, it is patent to my mind that secondary cells, if no better now than they were then, can be effectively applied to this kind of traction. I have elsewhere endeavoured to combat the erroneous impressions that have been formed by many, lacking in practical experience, of what was done and can be done in this respect. It may be interesting to point out that in this country, on the Continent, and in America there are a large number of experimental vehicles of the self-contained type that have given good results, and the question was gone into by me at length in some articles I wrote for *Industries and Iron* when editor-in-chief of that paper, about 18 months ago. For example, the carriages of Arnold, Cumming, Ward, Bersey, Garrard, Pouchain, Morris and Salom, Jeantaud, Morrison, McDonald, and others have proved that, given financial support, an urban service could be established that would prove a satisfactory investment. We have three companies in this country engaged in the work, and when their preliminary investigations are completed, some tangible results may be expected. It is impossible to deal properly with the *pros* and *cons* of a question like this in the space allotted to a letter, and I must leave the full discussion for a more opportune occasion. —Yours, &c., CHARLES H. YEAMAN.

134, Calabria-road, Highbury, N.,
September 2, 1895.

BRITISH *v.* CONTINENTAL TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There is a point raised by Mr. Bennett in your issue of the 30th ult. which is worthy of attention from the National Telephone Company—I mean provision for sickness and old age of its staff.

There have been various attempts, both by the public and former employés, to stigmatise this Company—by the former, owing to ignorance; by the latter, owing to malice—and we have seen how futile they have been when closely examined.

There is here, however, a genuine weak point of which I hope the Company will speedily take note. It has at the present moment a staff as loyal and devoted as can be found in the service of any public company in the country, and, considering every responsible company makes some provision for the future of its trustworthy servants, it is clearly a piece of policy, apart from the question of duty, for this Company to do the same.

The Company may plead as an excuse for this remissness the doubt and uncertainty that hang about the Government policy with regard to it; but in the meantime, while it benefits largely from this policy, the staff is being neglected.

The present General Manager has done much to deserve the deepest thanks of almost all grades of the service. He has relieved the pressure of petty local tyranny, and established a feeling of security within the limits of justice; and now we feel this point will not escape his administrative tact.—Yours, &c., AMICUS.

September 3, 1895.

LEGAL INTELLIGENCE.

Pembroke Town Commissioners v. Dublin Southern District Tramways Company (Limited).

On Tuesday an application was made to Mr. Justice Murphy (sitting as Vacation Judge) at Dublin by Mr. Piers White, Q.C., on behalf of the plaintiffs, for an injunction to restrain the defendant Company from breaking up or excavating the roadway between the tram rails and the footpath in the township of Pembroke. Counsel explained that on the previous day the defendants, in connection with the laying down of their new electric tramway, commenced to break up the road close to the boundary of the Pembroke and Blackrock townships in the face of the protests of the plaintiffs, in contravention of an understanding arrived at when the defendants were seeking powers in Parliament for the purpose of using electricity on their tramway, and in contravention of Section 14 of their Act, which gave them power to work the tramway by overhead wires only, whereas, as now alleged, they were about to sink cables in the roadway for the purpose of conducting the electric current by underground conductors. At the request of the defendant Company the application was allowed to stand over for a week, on the understanding that the work objected to would not be proceeded with in the meantime.

Quayle v. Caustic Soda and Chlorine Syndicate (Limited).

In this action, on Wednesday last week, Mr. Justice Mathew made an Order authorising the Receiver and Manager to borrow money to pay out a distress and keep the defendant concern in a fit condition.

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

LABORATORY NOTES AND FORMS.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett *(now ready)*. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. nett, is now ready.

TENDERS INVITED.—The Corporation of Sunderland invite tenders for (*a*) high-tension and low-tension concentric cables, (*b*) cast-iron pipes and box frames and covers, (*c*) stoneware casing, boxes, and bell-mouth protectors; (*d*) high-tension transformers for alternating current, and (*e*) meters for alternating current. Specifications may be obtained from the Borough Electrical Engineer (Mr. C. S. Vesey Brown), Electricity Supply Station, Sunderland. Tenders must be in by 6:30 p.m. on Friday, September 13th. Some further particulars appear in our advertisement columns.

——— The Vestry of Shoreditch invite tenders for insulated electric mains, conduits, and drawing-in boxes, to be laid in the parish. Specifications can be obtained of the Vestry's consulting engineers, Messrs. Kincaid, Waller and Manville, 29, Great George-street, Westminster, S.W. Tenders, addressed to H. Mansfield Robinson, Vestry Clerk, Town Hall, Old-street, E.C., must be sent in by four o'clock on Tuesday, 17th inst. Further particulars will be found in our advertisement columns.

——— The Gravesend Town Council invite tenders for supplying and fixing a telephone and connections between the Sanatorium and the office of the sanitary inspector and the police station. Tenders to Mr. Hatten, Town Clerk, Gravesend, by 20th inst.

——— The Dundalk Town Commissioners invite tenders for the erection and maintenance of the necessary plant for lighting the town by electricity from July 1, 1896. Tenders to Mr. Ferrar, Town Clerk, Dundalk, by October 7th.

——— The St. Giles and Bloomsbury Guardians invite tenders for wiring and fitting up the board room and offices for the electric light. Tenders to Mr. J. Appleton, 57, Broad-street, W.C., by 10th inst.

——— The Manchester Town Council invite tenders for the laying of a system of underground telephone pipes, with inspection pits, service boxes, &c., in certain streets of the city. Tenders to Paving, Sewering and Highways Committee, Town Hall, Manchester, by 17th instant.

——— The Asylums Committee of the London County Council invite tenders for the erection of fire alarm and telephone systems at their asylums at Banstead, Surrey, and Colney Hatch, London, N. Particulars from Mr. R. W. Partridge, Clerk of the Asylums Committee, and tenders must be sent in to 21, Whitehall-place, London, S.W., by 12 o'clock on the 30th instant.

——— The French Post and Telegraph Department invite tenders for the supply of a quantity of iron tubes for pneumatic telegraph lines. Tenders to the Direction Générale des Postes et des Telegraphes, 103, Rue de Grenelle, Paris, by the 16th instant.

——— Further particulars are to hand respecting the establishment of electric tramways in Braila, Roumania. They are to be worked on the accumulator system, the cars to be provided with outside seats, and the speed to range from 9 to 24 miles per hour. The concession is for 35 years, at the termination of which the cars, plant and rolling stock are to become the property of the town without compensation. There are five routes in the concession, for which offers are to be sent in to the Maire by October 2nd.

——— The Queenstown Town Commissioners require tenders for the erection of works and the necessary plant for generating electric current for the public and private lighting of the town. Tenders to be in by September 26th.

——— The Staffordshire County Infirmary Committee require tenders for wiring and fitting up the Infirmary for the electric light. Tenders must be in by noon on Saturday, September 14th.

——— The Baths Committee of the Oldham Corporation invite tenders for supplying and fixing wires, fittings, &c., for lighting a portion of the Central Baths, Oldham, by electricity. Tenders by noon on September 11th.

TENDERS ACCEPTED.—The Parish Council of Thorne (Yorks.) have accepted the tenders of the Thorne Gas Company for lighting by gas that part of the town which is included in the lighting area. The Town and Village Electric Lighting Company was the only other tenderer, but no price was given in their tender. The Gas Company receive 26s. per lamp for 71 lamps for a period of eight months from September 1st to April 30th.

——— The Cheltenham Town Council have accepted the tender of Messrs. G. E. Belliss and Co. (Limited), of Ledsam-street Works, Birmingham, for supplying an additional steam engine for their electricity works for £729. 17s.

——— The Electric Light Committee of the Belfast Corporation have accepted the following tenders: Doulton and Co., for insulators; Messrs. J. Shaw and Co., for ironwork; the Callender Company, for cable; the British Insulated Wire Company, for copper strip; Messrs. R. Paterson and Son, for inspection plugs; and Messrs. Wormald and Co., for covering exhaust pipes.

——— The Watch Committee of the Portsmouth Town Council have decided to accept the tender of Messrs. Newton and Co. for wiring and fitting up the Buckland, Southsea, Portsmouth and Portsea police stations for the electric light.

TENDERS RECEIVED.—The Islington Vestry (London, N.) received 32 tenders for the wiring of the Vestry Hall and municipal offices for the electric light, the highest of which was £756. The lowest and *accepted* tender was that of Mr. Sidney Newton, 15A, Baker-street, London, N., for the sum of £215.

——— The following tenders have been received for supplying the necessary plant, &c., for the electric lighting of the Naval Station, Garden Island, Sydney, N.S.W.:—

Kingsbury (H. H.) and Co., Sydney	£6,975
Gibson, Battle and Co. (Sydney Branch)	6,433
Crompton Electric Supply Company of Australia	5,800
Siemens Bros. and Co. (Sydney Branch)	5,189
Standard Electric Company (No. 1 scheme)	4,935
Ditto (No. 2 scheme)	4,683
Ditto (No. 3 scheme)	4,564
Ditto (No. 4 scheme)	4,351
Morris Bros., Sydney	4,675
R. W. Thomson, Adelaide	4,601
Edge and Edge, Melbourne	4,386
Brush Electrical Engineering Company	4,250

APPOINTMENTS VACANT.—The Electric Light Committee of the Borough of Kingston-upon-Hull are prepared to receive applications for the position of resident electrical engineer at their electricity supply station. Salary £250 per annum, and applications must be sent in to the Town Clerk (Mr. R. Hill Dawe), Town Hall, Hull, by noon on the 19th instant.

——— The Technical Instruction Committee of the Borough of Lowestoft require a Technical and Science Master. Salary £160 per annum. Applications to the Town Clerk, Town Hall, Lowestoft, by the 19th inst.

BUSINESS CHANGES.—Messrs. J. Lomax Kendal and Co. inform us that they have taken over the electrical engineering business lately carried on by Messrs. Lowcock, Hill and Co. (Limited), at St. James's-square, Manchester. Messrs. Kendal and Co. have decided to retain the staff of the late firm. The Company also forward us a lengthy list of installations carried out successfully.

LIQUIDATIONS.—A meeting is to be held at 68, Coleman-street, London, E.C., on October 3rd, at 12 o'clock, to receive an account of the winding-up of the Submarine Mining and Torpedo Explosives Company (Limited).

——— Amongst the creditors in the failure of Dalziel's News Agency of America (Limited) are:—

Dalziel's London Agency	£12,319	2	3
H. F. Jackson, London	125	0	0
Cie. Française du Télégraphe de Paris à New York	1,100	0	0
Postal Telegraph Company, New York	650	0	0
Western Union Telegraph Company, New York	75	0	0

——— In the matter of a Registered Deed by John Ball, trading as Ball and Co., electricians, St. Nicholas-street, Leicester, the following are some of the principal creditors under the failure:—

Bonella (D. H.) and Son, London	£19	0	0
General Electric Company	36	0	0
Showell (E.) and Sons, Birmingham	10	0	0
J. W. Heawood, Leicester	15	0	0
J. E. Lester, Leicester	14	0	0
Greatorex (S., jun.) and Bro. (Limited), Manchester	12	0	0

EXTENSION OF PREMISES.—Messrs. Marryat, Lillywhite and Co., in order to meet a gratifying growth of business, have taken additional premises at 28, Hatton Garden, where, in addition to offices, showrooms for machinery and fittings will be added.

TUDOR ACCUMULATORS.—The sole manufacturer in the United Kingdom of these accumulators is Mr. A. B. Pescatore, of 5, Cross-street, Manchester, who sends us a price list, just issued, containing, in addition to prices, particulars concerning the batteries. Works

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have been established at Dukinfield, near Manchester, for the manufacture of the batteries, of which some 5,000 are working in different parts of the world at the present time. It is claimed that the cells can be discharged daily in 1 hour and recharged in 2½ hours without damage to the plates. A guarantee is given. The maintenance of the batteries is contracted for at the rate of from 3½ to 6 per cent. of the list prices. A supplementary price list will shortly be issued of portable cells and of a new and improved type of automatic regulating switch.

THE "WEINERT" ARC LAMP.—Messrs. Wilhelm and Co., of the Wool Exchange, Coleman-street, London, E.C., have been appointed sole agents for the United Kingdom for the arc lamps, arc lamp accessories, &c., manufactured by Mr. K. Weinert, of Berlin. Fig. 1 shows the differential type of lamp, which, however, by the necessary alteration of the coils, can be used also as a shunt

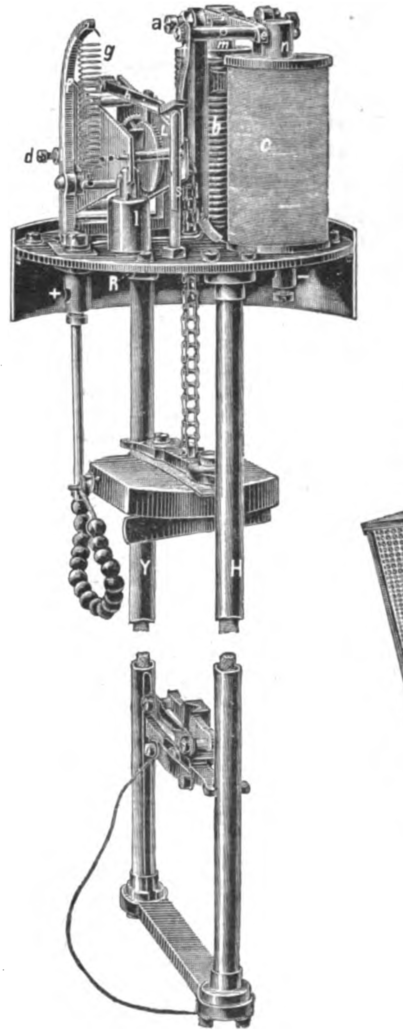

FIG. 1.

FIG. 2.

or series-coil lamp, for continuous or alternating current. The general principle of this lamp is not unlike that of the old Crompton lamp. Fig. 2 shows an arc-lamp lantern, the panes being of crystal glass, one side of which is formed prismatically, ensuring the better distribution of light. Some of the fittings illustrated in the catalogue, from which these particulars are obtained, are of very ornamental design.

"THE ENGINEERING MAGAZINE."—The September issue of this magazine is now ready, and in the variety of the subjects dealt with and in its illustrations fully maintains its high standard of excellence. The contents of the present number (No. 6, Vol. IX.) include: "The Business Situation in Review, and Factors in the Recent Improvement," by Newton Sharp; "The Emancipation of Labour by Machinery," by A. E. Outerbridge, jun.; "Natural Science Training for Engineers," by N. S. Shaler; "Labour Legislation in the United States," by George Kirby Holmes; "The Modern Problem of Grade Crossings," by William O. Webber; "The Earliest Transatlantic Steamships," by S. W. Stanton; "Surveying and Mapping a City," by C. H. Rice; "The Revolution in Steel Making," by William Metcalf; "Ontario Drain Tunnel and Electric Plant," by C. R. McKay; "The Architecture of Modern Hospitals," by E. C. Gardner. The usual exhaustive Review of the World's Industrial Press is also given. All the back numbers may be obtained at the offices, 1, 2 and 3, Salisbury-court, Fleet-street, London. A complete index to the main articles in the magazine from the commencement in April, 1891, will be ready in a few days, and will be forwarded post free on request.

CATALOGUES.—Mr. L. C. H. Mensing, of Worship-street, London, E.C., has just issued a catalogue of electrical engineering plant, including dynamos, motors, and arc lamps. Illustrations are given of Mensing machines, and a full text description, accompanied by sectional drawings, is included in the catalogue, which consists of 70 large quarto pages.

——— We have received from Mr. R. W. Paul, of Hatton-garden, the advance sheets of a very complete catalogue of electrical instruments. Amongst other things the large variety of resistances made by Mr. Paul is noticeable. These resistances include ordinary rheostats, Varley carbon rheostats, and liquid rheostats, with zinc electrodes immersed in zinc sulphate solution. Mr. Paul has also brought out some handy forms of lecture-room galvanometers, with 10in. pointers and boldly-divided scales. Ordinary and extra-ordinary galvanometers, celluloid scales, semi-transparent scales, portable testing sets, &c., will be found described within the covers of this catalogue, the only drawback to which is the embarrassing choice it offers to intending purchasers with limited funds.

OUTING.—The employés of Messrs. Marryat, Lillywhite and Co. held their annual outing on the 24th ult. on the Thames, where a steam launch conveyed the party from Kingston to Windsor and back, dinner, &c., being provided at Chertsey. The party numbered over 30, and a pleasant day was spent.

ABERDEEN.—The electric light is making steady progress in this city. The accounts of the electricity department of the Corporation show a small loss for the past year. Numerous additional applications for current, including several from medical men in Union-street and Bridge-street, have recently been received. New mains are being laid in Bridge-street, and a considerable demand for current is anticipated from the owners of large warehouses in that district.

ALDERLEY EDGE (CHESHIRE).—At the last meeting of the District Council a letter was read from Mr. S. V. Clirehugh, electrical engineer, of Manchester, offering to purchase the Council's Provisional Order, and stating that he was authorised by his clients to offer in return for the Order to pay the costs incurred in obtaining it, and that his clients were prepared to supply the Council with electric current for lighting purposes at 32s. 6d. per lamp per annum. The present gas lamps cost 35s. each. The letter has been referred to the Finance Committee for consideration.

THE ANGLO-FRENCH TELEPHONE.—In the House of Commons Mr. Hanbury said that the Postmaster-General was not prepared to grant statistics relating to the Paris-London telephone, as he was of opinion that the telegraph business of the State must be dealt with as a whole; nor could the Postmaster-General reduce the cost of conversation between France and England from 8s. to 2s. 6d. for three minutes, as such a reduction would necessarily lead to a loss of revenue from the telephone, which, during many hours of the day, is fully occupied.

BANGOR.—At the last meeting the City Council discussed the report of the Electric Lighting Committee, which recommended that the Council apply for a Provisional Order and that the Committee be empowered to carry out a scheme for the electric lighting of the city at once, so that current may be available by the end of 1896. The Committee further recommended that a field near the Police Station be purchased from Lord Penrhyn for £400 to serve as a site for a generating station. The recommendations were, after a brief discussion, adopted.

BERLIN INDUSTRIAL EXHIBITION.—In our issue of August 23rd we gave some particulars of this Exhibition, which is to be held in Berlin next year. The prime object of the promoters was to demonstrate the progress and expansion of the various industries of the city of Berlin since its recognition as the imperial capital in 1871; but it is stated that the Exhibition has been received with such favour that it has already acquired the dimensions of a national enterprise of the first rank. A guarantee fund of more than 5,000,000 marks (£200,000) has been subscribed, and 5,000 intending exhibitors have already applied for space. The main building has a capacity of 60,000 square meters, but around this there are about 50 smaller buildings which will be utilised for special exhibits. The exhibits will be divided into 24 groups, and sections will be devoted to applied electricity, machine construction, building and engineering, shipbuilding and transport, and to textile, chemical, metal and india-rubber industries. The Fishery and Colonial Exhibitions will be amalgamated with the Industrial Exhibition, and will embrace the industries of the German Empire within their scope. It is also stated that a large number of electric and elevated railways are to be laid down in order to facilitate passenger and other traffic between the city and the exhibition building, which will be erected on the Treptow Park.

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BIRKDALE (NEAR SOUTHPORT).—At the last meeting of the District Council a request from a Birkdale resident gave some trouble. An application was made for the consent of the Council to allow Mr. Buckley, who resides within the district, in case the Southport Corporation bring their electric light mains to the boundary, to put down a small private cable to his house and take current from the Southport Corporation's mains, the applicant undertaking to remove his cable when the District Council adopt the electric light. The consent of the Council involved important considerations, one being the rebate on the gas supply as arranged with the local gas company. Nothing definite was, however, decided.

BLACKPOOL.—At the meeting of the Blackpool Town Council on Tuesday last the recommendations of the Electric Lighting and Tramways Committee, that two complete sets of electric lighting plant, having a combined capacity of 600 kilowatts, should be immediately laid down; that Mr. Robert Hammond should prepare the specifications, and that the Finance Committee should borrow £30,000, met with considerable opposition, which finally won the day. Mr. Councillor Pearson, Chairman of the Committee, said that, with regard to the financial question, they estimated last year that their loss would have been £500, but after charging everything they possibly could to revenue account, and putting £716 to the sinking fund, they had only a net loss of £277. The total cost of the unit, he said, came out at 3·78d. At the present moment the profits were going up by leaps and bounds. Comparing the cost of the arc lamps at Blackpool with those of other towns, he stated that, including the sinking fund, their arcs cost them £22. 10s. per annum, while at Eastbourne the figures were £30, Hastings £25, Chelmsford £28, and Brighton £30. As an instance of the economical manner in which the capital had been expended at Blackpool, he pointed out that the expenditure at that town was £52,000, or £78 per kilowatt; the corresponding figure at Brighton was £131. Each lamp installed, according to the capital account, cost £2. 5s. 3d., and at Brighton £3. 2s. 5d. Mr. Councillor Ward moved the following amendment to the Committee's recommendations: "That the Corporation do not sanction any extension for electric light plant within twelve months from this day, and that the services of Mr. Robert Hammond as consulting engineer be immediately dispensed with." In the course of a lengthy speech, Mr. Ward adversely criticised the policy of extensions and the financial methods of the Electric Lighting Committee. The Corporation, he said, were charged at the rate of 6d. per unit, less 10 per cent., while the Winter Gardens Company, which only required heavy current for a few minutes at a time, and therefore kept a large amount of machinery idle, were charged 4d. per unit, less 10 per cent. He thought that the resident electrical engineer, Mr. Hesketh, was perfectly competent to carry out all extensions. After a lengthy discussion, Mr. Ward's amendment was carried by 10 votes to 6. It is rumoured that the delay in passing this vote for £30,000 is only until the results of the November elections are known, the Chairman of the Committee, Mr. Councillor Pearson, going before the electors at the next election.

BLACKBURN.—Some time ago Mr. E. M. Lacey, consulting engineer to the Corporation, brought proposals for extending the electric light mains before the Gas Committee. These were, however, rejected, but when the Town Council discussed the minutes of the Committee, it was, as stated in our issue of August 9th, decided to refer the matter back for reconsideration. It is now stated that the Committee have decided not only to recommend the extensions referred to, but are negotiating for the supply of electrical energy to the local tramways. Would not greater progress be made in electric lighting matters in this town if a special committee were appointed to deal with the subject? Here, as elsewhere, gas and electric lighting interests seem to clash, of course to the detriment of the newer and better illuminant.

CAPE TOWN.—The Town Council have purchased property adjoining their electricity station, for the purpose of making additions thereto, for the sum of £1,681.

CHELTENHAM.—The electric light is evidently "booming" in this town. In our issue of the 9th ult. we referred to the rapid development of the electric light, and at the last meeting of the Town Council Ald. Norman (Chairman of the Electric Lighting Committee) submitted proposals for lighting the principal parts of the town electrically, for which about 50 alternate-current arc lamps would be required to replace more than 300 gas burners. The capital cost was estimated at £3,100, and the annual upkeep £957, or a little over £19 per lamp. A resolution approving these extensions was moved, but an amendment by Mr. Margrett that the light be extended beyond the area recommended by the Committee was adopted as part of the original motion. It has been decided to divide the order for the supply of transformers for a period of 12 months between Messrs. Crompton and Co. and the Brush Company, the former firm to supply all transformers not exceeding 4 H.P., and the latter all of a larger size up to 40 H.P. The electrical engineer's report to the Council contains evidence of a demand throughout the district for current for electric light and power purposes, and the recommendations contained therein have been approved by the Council, including the supply, by Messrs. Siemens Bros. and Co., of an additional 100-kilowatt alternator. Mr. Alderman Norman, in reviewing the work of the past month, said that the record of the electric light was entirely satisfactory. They had either connected up or had applications in hand equivalent to 3,376 8 c.p. lamps. He announced that the Lighting Committee had decided to supply current for power purposes at 3d. per unit. The Council's electrical engineer, Mr. Hamilton Kilgour, has been directed to report as to the lighting of the town clock by electricity, and it has been decided to connect each member of the fire brigade on the electric call system.

CORK.—The question of the lighting of the waterworks by electricity has been referred to Mr. O'Toole (Waterworks Superintendent) to report upon. At the last meeting of the Waterworks Committee the Chairman (Alderman H. Dale) said, as they were now introducing their new turbines, they would have surplus power available, and he was assured they could effect a saving of £50 a year by adopting the electric light, and in addition they would be obtaining a much better light.

DESTROYING TELEGRAMS.—A lad named Johnson, aged 14, messenger, in the service of the Eastern Telegraph Company, has been charged at the Guildhall, London, with wilfully destroying telegraph messages entrusted to him to deliver, and he pleaded guilty to the charge. The Company instituted the proceedings merely to serve as a caution to other boys in the service. Six complaints were made against the boy Johnson, but the Company wished the magistrate to deal leniently with him. In consequence of complaints received, Johnson was questioned, and admitted that he had destroyed the messages, "as he felt too tired to work any more that day." The matter was a very grave one, as the Company's clients were most seriously inconvenienced by the boy's action. Sir J. W. Ellis dealt with the case under the First Offenders Act, and, as the Company desired to act mercifully, bound the lad's father over in the sum of £5 to bring him up for judgment if called upon.

DOVER.—The Harbour Board have decided to erect electric cranes on the Admiralty pier, in order that additional facilities may be provided for dealing with passengers' luggage and mails to and from the Continent. The cranes are to be actuated by alternating current from the Dover Electricity Company's mains, power being required to raise a load of 2½ tons gross about 30ft. in two minutes, for which it is estimated that motors equal to an output of 35 H.P. will be required. Some little difficulty is supposed to exist as to the applicability of alternating current for this purpose, and the Dover Electricity Supply Company have now under consideration various types of plant. It is estimated that when the electric cranes are in full work a saving of 20 minutes or more will be made in the despatch of mail steamers and trains, and, in addition, during the winter months what is always a most irksome and sometimes a most dangerous wait will by this means be avoided.——The lighting of Snargate-street is still a subject for much recrimination at the meetings of the Dover Town Council. On Tuesday the matter was again discussed, and a letter from the Dover Electric Lighting Company was read calling attention to the fact that considerable expense had already been incurred in the matter, and that the delay in carrying out the lighting of Snargate-street was not caused from any action of the Company. A unanimous petition has been presented by the residents of Snargate-street in favour of the electric light, but notwithstanding this, and the resolution passed some back to used arched electric lights, the Council have decided to use incandescent gas lights for the next twelve months.

DUNDALK.—At the meeting of the Town Commissioners on Tuesday it was stated that several offers had been received in connection with the lighting of the town by electricity. The Commissioners at present favour a scheme by which an electric light contractor would supply the necessary machinery and guarantee the working of the plant for a term of years, but on the suggestion of Mr. Maxwell a committee has been appointed to consider and report upon the possibility of converting the present debt of the town into a consolidated loan (repayable in a much longer period), and thus the Commissioners would be in a position to borrow a sum sufficient to at once start an electric lighting system of their own.

EDINBURGH.—At the meeting of the Town Council on Tuesday, a letter from the National Telephone Company suggesting that the Corporation should lay down underground tubes for telephone wires at the Company's expense, was strongly criticised by Sir James Russell, who contended that such action would have the effect of confirming the telephone monopoly in the city. Underground rights should not be granted to any private company. The letter was referred to the Lord Provost's Committee.

ELECTRIC LIBRARY APPARATUS.—The *Morning* states that the new library at Boston, U.S.A., is fitted with a device by which an attendant on the main floor has only to pick out the book wanted, put it in a railway car with a cable attachment, put it off the side switch to the main line, and let it travel round at the rate of 500ft.

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a minute to a special lift, which drops automatically, as soon as the car is in position, down to the delivery room. When the entry has been made, the car, which has been waiting, rolls back with its load on a return track to the switch from which it started. For the accommodation of hundreds of thousands of volumes, the books are distributed throughout six stories, the aim of the designers being to focus all the books toward a central point, to facilitate delivery. A lift well, long and narrow, which pierced the entire building from basement to roof, was constructed, and in this were set up shafts for three lifts. These are worked by a 10 H.P. electric motor in the basement, each lift being assigned to its special work. To make the system of delivery complete, a miniature railway track, with an 8in. gauge, was run along the lines of the interior courtyard. The cars are made of wire, and travel 300ft. a minute, with 10lb. to 30lb. weight of books in them. At certain points are switches working automatically, by means of which the cars are diverted to whatever part of the building they are destined for. The system by which cards, tickets and messages are despatched to any part of the building is also electrically controlled.

EXETER.—All the material requisite for an autumn battle over the purchase of the local electric light company's undertaking are at hand. The offer of a London company to purchase for £7,000, which offer, in the absence of a better, the Directors of the Exeter Company were disposed to consider, is being made the basis of an attack by one of the leading local journals, which regards the price of £10,000, for which the undertaking has been offered to the Local Authorities, as excessive. The arguments of the local journal have been met with a rejoinder from the solicitors acting for the Company, in which it is stated that the Directors have received from an expert, who has made a thorough investigation, an intimation to the effect that £10,000, the price quoted to the City Council, is the actual value of the undertaking. It is to be hoped that whatever decision is arrived at, the example of Fareham will be avoided.

EXHIBITIONS.—The Vienna I. R. Agricultural Society intend to hold a second exhibition of agricultural machinery, &c., in May, 1896. All branches of industry in any way connected with agriculture will be represented, and there will be a section devoted to tools and machinery used in forestry, sawmills, and celluloid factories, which will also comprise electrical machinery and appliances used in these industries. Provisional applications for space must be made to 13, Herrengasse, Vienna I.

——— An important industrial and agricultural exhibition will be held next year at Nijni Novgorod, and will be open during the whole period of the famous fair. It is stated that the buildings and grounds will be of unusually large dimensions, and an electric railway is being constructed for the convenience of exhibitors and visitors alike.

HAMMERSMITH (LONDON, W.).—The Electric Lighting Committee of the Vestry have been for some time past in negotiation for the purchase of land in Fulham Palace-road as a site for their electric generating station. The Governors of the Latymer Foundations recently offered £2,100 for the land, but the Committee have gone one better, and have offered £2,200.

H.M.S. "VENUS."—This second-class protected cruiser, which was launched from the Fairfield Shipbuilding and Engineering Company's yard yesterday, has three powerful electric search-lights fitted, which are operated from the conning bridges erected fore and aft; the vessel is, in addition, fitted throughout for the electric light.

KETTERING.—Notice has been given for the next meeting of the District Council that a special committee be appointed to consider and report upon the question of the lighting of the town by electricity.

LIVERPOOL.—A special meeting of the City Council was held on Wednesday, when it was finally decided to apply for a Provisional Order to supply electric current within the area of the city as it may exist at the time of granting the Order.

MIDDLESBOROUGH.—Mr. R. Hammond has been appointed consulting engineer by the Corporation, for the purpose of advising them as to their proposed electric lighting scheme.

NEW CABLE STEAMER.—The twin-screw cable-laying steamer which Messrs. Lobnitz and Co. are completing for the Japanese Government is to be fitted complete with cable-laying gear of the most modern design by Messrs. Johnson and Phillips, who have also secured the order for fitting the vessel throughout with electric lighting plant and fittings.

NOTTINGHAM.—The annual report of the Lighting Committee of the Town Council states that there are now 3,564 lamps connected up to the Corporation mains, and that the Great Market-place is now lighted electrically by means of eight 4,000 c.p. arcs.

OLDHAM.—Mr. W. J. Bird Clarke, C.E., held a Local Government Board inquiry last week into the application of the Corporation to borrow, amongst other sums, £15,000 for electric light extension purposes. There was no opposition.

OSTEND.—The Belgian Senate have decided in favour of the purchase by Colonel North of certain Government land on the sea front at Ostend. The purchase includes a concession for a period of 99 years giving the right to lay an electric tramway along the sea-front from the pier. The tramway will be commenced immediately in order to enable this part of the undertaking to be completed by the opening of the Ostend Exhibition in 1897.

OSWESTRY.—At a meeting of the Town Council on Monday a letter was read from the Oswestry Electric Lighting Company stating that current would shortly be available in the compulsory area, except Willow-street, and that the charge for current would be 7d. per unit.

PEMBROKE.—Reference is made in another column to the proceedings in the Courts against the Dublin Southern Tramways Company by the Pembroke Commissioners. An extraordinary scene was witnessed on Monday morning at the works which are being carried out by the contractors for the electric tramway between Blackrock and Haddington-road. While a number of the contractors' men were digging a trench for the underground electric mains, a gang of labourers in the employ of the Commissioners followed and filled up the trench which had been made—much to the enjoyment of both sets of labourers.

REDCAR.—Some time ago the District Council granted a concession for the electric lighting of this district to Messrs. F. H. Stacey and Bennett, of Sheffield, and these gentlemen have now transferred all their powers and obligations to the Redcar Electric Light and Power Company. By the terms of an agreement just approved by the Council the Company undertake to lay all mains and make connections and do all the necessary wiring in connection with the installation, and carry out all the work in accordance with the Board of Trade regulations. They also undertake to supply the Council with electric current for public lighting at 10 per cent. below the charge to other customers. The Council in return are, it is stated, to support only the application of this Company for a Provisional Order, and to oppose any other.

RIPON.—The question of the introduction of the electric light into Ripon came before the City Council at their meeting on Monday. Messrs. Harrison and Co. have already introduced the light at Ure Bank, and the present discussion arose on a proposal to supply electric current to the north end of Ripon. After a lengthy debate the matter was referred to the Gas Committee for consideration, and when this report is presented, a special meeting of the Council will be held to finally consider the matter.

RUGELEY.—At the meeting of the District Council on Wednesday the Lighting Committee were empowered to consider and report upon the question of lighting the public lamps next season by electricity. The Gas Company have just announced a reduction in the charge for public lighting of 1s. per lamp.

SALFORD.—Mr. W. J. Bird Clarke, C.E., held a Local Government Board inquiry on Friday at Salford into the application of the Corporation to borrow £18,000 for electric lighting purposes. The Town Clerk (Mr. S. Brown) said that some time ago application was made to the Local Government Board for power to borrow £50,000, but only £32,000 was then sanctioned, and the present inquiry related to the balance. The Town Council intended to spend £7,770 almost immediately, and they hoped it would not be necessary to hold a further inquiry for the remainder. They trusted that the Board would allow the estimates for the further expenditure to be forwarded to them, and that, upon being satisfied as to the estimates, the Board would sanction the borrowing of the sum required. The Inspector said if the Town Council could now submit a definite proposal for the balance of the £18,000 he thought there would be no necessity for further inquiry. Mr. E. Manville gave details of the scheme, and said that, in regard to the £7,770 now proposed to be expended, £6,270 was for extensions to mains, &c., outside the compulsory area, and the remainder (£1,500) was to be spent on premises, &c.

SOUTHPORT.—The Town Council have been making considerable extensions to their electricity works, and Friday, the 27th inst., has been fixed for the inauguration. Lord-street and the Promenade will be lighted electrically for the first time in the evening.

STAFFORD.—The formal opening of the electricity works takes place on the 25th inst., and a sub-committee has been appointed for the purpose of making the necessary arrangements.

STOCKTON.—A report by the Gas Committee on the electric lighting question will be discussed at the next meeting of the City Council. The Stockton Provisional Order expires in August next.

STOKE.—At the meeting of the Town Council last week a draft agreement embodying the consent of the Corporation to the introduction of electric traction on the tramways was received from the North Staffordshire Tramways Company, but it was decided before formally approving the agreement to send a deputation to Walsall, where the overhead system of electric traction is employed, for the purpose of inspecting and reporting on the applicability of the system to their tramways.

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Trunk Tolls of the National Telephone Company to Subscribers for Three Minutes' Conversation between London and

	s.	d.		s.	d.		s.	d.		s.	d.		s.	d.
Accrington	3	0	Crewe	2	0	Huddersfield	2	6	Newcastle-under-			Sunderland	4	0
Ashford	1	0	Darlaston	1	6	Kidsgrove	2	0	Lyme	2	0	Tunbridge Wells	0	6
Barnsley	2	6	Darlington	3	6	Llandaff	2	0	Northampton	0	9	Tunstall	2	0
Bath	1	6	Deal	1	0	Leamington	1	0	Northwich	2	6	Walsall	1	6
Birkenhead	3	0	Derby	1	6	Leatherhead	0	3	Nottingham	1	6	Warrington	2	6
Birmingham	1	6	Dewsbury	2	6	Leek	2	0	Ramsbottam	3	0	Warwick	1	0
Blackburn	3	0	Didsbury	2	6	Leicester	1	0	Ramsgate	1	0	Watford	0	3
Blackpool	3	6	Dorking	0	3	Lewes	1	0	Reading	0	6	Wednesbury	1	6
Bolton	3	0	Dover	1	0	Liverpool	3	0	Retford	2	0	Wellingborough	0	9
Brierley Hill	1	6	Dudley	1	6	Longton	2	0	Rochdale	2	6	West Bromwich	1	6
Burslem	2	0	Eastbourne	1	0	Lye	1	6	Rickmansworth	0	3	Westgate	1	0
Burton	1	6	Faversham	1	0	Maidenhead	0	3	Sandwich	1	0	Whitstable	1	0
Bury	3	0	Folkestone	1	0	Maidstone	0	6	Scarborough	4	0	Widnes	2	6
Canterbury	1	0	Gainsboro'	2	0	Maindee	2	0	Sevenoaks	0	6	Wigan	3	0
Chatham	0	6	Halifax	2	6	Manchester	2	6	Slough	0	3	Windsor	0	3
Chesterfield	2	0	Hanley	2	0	Margate	1	0	Stafford	2	0	Winsford	2	6
Chorlton-cum-Hardy	2	6	Hastings	1	0	Marlow	0	3	Stoke	2	0	Wolverhampton	1	6
Coventry	1	0	Henley-on-Thames	0	6	Matlock	2	0	Stone	2	0	Worksop	2	0
Cradley	1	6	Hinckley	1	0	Minster	1	0	Stourbridge	1	6	Worthing	1	0

Telephone Trunk Fees.—Complementary to the tabulated list of Post Office trunk-line fees published with our issue of August 2nd, we give above the latest list of trunk-line tolls charged by the National Telephone Company to subscribers for three minutes' conversation between London and various towns, and *vice versâ*. It will be seen that these fees range from 3d. to 4s., against a minimum of 3d. and a maximum of 8s. 6d. on the Post Office service. The list discloses what we have every reason to believe is little known to the public—viz , that communication can be effected direct to London from such places as Margate, Ramsgate, Folkestone, Hastings, Deal, Blackpool, Eastbourne, Tunbridge Wells, and other favourite health resorts, as well as many of the principal commercial centres in the provinces. We are prepared to state that the majority of visitors to many of these towns are totally unaware that telephonic communication is possible between these places and the metropolis, and that this ignorance is by no means confined to visitors. The National Company is not generally credited with hiding its light under a bushel, except in the matter of these trunk connections, and here, certainly, little or no publicity is given. Surely it should be somebody's business to make known the possibility of this through communication, and the National Company should itself give some prominence to the facilities offered at the various exchanges in the provinces. If the traffic is worth encouraging, a moderate outlay would, we think, bring in a considerable revenue. The tariff in many cases is as low as can be expected, and it is reasonable to suppose that when the Post Office takes over these trunks many of the rates will be raised, although, as may be seen in the table published in our issue of August 2nd, there is still one 3d. rate in the Post Office list—that between Colchester and Ipswich. In the above list there are eight towns with which London subscribers can communicate for the sum of 3d., and some of these (as Watford) are of considerable importance.

Telegraphists' Mortality.—The *British Medical Journal* of August 31st contains a brief summary of the evidence taken before the Committee of Inquiry regarding the grievances of telegraphists in the service of the Post Office. Some of the rules of the Post Office of which telegraphists complain are severely handled by the *Journal*. Much complaint is made against the practice of the weekly changing of the hours of work, necessitating change of habits, irregularity of meals, &c., to the great detriment of health. The most startling evidence, however, was that which showed the very large preponderance of phthisis amongst the causes of death in the telegraph service, which produces a mortality greater than that amongst the Sheffield grinders, a trade which has hitherto been considered as most fatal in respiratory disease. A table prepared by Mr. C. H. Garland, a first-class telegraphist, goes to show that in cases of death from respiratory diseases, including phthisis, up to 55 years of age, telegraphists compare with those engaged in the cutlery trade as 59·5 is to 57·3. In the case of the adult male population of this country these diseases are responsible for a death-rate of 24·4 between the ages of 15 and 55, so that they are nearly $2\frac{1}{2}$ times more fatal in the telegraph service than among the ordinary population. This is still more pronounced in the case of phthisis alone, the ratio being: telegraphists 46·6, Sheffield grinders 33·1, and adult males generally 13·8.

Telegraphic Communication in South Africa.—Telegraphic communication between Umtali and Fontesvilla has now been established, and it is proposed to connect Palapye and Belingwe and district with Buluwayo by telegraph.

Wells.—The Town Council have adopted the report of the Lighting Committee, recommending that Dr. J. Hopkinson be retained to advise the Council as to the lighting of the city by electricity, at a fee of fifty guineas and travelling expenses.

Wilmslow (Manchester).—The question of applying for a Provisional Electric Lighting Order for this district was discussed at the last meeting of the District Council, but was adjourned.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

August 22, 1895.

15,787. R. W. Braham. London. An improved electric connecting device applicable to electroliers, electric light standards, brackets, and the like.

15,794. R. Walther. London. Improvements in incandescent filaments and other similar bodies for use in incandescent electric lamps.*

15,826. G. G. M. Hardingham. London. Improvements in the insulation of electric cables. (The firm of Felten and Guilleaume, Germany.)

15,827. B. Ribikoff. London. An improved arrangement of apparatus for the generation of electricity on railway carriages or trains for lighting or other purposes.

August 23, 1895.

15,863. J. G. Statter. Westminster. Improvements in dynamo electric or electro-dynamic machines.

15,868. J. D. F. Andrews. London. Improvements in arc lamps.

15,870. L. H. Mutting. London. Improvements in and relating to electrically controlled weighing apparatus.

15,880. E. W. Jungner. London. Improvements in electric accumulators.

15,886. C. J. Wollaston. London. Improvements in or connected with electric batteries.*

15,889. La Société les Fils d'Adolphe Mougin. London. Improvements in the construction and working of electric arc lamps. [Date applied for under Patents, &c., Act, 1883, Sec. 103, February, 1895, being date of application in France.]

15,895. S. Quincey and J. H. Collins. London. Improvements in electric contract making and breaking apparatus.

August 24, 1895.

15,899. T. F. J. Truss. Cheshire. Improvements in the construction of telephone instruments.

15,952. W. P. Thompson. Liverpool. Improvements in or appertaining to electric lighting apparatus. (Wilhem Kaiser, Austria.)

15,959. P. Stiens. London. Improvements in incandescence lamps.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

14,988. Wise (Solway). Electrolytic cells.

15,219. Müller. Telephonic, &c., lines.

16,162. Engel. Secondary batteries.

17,066. De Ferranti. Electric cables.

17,737. Nisbett. Electric cables.

17,774. Phonopore Company (Limited) and Smith. Electrical signalling apparatus.

18,661. Acme and Immisch Electric Works (Limited) (D. Moy). Electric fuse-holder.

18,662. Acme and Immisch Electric Works (Limited) (D. Moy). Electric switches.

18,809. King. Secondary batteries.

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COMPANIES' MEETINGS AND REPORTS.

Electric Construction Company (Limited).

The report of the Directors of this Company, which will be submitted at the second annual general meeting of the shareholders on Thursday next, the 12th instant, at Winchester House, Old Broad-street, London, E.C., at 2:30 p.m., states :—

The accounts for the year ended June 30th show a gross profit of £46,690. 15s. 2d., including £2,250. 5s. 7d. brought forward. Deducting interest, outlays on maintenance of buildings, plant, and patents, general expenses, and £5,000 for depreciation, the result is a net profit of £12,091. 10s. 3d., and of this sum the Directors recommend that £1,956. 14s. 5d. be applied in payment of the dividend of 7 per cent. on the Preference shares, and the balance of £10,134. 15s. 10d. be carried forward. The profit and loss account shows a considerable reduction of general expenditure, and, notwithstanding keen competition, a substantial increase of manufacturing profit.

Several important electrical installations have, the Directors state, been successfully completed during the year, production at Bushbury has increased, and the quality of the machinery and plant manufactured has been fully maintained. The works are fully employed on orders, at prices somewhat in advance of those obtainable last year, while the plant and number of workmen have been increased. Among the works in progress special mention is made of the electric lighting installation at Clerkenwell and the electrical equipment of the Hartlepool tramways, and the Directors confidently anticipate that the substitution of electric traction for steam power formerly used at Hartlepool will prove that tramways hitherto worked by horse or steam power unremuneratively may be judiciously adapted for electric traction and yield a satisfactory return on the necessary outlay. Such a result, the Directors feel, cannot fail to give a great impetus to the development of electric traction.

The retiring Directors are Messrs. J. W. Barclay and J. Irving Courtenay, who offer themselves for re-election, as do the auditors, Messrs. James Meston and Co.

NEW COMPANIES, STATUTORY RETURNS, &c.

THAMES VALLEY LAUNCH COMPANY (LIMITED).—This Company was registered on August 30th with a capital of £10,000, in shares of £5 each, to purchase and take over as a going concern the business carried on at Riverside Works, Weybridge, Surrey, and elsewhere, under the style of "The Thames Valley Launch Company," by W. Rowland Edwards, electrical engineer, of Weybridge ; to enter into an agreement dated Aug. 27th last between the vendor and George Willson (for the Company), and to carry on the business of launch and boat builders and owners, electrical and general engineers, suppliers of electricity for motive power, light, heat, &c. The subscribers are: W. Rowland Edwards, electrical engineer (300 shares), S. F. Beevor, electrical engineer (400 shares), George Willson W. H. Smith, T. D. Hollick, engineer, F. W. Hollick, engineer, and George Mansfield, with one share each. The first Directors are S. F. Beevor and W. Rowland Edwards.

BOURNEMOUTH AND DISTRICT ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return to May 24th was recently filed. Of a nominal capital of £50,000, in £5 shares, 5,725 shares had been allotted, and the full amount thereon called.

BRITISH ELECTRO-CHEMICAL AGENCY (LIMITED).—The annual return to April 30th was recently filed. Out of a capital of £50,000, in 5,000 £5 Ordinary and 2,500 £10 Vendors' shares, 2,500 of each class have been taken up, and the latter have been issued as fully paid ; £4 per share has been called on the Ordinary shares.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED).—The annual return to August 12th has been filed. The nominal capital is £1,000,000, divided into 150,000 "A" and 50,000 "B" shares of £5 each. 89,261 "A" £3 paid, 17,139 fully-paid "A" and 23,564 fully-paid "B" shares have been taken up, and the 17,139 "A" and the "B" shares have been issued as fully paid, while the sum of £2. 10s. per share has been considered as paid on the other "A" shares. Resulting from a call of 10s. per share on the 89,261 £3 paid "A" shares, the full amount of £44,630 10s. has been received.

MANCHESTER EDISON-SWAN COMPANY (LIMITED).—The annual return to August 8th has been filed. The nominal capital is £550,000, in 50,000 "A" shares of £9 each, and 10,000 "B" shares of £10 each. 20,000 of the former and all of the latter have been allotted. The full amount has been called on the "B" shares, but only £1. 10s. per share on the "A" shares.

NEW PHONOPORE TELEPHONE COMPANY (LIMITED).—An agreement recently made provides for the purchase from the Phonopore Company (Limited) of letters patent for Great Britain (17,774 of 1894) for improvements in electrical signalling apparatus, and the French and Russian patents for the same invention, and for the exclusive licence to use and enjoy certain patents, including four British, two French, one Russian, two Austrian, two Belgian, one Canadian, one German, two Indian, two Italian, one Portuguese, two Spanish, one Swiss, one American (U.S.A.), and three Argentine, for improvements in telephony, telegraphy and in electrical receiving instruments and relays. The purchase consideration has been fixed at £2,000, payable £1,000 in cash and the allotment of 1,000 fully-paid Founders' shares of £1 each in the New Phonopore Telephone Company (Limited).

RICHMOND (SURREY) ELECTRIC LIGHT AND POWER COMPANY (LTD.).—The annual return to December 31, 1894 (as no meeting was held during that year), was not filed till August 31st last. Of a capital of £50,000, in £5 shares, 4,066 shares have been allotted, and the full amount called.

CITY NOTES.

MEMORANDA.—Bank rate, 2 per cent. (Feb. 22, 1894). Pric of silver, 30 9/16d. per oz. (Sept. 5th). Consols (2¾ per cent.) 107⅜—107½ for money, 107 7/16—107 9/16 for account (Sept. 5th); 2½ per cent. 106—106¼. Stock Exchange Settling Days: Consols, Oct. 1st; Stocks and Shares Continuation Day, Sept. 10th ; Ticket Day, Sept. 11th ; Pay Day, Sept. 12th ; Mining Shares Carry-over Day, Sept. 9th ; Railway and Foreign Stocks, &c., Sept. 10th—12th.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ending September 1st were £786, against £794 in the corresponding week of 1894, a decrease of £8. The total receipts for the half-year amount to £7,669, against £7,735 for corresponding period of 1894, a decrease of £66.

COMMERCIAL CABLE COMPANY.—The Directors of this Company have declared a quarterly dividend of 1¾ per cent., payable on October 1st. The transfer books will be closed from 20th instant to October 2nd.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of August, 1895, were £1,957, against £1,583 in the corresponding period of last year, an increase of £374.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of August amounted to £62,661, and to £60,279 in the corresponding period of last year, an increase of £2,382.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of August amounted to £54,357, and to £44,638 in the corresponding period of 1894, an increase of £9,719.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this Company in August were £28,000, and the total receipts for the period from January 1st to August 31, 1895, £202,800, against £180,000 and £182,200 in the corresponding months of 1893 and 1894 respectively.

JAPAN.—As in many other matters, Japan is stated to be a shade in advance of Great Britain in the matter of dividends of electric lighting concerns. It is reported that the shareholders in the Kyoto Electric Light Company have recently received a dividend of 18 per cent. per annum. Complete particulars are wanting.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ending 1st inst. amounted to £1,272. The amount for the corresponding week last year was £1,152. Increase, £120.

MILVER PORTABLE ELECTRIC BATTERY SYNDICATE (LIMITED).—The statutory meeting of this Syndicate was held on Monday at Birmingham, Mr. Hyman Levetus presiding. The Chairman explained that the Company was a private limited one—all the shares having been subscribed for. He congratulated the shareholders upon the property they possessed, and calmly anticipated a return equivalent to 20 times the sum invested, although no date was fixed when this return was likely to happen. The Company had met with very much discouragement from men who had more or less scientific knowledge, who had pointed out that it was impossible for them to attempt to compete with those whose electric current was generated by engines and dynamos ; but in reply to these objections he said they did not use zinc, but a substitute with a special solution costing about one-twentieth the price of zinc. He thought there was an important future for them, because they could supply power at 4d. per horse-power, and when their electric horse was not at work it cost nothing, and when charged it would run for 10 hours without refreshment, and could take its next meal in 10 minutes, and when the law had been altered to permit the working of vehicles by electricity along country roads there would be no necessity for light railways. Every farmer could have his own produce waggon and take it along the roads at the highest rate of speed allowed by the authorities. The tramways in Bristol Road had not been successful owing to the dead weight and uncertainty of the accumulators. The weight of an ordinary accumulator for 10 hours' discharge was from 800lb. to 1,500lb., while the outside weight of a Milver battery was 400lb. They could have a Milver battery large enough to light a cathedral, or small enough to carry in the hand for a bed-room candle. To bring about these results they had had to construct new receptacles. They hoped shortly to call the shareholders together and show them a horseless carriage and electric lighting with Milver batteries. The Company had applied for patents in 15 countries, and provisional protection had been obtained. They had been authoritatively informed their patents were all valid. In regard to the construction of the Milver battery they had been told by experts that the difficulties of polarisation were insuperable, and that the cost of zinc was too prohibitive; but the impossible had been overcome. Their light would not exceed a cost of 6d. per unit. There were only a few shareholders present at the meeting, and it is not reported whether anyone asked for an instalment on account of the 400 per cent. profits prophesied by the Chairman.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ending August 30th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,038.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the half-month ended August 31st are £1,538, as compared with £1,719 in the corresponding period of 1894.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, August 28.	Price Wednesday, Sept 4.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Sept. 4. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£1,012,880	Stock	11/0	Anglo-American	47 49	48 50	4 0 0	Jan., Apr., July, Oct.	..	..
£2,993,560	Stock	22/0	Do. Preferred	89 90	89 90	5 8 0	" "	90	89½
£2,993,560	Stock	5/0	Do. Deferred	8½ 9	8¾ 9½	..	" "	8½	..
£173,400	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102 105	102 105	3 16 9	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	13¾ 14¼	13¾ 14¼	4 11 3	Mar., June, Oct., Dec	14 1/16	13¾
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111 115	111 115	4 7 9	June and December	..	..
10,000,000	$100	1¾%	Commercial Cable Capital Stock	160 165	160 165	4 4 10	Jan., Apr., July, Oct.	..	..
16,000	10	3/0	Cuba Submarine	13 14	13 14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20 21	20 21	3 16 2	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	4 5	4 5	4 0 0	April and October	..	–
6,000	5	10%	Do. Preference 10 per Cent.	9¾ 10¼	9¾ 10¼	4 7 7	" "	..	–
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103% 106%	103% 106%	4 4 11	" "	..	–
60,710	20	2/0	Direct United States Cable, 1877	9 9½	9 9½	4 4 3	Jan., Apr., July, Oct	9½	..
400,000	10	5/6	Eastern	17 17½	17½ 17⅞	3 14 10	" "	17½	17⅛
70,000	10	6%	Do. 6 per Cent. Preference	17¾ 18¼	17¾ 18¼	3 5 9	" "	17⅞	..
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	127 130	127 130	3 1 7	May and November	128½	128
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105 108	105 108	4 13 0	February & August	104½	..
250,000	10	2/6	Eastern Extension	17⅝ 17⅞	17¾ 18	3 17 9	Jan., Apr., July, Oct.	17 11/16	17⅝
£820,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125 129	126 129	3 2 0	February & August	..	..
£54,100	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	102 106	102 106	4 15 3	January and July	103½	..
£80,000	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	102 106	102 106	4 15 3	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106 108	105 108	3 1[illegible] 3	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	113% 116%	113% 116%	3 9 9	May and November	..	..
180,227	10	3/3	Globe Telegraph and Trust	10½ 10⅞	10½ 10⅞	3 19 6	Jan., Apr., July, Oct.	10¾	10½
180,042	10	6%	Do. 6 per Cent. Preference	16¾ 17¼	16¾ 17¼	3 10 1	" "	17⅛	16¾
150,000	10	5/0	Great Northern	21¾ 22¼	21¾ 22¼	3 16 3	Jan., April, and July	21¾	22
£190,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue ...xd	105 108	103 106	4 14 4	March & September	..	..
17,000	25	37/6	Indo-European	50 53	50 53	4 14 4	May and November	52	50½
87,548	10	2/6	London Platino-Brazilian	5 7	5 7	..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures ...xd	107 111	104 108	5 11 1	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	107 110	107 110	3 13 1	..	–	..
11,839	8	4/0	Reuter's	3½ 4½	3½ 4½	..	April and October	..	..
8,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	127 132	127 132	4 12 4	" "	..	..
15,609	10	2/0	West African Telegraph	5½ 6½	5½ 6½	..	January and July	..	–
£235,300	100	5%	* Do. 5 per Cent. Debentures (red.) ...xd	105 108	103 106	4 14 4	March & September	..	..
30,000	10	2/0	West Coast of America	1½ 2½	1 2	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99 104	99 104	7 13 10	June and December	..	..
85,321	10	6d.	West India and Panama	¾ 1	¾ 1	..	..	⅞	..
31,563	10	6%	Do. 6 per Cent. 1st Preference	10 10½	10 10½	5 14 3	May and November	10 1/16	10 5/16
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½ 9½	8½ 9½	5 13 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110 113	110 113	4 9 1	June and December	..	..
64,242	15	6/0	Western and Brazilian	10½ 10¾	10½ 10¾	3 4 4	May and November	10 7/16	10⅜
83,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½ 7	6½ 7	..	–	..	..
83,129	7½	1/6	Do. 5 per Cent. Deferred	4¼ 4¾	4¼ 4¾	..	–	..	..
£165,200	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101 105	101 105	5 14 10	February & August	..	..
£206,400	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101 105	101 105	5 14 10	" "	..	..
$1,177,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113 118	113 118	6 0 11	May and November	..	..
£164,300	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.) ...xd	102 104	100 103	5 16 6	March & September	..	..
			TELEPHONES.						
44,000	5	2/6	Chili Telephone (fully paid)	3 3½	3 3½	..	..	–	–
224,850	10/0	1½d.	Consolidated Telephone Const. & Maintenance	1/16 3/16	1/16 3/16	–	May and November	..	–
171,504	£1	8·215d.	Oriental Telephone and Electric (fully paid)	9/16 11/16	9/16 11/16	..	Yearly	..	..
484,597	5	2/6	National	6 6½	6 6½	4 0 0	June and December	6¼	6 1/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	16 18	16 18	3 6 8	" "	17	16½
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15 16	15 16	3 15 0	" "	15⅛	..
119,234	5	2/6	* Do. 5% Non-Cumulative 3rd Pref.	6 6½	6 6½	4 0 0	–	6 3/16	6½
1,100,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	106 108	106 108	3 5 1	January and July	106½	..
58,000	5	3/0	United River Plate	2½ 3	2¾ 3¼	..	" "	2 13/16	..
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	92 97	92 97	5 3 1	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.						
40,000	£10	5/0	City of London Electric Lighting (fully paid)	14½ 15½	15 15½	1 12 3	–	15¼	15⅛
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15½ 16½	15½ 16½	3 12 9	–	16⅛	15⅞
£100,000	Stock	5%	Do. 5% Debenture Stock (red.)	131 134	132 135	3 14 1	June and December	135	133½
19,900	£5	..	Electricity Supply Co. for Spain	..	..	..	–	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	5½ 5¾	5½ 5¾	..	–	..	–
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..	–	..	–	..	–
8,322	£5	..	House-to-House Electric	–	–	..	–	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	–	–	..	–	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..	..	..	January and July	..	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7⅞ 8⅜	7⅞ 8⅜	..	–	..	..
111,000	5	..	London Electric Supply	..	..	..	–	..	–
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	11½ 12½	12 12½	2 8 0	..	12¼	12
£150,000	Stock	4½%	* Do. 4½% Debs.	117 119	117 119	3 16 1	June and December	117	..
6,452	£10	2/0	Notting Hill Electric	8½ 9	8½ 9½	..	–	..	–
19,980	£5	2/0	St. James and Pall Mall	8¼ 8¾	8¼ 8¾	..	–	8⅜	–
20,000	£5	7%	Do. 7 per Cent. Preference	9 10	9 10	3 10 10	–	9¼	9¼
59,900	5	2/6	Westminster Electric Supply (fully paid)	8½ 9	8½ 9	3 1 1	–	..	..
..	..	..	Rand Electric	1/16 3/16 prem.	..	..	..	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	3	1/6	Brush Electrical Engineering	2 2½	1¾ 2¼	7 1 4	–	2	..
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2 2½	1¾ 2¼	5 13 11	–	2¼	2
£125,000	Stock	4½%	* Do. 4½ per Cent. Debentures ...xd	113 116	111 114	3 18 11	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1 2	1 2	..	January and July	..	–
12,139	5	1/6	Edison and Swan United	2 2½	2 2½	..	..	..	..
£100,000	Stock	4½%	Do. 4% Mortgage Debenture Stock	104 107	104 107	4 4 1	..	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	–	..	..	..	–	..
120,000	2	..	Electric Construction	⅝ ⅞	⅝ ⅞	..	..	..	..
12,846	2	2/9¾	Do. 7 per Cent. Cumulative Pref.	2 2½	2 2½	..	..	–	..
91,195	2	10/0	Elmore's Patent Copper Depositing	¾ 1	¾ 1	..	..	–	–
20,000	5	..	Fowler-Waring Cables (fully paid)	¼ ¾	¼ ¾	..	..	..	..
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	19 21	19 21	4 15 3	February & August	..	..
£100,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102 104	102 104	4 8 3	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..	..	..	–	–	..
16,000	£10	..	Do. 8 per Cent. Preference	–	..	..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	⅛ ⅜	⅛ ⅜	..	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	43 45	43 45	4 0 0	March and July	44½	43½
£150,000	100	5%	Do. 5 per Cent. Bonds	104 107	104 107	4 13 6	January and July	..	–
37,514	£5	–	Woodhouse and Rawson Ordinary (£3 15s. paid)	..	..	..	..	..	–
41,098	£5	..	Do. Preference (fully paid)	..	..	..	..	..	–
£100,000	10	6/0	W. T. Henley's Telegraph Works Ordinary	11 11½	11½ 11¾	..	..	..	–
£30,000	10	..	Do. 7 per Cent. Preference	15 15½	15 15½	4 10 4	..	15½	..
£.0,000	Stock	4½	Do. 4½% Mortgage Debenture Stock ...xd	106 109	104 107	4 4 1	..	..	–
			RAILWAYS AND TRAMWAYS.						
£330,000	Stock	1½%	City and South London Railway	38 40	38 40	3 2 6	May and November	39½	..
7,000	10	5%	Do. 5% Perpetual Preference	14½ 15½	14½ 15½	3 4 6	..	..	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	134 136	134 136	2 18 10	May and November	..	..
87,500	£10	2½%	Liverpool Overhead Railway	10¾ 11	11 11¼	2 0 5	–	–	–
6,295	10	5%	Do. 5% Preference	15 15½	15 15½	3 4 6	..	–	–
25,000	Stock	4%	Do. 4% Debenture	111 113	111 113	3 10 10	January and July	–	..

In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 904. [No. 20. Vol. XXXV.] FRIDAY, SEPTEMBER 13, 1895. PRICE SIXPENCE.

NOTES.

THE vision of transcendent knowledge which Prof. W. M. HICKS has conjured up in his Presidential Address before Section A, which will appear in our next issue, is still far distant; the day is not yet when "all physical phenomena will be a branch of pure mathematics," and when we, viewing all phenomena as "manifestations of motion of one single continuous medium," shall replace the study of dynamics by the study of that quintessence of finality, the equation of continuity. We will not stay to question in detail whether, in the evident trend of modern science along converging paths towards unity, we are justified in believing that "the ultimate aim of pure science is to be able to explain the most complicated phenomena of Nature by the fewest possible laws from the simplest fundamental data." The trend is evident; but if the aim of science be to find out Nature as she is, it must first be proved that Nature herself is explicable in these simplest and most unified terms. We can point to at least one set of phenomena in Nature—the mental and its allies—which are likely to baffle Prof. HICKS's analytical reagent for all time. However this may be, the live load of scientific thought is increasingly imposing itself upon the properties of the ether for its support; and questions of physical phenomena are more and more numerously resolving their issues into the highly debatable ground of the mechanism and behaviour of that subtle substance. The wreckage of rejected theories of the ether, says Prof. HICKS, is appalling. Yet all this disastrous running on to rocks will not have been altogether calamitous if we are in future led to look out more carefully for rocks ahead. The danger lies in simplifying ordinary phenomena at the expense of the simplicity of the ether. We gain nothing if we rob material phenomena of their complexity in order to make a present of that complexity to the ether. The action of an engine is none the more readily explained when its working parts have been made invisible by the guard plates with which we may cover it in; the theory of a Willans engine gains nothing in simplicity on account of the enclosing crank case. At all costs, if we are to simplify everything by means of the ether, let us have an ether which is in itself simple, or at any rate less complex than that which it is designed to explain.

TAKE, for example, that ingenious speculation of which Prof. HICKS gives some account, in which the ether is conceived to be composed of a medium "spaced into rectangular boxes," within which the fluid medium "streams up in the centre of the box, then turns round, flows down the sides and up the centre again," like a badly-packed Hill's vortex, which "can swallow another and retain it inside in relative equilibrium." Or take the hypothesis that the ether consists both of a primary raw stuff and a secondary cellular stuff, within which are embedded the atoms of matter, either composed of the primary or secondary stuff, each atom being connected to other atoms by means of vortex ether filaments. In what way, may we ask, does either of these conceptions, whether plainly stated or garbed in the language of the mathematics from which the idea is evolved, assist us to any better understanding of the How or the Why of Nature? To what extent can such complex speculations, located in infra-microscopic, infra-atomic spaces in an invisible medium, supply us with anything better than a new shibboleth, with which to formulate our ignorance of the ultimate end of phenomena? Where, in these conceptions, are we to discover that step towards the simplification of laws and the narrowing down of data, which it is said to be the aim of science to achieve?

PROF. L. F. VERNON-HARCOURT makes a very plausible point towards the end of his Presidential Address to Section G, which we hope to find room for next week. Physicians, he remarks, try to cure people when they are ill, whereas engineers do much to render doctors unnecessary by maintaining the community in good health by the provision of good water supplies, good drainage systems, and facilities for getting away to "fresh woods and pastures new" when the strain of business threatens to result in a breakdown. Inasmuch, therefore, as prevention is better than cure, mankind is more beholden to the preventive benefits of engineering than to the drugs of the medico. This is, however, but half the case. Speaking generally, the operations of the medical profession do not give rise to new diseases as fast as old ones are stamped out. The same cannot be said of the operations of the engineering profession, by which the socially and physically unhealthy aggregations of human beings that characterise the age have alone been made possible. True it is that incidentally the engineer of one branch tends to ward off or mitigate the evil effects of the labours of the engineer of

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another branch. But it does not seem more rational to shower praise on such a performance than on the performance of an ingenious individual who is engaged in knocking down ninepins of his own setting up.

Prof. Harcourt is in favour of the engineering degree. So are we, provided the antecedent practical training is sufficiently thorough. To grant engineering degrees for mere book learning and college laboratory proficiency is, we think, a course full of danger to the public and disappointment to the graduates.

It is interesting to note that the technical literature of even inland navigation is accumulating so fast that a comprehensive and authoritative catalogue has become a prime necessity. The last scene of all of this strange eventful history will, no doubt, be a catalogue of catalogues, with half the engineering profession engaged in abstracting and indexing the records of the other half.

The noise of the Niagara word-fall still continues, and the special number of *Cassier's Magazine*, to which we alluded last week, is not, alas, to be the final fanfare. In the current number of *Blackwood* will be found an exceedingly lively and discursive article on "Harnessing Niagara," from the pen of Prof. George Forbes. It would be difficult to imagine a disquisition better calculated to stir up the dying embers of a very unpleasant controversy, redolent of personalities, professional prejudice and mistaken patriotism. As one might naturally suppose, the tale of the harnessing of Niagara, as told in "Maga," is meant to tickle "the ear of the groundlings," and contains no engineering information not previously available. Nevertheless, Prof. Forbes's homily has its educational value. Engineers will learn that Americans are neither inventive nor humorous, they will learn not a little as to what is and what is not professional etiquette; they will learn how to deal with presidents and vice-presidents, how to manage millionaires and associate with the Potters and Lorillards, and if they wish to know, without the trouble of a trip to the United States, how the average American strikes the average Englishman, Prof. Forbes's character sketch will serve that purpose as well as anything we know of. The author is inclined to believe that the "splendid results" attained at Niagara are due not only to engineering skill but to the "exercise of tact, judgment and forbearance, combined with firmness." We also are quite ready to believe this, though we look in vain for these particular qualities in the article in question.

We cannot help thinking that it is about time to pass an Act of Oblivion in connection with all that took place with reference to the design and construction of the Niagara plant. The dispute has not at any time been particularly edifying, and it now bids fair to become wearisome. At any rate all further contributions to the discussion might be confined to the American technical Press. It is difficult to see in what way these minutiæ can interest the British public, and yet the greater part of the discussion is taking place in the columns of *The Times*. Only on Tuesday last there was a column-long letter from the Westinghouse Company, the most important part of which is that Company's account of the relative parts played by it and Prof. George Forbes in the design of the Niagara generators. This account runs as follows:—

The Cataract Construction Company, in September, 1893, submitted to us plans for a 5,000 H.P. generator, saying that such plans had been prepared by their engineers, and asking us to make a tender for its construction and erection. The careful consideration of the plans submitted disclosed the fact that, if constructed according to such plans, the generator would be a failure, and this Company thereupon refused to tender on the drawings and specifications presented. We however, offered to accept the general form of generator, and to redesign it so that it would be a perfect machine mechanically and electrically, and to submit new plans and specifications upon which the Company could tender. This was agreed to by the Cataract Construction Company, and the generators now in use at the Niagara Falls were built by us according to plans and specifications prepared by our own engineers. There is about the same difference between the machine designed by Prof. Forbes and that designed by us, as there is between the picture of a man and the man himself—the appearance externally being very similar, but internally there is no resemblance whatever.

The non-technical Press is not so often wrong in its science as lacking in a due sense of proportion. Thus, in an interesting article in the *New York Law Review*, entitled "Liability for Escape of Electricity," we learn that "telephone lines are invariably the sufferers, since the relatively weaker current which they employ and the greater delicacy of the instruments used for the transmission of speech, render them easy victims of the stronger currents and less susceptible machinery of the railway lines." There is no doubt, of course, about a telephonic current being "relatively weaker" than that sent out by an average street railway generator; but one might just as well speak of a gnat as being relatively weaker than an elephant.

Battersea Polytechnic Institute.—Full particulars of the day and evening classes at this Institute are given in the prospectus of 1895-96, just to hand.

Cable Interruption and Repairs:—

	Date of Interruption.
Aden-Zanzibar	September 2, 1895.

The Fatal Accident on Electric Tramway at Portrush.—The Board of Trade inquiry will be held on Wednesday next, at 11:30 a.m., in the Town Hall, Portrush.

The Length of the Metre.—Last Tuesday's sitting of the International Metric Congress was entirely devoted to the question of the comparison of the metre with the wave-length of light. The result is that the metre is said to be 1,553,663 times the length of the standard wave of red light.

Electric Launches in Copenhagen.—A company was formed some time ago in Copenhagen for the purpose of starting electric launches on some small lakes within the town in lieu of petroleum launches, which had been very far from a success. The company has secured a 30 years' concession. It was in contemplation to have the accumulators made in Germany, but they are now being manufactured in Copenhagen, as the German firms could not guarantee sufficiently early delivery.

Electric Lighting in Chelsea.—In the thirty-ninth annual report (1894-95) the surveyor to the Chelsea Vestry reports that the customers of the Chelsea Electricity Supply Company are now 598 in number, an increase of 98 in the year. Only one application was made during the year to have a meter tested; it was found to be registering 1·3 per cent. *under* at full load, to be correct at half load, and 15 per cent. *over* at a light load. As the load was very light at these premises a smaller meter was inserted by the Company, and the cost of the test was paid by them. Up to the present the difference in cost of the electric lighting of the Town Hall as compared with gas is inappreciable.

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The Telephone in Paris.—Government purchase is evidently no panacea for telephone troubles. M. André Lebon, Minister of Commerce and Posts, announces, says the Paris correspondent of *The Times*, "some improvement in the telephone system for next January, but the deficit is pleaded as an excuse for not as yet reducing the subscription in Paris, which is heavier than in other large cities. The possibility of increasing the revenue by lower rates and more subscribers does not seem to be considered. We must, therefore, be thankful for such small mercies as a reduction from 50c. to 25c. for a three minutes' conversation in Paris, a reduction from 160fr. to 50fr. for a subscriber's supplementary wire, and the abolition of the surtax on clubs and restaurants."

The Electric Furnace—Dr. Baxeres Torres, of the Technical Association of London (Limited), writes us as follows:—

SIR: In the interesting Paper upon electric furnaces, by Mr. Ch. Street, which, as read before the Société Internationale des Electriciens, you quote in your issue of the 23rd ult., as well as in the summary of patents with which the Paper closes, I am surprised to find that, though many French patent office records have been duly extracted and included, yet no mention whatever is made of my original French patent No. 220,519, March, 1892, nor of the four additions thereto—viz., three in the following April and the fourth in May of the same year. I have been working earnestly at the development of this furnace since I took out the above patent, and I am happy to inform you that now an English company is established to exploit and put into practical work my various metallurgical processes and patents, under the title of The Technical Association of London (Limited), with offices in London, and somewhat extensive experimental work with powerful machinery in St. Anne's Court, Wardour-street.

Paper Insulated Cables.—Notice is given that it is the intention of the Amos Emerson Dolbear and the British Insulated Wire Company of Prescot to present a petition to Her Majesty in Council praying that the term of Patent No. 1,368 of 1882 may be extended. Notice is further given that on November 1st next, or on such subsequent day as the Judicial Committee of Her Majesty's Privy Council shall appoint for that purpose, application will be made to the said Committee that a time may be fixed for hearing the matter of the said petition, and notice is also given that any person or persons desirous of being heard in opposition to the petition may enter a caveat to that effect in the Privy Council on or before November 1st next. The patent in question relates to the construction of an electric cable consisting of a paper tube containing a copper conductor of smaller diameter, which conductor either rests at the bottom of the tube or is supported in its centre by an open spiral of cord.

Working Expenses on Electric Railways.—The *Railway Age* of America expresses the opinion that on its side of the Atlantic "electric railways have not yet been in operation long enough to fairly test the comparative cost of operation and maintenance, although some claims for great economy have been ventured. A statement of the gross and net earnings of the electric lines in five cities—Buffalo, Columbus, Lehigh, Scranton and Indianapolis—appears to show that the percentage of operating expenses to earnings was, respectively, 53, 51, 58½, 68½ and 59. If these widely-varying results may be taken as at all representative they show an average of about 60 per cent., which, compared with nearly 70 per cent., the average of the steam railways of the country, seems favourable. But when the time for renewals of electric appliances has come and gone statistics of expenses will have much more value than they now can possess.' In other words, when it is seen how much foresight there has been to provide against depreciation, we shall the better know whether these are or are not the true relation between earnings and working expenses.

A Fortunate Lightning Stroke.—Writing to *The Times* on the subject of lightning, Mr. C. Tomlinson, F.R.S., states that in the sixties it was generally held at the Admiralty that lightning conductors attracted lightning instead of warding the stroke off. Snow Harris had strenuously recommended his metallic conductors for ships, and had abundantly proved what important losses had occurred through their absence. He had obtained permission to erect his conductors on ten ships destined for foreign service, and in one of them a flagstaff had been put up above the conductors, and was consequently shattered by a lightning stroke, but no further damage was done. This trifling accident seemed to justify the order for the removal of the conductors from each ship on its return home. At Devonport a bifurcated discharge had most singular results. Sir John Rennie was employed by the Admiralty to erect two victualling houses at Devonport. Each was furnished with a granite chimney rising 60ft. above the roof. One of these was furnished with a lightning conductor; but before the other was erected Rennie called on Snow Harris with the indignant complaint that the charge for lightning conductors had been struck out of the estimates. Harris said, "Well, never mind, Nature will avenge us!" Never was prophecy more amply fulfilled. A bifurcated stroke of lightning fell on the two victualling houses; the protected building suffered no injury, the unprotected chimney was torn open, with other damage to the building, to the admiration of the British Association, which met at Plymouth that same year, namely, 1841. This fortunate bifurcation at once made lightning conductors popular.

The Compagnie Française des Cables Télégraphiques.—The Venezuelan *Gacetta Official* of January last announced the grant, for a term of 50 years, of two exclusive concessions to the Société Française des Télégraphes Sous-Marins (now united with the "P.Q." Company under the title of the Compagnie Française des Cables Télégraphiques), the one being for cable communication, direct or indirect, between Venezuela and the United States, and the other for cables on the Venezuelan coast. These concessions were ratified by the Government of the Venezuelan Republic in June. It is reported that the Compagnie Française claims also to have obtained landing rights in New York for a cable extension, thence down to the West Indies, with a view to thus bringing their Venezuelan, Brazilian and West Indian cable system in direct communication, *viâ* France, with Europe, and that after the deep-water repair of their Penzance-St. Pierre cable, upon which the "Faraday" is now engaged, has been effected, they will proceed with this extension. The report would seem to be based upon a misconception of United States law, which forbids the landing on American shores of cables, for which exclusive landing rights elsewhere are held. Should the "Faraday" fail in repairing the deep-water break above-mentioned within two months, the repair will probable be abandoned for the season, as was that of another Atlantic cable upon which the same vessel was so long at work last summer. According to the *Bulletin de l'Electricité* of the 1st inst., the Compagnie Française are paying for the charter of the "Faraday" no less than £300 a day.

Military Telegraphy at the New Forest Manœuvres.—The following extract from a letter of *The Times* correspondent present at the recent military manœuvres in the New Forest will be read with interest. The incident referred to is the outpost duty practice at night which took place:—

"And here came again into play the 'wire' as an invaluable aid in war. From the tents of the two generals lines were laid to the several pickets and detached posts, with orders to reel up and retire with the pickets if these were compelled to fall back, but to at once reopen communication when the pickets halted. In the Northern force the sapper clerks were at the ends of the 'wire' for the long period of 26 hours. In the Southern force the general, pushing out at daybreak some cavalry, gave the clerks a little rest. But the Northern general, owing to the nature of the duty specially imposed upon him, could not afford to dispense with the 'wire' for a single instant. . . He preferred to be in conversational contact with the picket officers, to hear their reports, to ask them himself for information required to complete or supplement those reports; and this he did through the 'wire,' and thus exactly at the right moment he was able to give the order to strike the camp, move off his force, and ride away himself to the new battlefield, not giving up the 'wire,' but to all intents and purposes tying it to his horse's tail for subsequent use. . . As affecting the movements of the troops, the semi-close ground has rendered frequently unavoidable the breaking up of larger units into smaller ones, temporarily out of touch and sight of each other. This disintegrating process would make itself felt much more in the really close country of cultivated England. It is the 'wire' alone that can effectively connect those out of sight but still very much in mind. Here daily has been seen accompanying the generals as they moved about, a well-horsed cart or waggon capable of being taken across country or at racing pace along roads. On the vehicle sits the telegraph clerk, in a box by him is the telephone, and from it streams the 'wire' to the unit temporarily lost to view, or perhaps executing a wide turning movement; and thus the general is kept accurately informed of the position and the progress of the absent unit. It is satisfactory to be able to report that German officers have admitted that in field telegraphy our Army is far ahead of their own."

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WILLIAM STURGEON.

William Sturgeon, the electrician and natural philosopher, was born (on May 22, 1783)* at Whittingham, a village close to the Westmorland border of Lancashire, and near the town of Kirkby Lonsdale. His father, John Sturgeon, was a clever but idle shoemaker, who came from near Dumfries, and married Betsy Adcock, daughter of a small shopkeeper in Whittingham. William Sturgeon's early years were passed under conditions of great hardship. His father devoted more attention to poaching salmon in the river Lune than to his trade, and young William had to assist in the nightly raids. At 13 he was apprenticed to a shoemaker at Old Hutton, near Kirkby Lonsdale, and was doomed to be even more cruelly treated than at home. Yet, amid all the hardships that a bad master was then able to inflict on an apprentice, and although surrounded by every temptation and evil influence, he contrived to learn something of music and several mechanical arts, such as the repairing of clocks and watches.† At the age of 19, seeing little prospect of improving his position as a journeyman shoemaker, he enlisted in the Westmorland Militia, and in 1804—two years later—he became a private in the 2nd Battalion of the Royal Artillery, and remained in the Army as a "private and gunner" until 1820. This period included the stirring times of the Peninsula War and the Battle of Waterloo, but an examination of the R.A. records shows that Sturgeon was never on war service.‡ His leisure time was devoted to his trade, to making artillery models and electrical instruments, and to study. "The soldier's life," says Major Murdoch, "was then more monotonous and less arduous than now; and there not being any meal after dinner, many unbroken hours of leisure were at the command of the soldier—for good or evil. 'Out lights' was sounded at 8 o'clock in winter and 8:30 p.m. in summer; but with the aid of a rush-light, and covering the windows with blankets secured by forks, Sturgeon was in the habit frequently of preferring his studies to sleep—the mess conniving at his breach of the regulations in consideration of his geniality and occasional 'odd jobs to their boots.'" His attention was directed to electrical science by a terrific thunderstorm,§ and he resolved to fit himself for its study. He worked at mathematics and learnt sufficient Latin and Greek to understand the meaning of scientific terms. French, German and Italian he was finally enabled to read with considerable facility. Thus prepared, he entered upon the general study of natural philosophy, but the phenomena of electricity and magnetism had the greatest attraction for him.

He left the army at the age of 37, his conduct, according to the testimony of his commanding officer, having been "altogether unimpeachable." He then followed his trade as a bootmaker in a shop at Artillery-place, Woolwich, but he kept up his interest in science especially by constructing apparatus. His pursuits during this time will be best given in his own words: "After leaving the service of the R.A. in 1820, and as my slender finances presented opportunities, I turned my attention to scientific inquiries, and to the construction of some of those philosophical apparatus which from my boyhood I had been an admirer of, but which during *my* service at least a military profession precluded all further knowledge of than which was to be derived from books of science—a species of commodity at that time exceedingly rare in the Army, even in the distinguished branch to which I had the honour to be ong. My first step towards constructing apparatus was the purchase of an old lathe and a few tools to work with. My stock of tools, however, was very limited, from a want of means to purchase more, so that many rude substitutes were brought into requisition; and as I had no practice either at the lathe or the vice, my first essays in apparatus-making were necessarily deficient of those elegancies of structure and refinements of workmanship which always characterise the productions of regular instrument makers. Notwithstanding these disadvantages, however, hope and perseverance surmounted every difficulty that was met with, and I soon found myself capable of constructing such pieces of apparatus as I immediately wanted for my purpose; and it was not long before I found purchasers for others, even amongst the first-rate instrument makers in London." His philosophical pursuits brought him in contact with Marsh the chemist, Barlow, Christie, and Gregory. Owing to their influence he was appointed Lecturer on Experimental Philosophy to the Hon. East India Company's Military Seminary at Addiscombe. This college was originally founded for the appropriate education of young men who desired a commission in the artillery or engineer corps of the Company's army in India. He also lectured at the Adelaide Gallery of Practical Science, Addiscombe. In 1840 he was invited to Manchester to act as superintendent of a new institution—the Royal Victoria Gallery of Practical Science—which was established to commemorate the Queen's marriage. The aims of the founders were set forth as follows:—

1. To provide a permanent collection of models and apparatus to illustrate the arts and manufactures, and for the display of experiments combining philosophical instruction with general entertainment.

2. To afford facilities for demonstrating *practically* such elementary principles in mechanism, chemistry, and other departments of practical science as admit of direct application to the useful arts.

3. To exhibit the progress which has been gradually making and which may still be made in branches subservient to productive industry.

4. To stimulate research and foster inventive talent by honorary or pecuniary rewards, and to furnish to the junior members of the community such attraction as may allure them to the acquisition of valuable knowledge by affording them pleasure in the pursuit of it.

Sturgeon, now 57 years of age, entered on his duties early in 1840. On March 3rd he commenced the first course of lectures, and in June the Exhibition Gallery was formally opened. Most energetic attempts were made to bring success to the Institution by exhibits of apparatus, models, &c., and making the lectures as popular and interesting as possible. The lectures related to electricity and magnetism, optics and mechanical philosophy. The latest inventions, such as electrotyping and the electric telegraph, were exhibited; nevertheless, the Royal Victoria Gallery failed for want of adequate financial support. An attempt was then made to found an institution on similar lines, called the Manchester Institute of Natural and Experimental Science. The first course of lectures related to Mechanical Philosophy, and Sturgeon commenced the series by observing that this was the second time in Manchester that it had fallen to his lot to open the lecture department of a newly-formed scientific institution; and "although in the first instance this hope of success was doomed to disappointment (from a cause which was not properly explained), he still felt a confidence that in this town the love of scientific investigation among the inhabitants was not a topic of controversy, but was established beyond dispute. Under these circumstances there seemed no reason to suppose that a scientific institution should fail in being supported in this metropolis of manufactures." Nevertheless, Sturgeon's hopes were again disappointed, and at the age of 61 he was thrown out of regular official engagements, and had to rely upon chance lecturing and literary work for the support of himself and his family. He remained in Manchester lecturing from time to time at the Royal Institution and the Mechanics' Institution until 1846, suffering from ill-health and poverty. In September of that year he went to Biggins, near Kirkby Lonsdale, to recruit after a long and serious illness; and, notwithstanding his shattered health and depression of mind, he made certain observations, and wrote "Three Accounts of the Aurora Borealis and the Formations of Clouds as observed in the locality of Kirkby Lonsdale." In August, 1847, Lord John Russell was induced to grant him the sum of £200 from the Royal Bounty Fund. Sturgeon being now 64 years of age, and it was strongly urged by his friends that this sum would only release him from temporary embarrassment, and that he ought to be pensioned. These representations succeeded, and in July, 1849, his name was placed on the Civil List for a pension of £50 per annum.

* This date is taken from the register by the Rev. Edward Pigot, of Whittingham.

† See "A Short Account of the Life and Writings of the late William Sturgeon," by J. P. Joule, *Mem. Manchester Literary and Phil. Soc.*, 1857.

‡ I am greatly indebted to Colonel A. E. Turner, A.A.G., R.A., for this information, and also for the following pamphlets: "The Cantor Lecture, 1890—William Sturgeon," by Major R. H. Murdoch, R.A., reprinted from the *Proceedings* Royal Artillery Inst., No. 2, Vol. XIX.; and "A Distinguished Gunner," by the same author, from *Proceedings*, R.A.I., No. 6, Vol. XIII.

§ See *Manchester Examiner and Times.* Obituary Notes. Dec. 14, 1850.

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Wm Sturgeon

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This was, however, of little service to him. He never entirely recovered from a severe attack of bronchitis, from which he suffered when living in Greenheys, and he removed to the highest part of Manchester—Prestwich—in the hopes that the air there might be better suited to him. On Thursday, November 28th, 1850, he caught a severe cold, and although assiduously attended by his friends Leigh and Burrow, he died on Sunday, December 4th. He was interred in Prestwich churchyard in the presence of Joule and other scientific men. The gravestone—an ordinary flat one—bears the simple inscription :—

WILLIAM STURGEON,
The Electrician,
Born 1783, died 1850, aged 67.
Also
MARY STURGEON,
Died October 2, 1867, aged 77.
ELLEN, wife of Luke Brierley,
Died January 19, 1884, aged 51.

Soon after entering the Royal Artillery, Sturgeon had married a widow, Mrs. Hutton, who had a shoe shop in Woolwich. They had three children, who all died in infancy. In 1829 he again married. His second wife was Mary Bromley, of Shrewsbury, by whom he had one daughter. On the death of this child they adopted his neice, Ellen Coates, who married Luke Brierley. It may be interesting to give a list of Sturgeon's places of residence:—(1) 8, Artillery-place, Woolwich; (2) Westmorland Cottage, Old Kent-road; (3) 55, Burlington-street, Hulme, Manchester, described as Lecturer, Royal Victoria Gallery; (4) Albert-terrace, Radnor-street, Hulme, described as Lecturer, Manchester Institution of Natural and Experimental Science; (5) 20, White-street, Hulme; (6) 13, Wash-lane, Prestwich, where he died. This house is still standing. It is the last of the old tall houses, and when Sturgeon lived there it was the last in the lane.*

With the aid of the accompanying steel engraving some idea will be obtained of Sturgeon's personal appearance. The engraving is taken from a portrait found pasted in a volume of Sturgeon's researches, bought from a bookstall in Shudehill Market, Manchester, by Mr. J. B. Shaw. It has been compared with an oil painting in possession of a relative, and has been submitted to those who remember Sturgeon, and is no doubt a good likeness. It is the first time that an engraving of Sturgeon has been published, although many attempts have been made to obtain a portrait for the purpose. The autograph has been obtained by engraving a tracing of the signature from the book of Candidates of the Manchester Literary and Philosophical Society. It represents the general characteristics of his handwriting, but it should be somewhat bolder, his penmanship being thick, heavy and rather clumsy, possibly from his service in the Artillery. This regimental record furnishes us with the following particulars :—

WILLIAM STURGEON, Senior.†

Rank and name.		Enlistment.					Born.		Trade.	Read and write	Description.
		Age.	Height, &c.	Date.	Place.	By whom.	Parish.	County.			
Gunner and driver.	William Sturgeon.	21 years.	5ft. 8½in. Chest, 35in.	April 23, 1805.	Hull.	Capt. Desbrisay.	Whittington.	Westmoreland.	Cordwainer (Bootmaker).	Yes.	Hair .... Brown. Eyes .... Grey. Complexion, Fresh.

Discharged at Woolwich to pension of 1s. a day, October 1, 1820.
Died in Manchester district, December 18, 1850.

* From information collected from the signed articles in the Scientific Researches; Manchester Directory; Mr. George Middleton, Assistant Overseer of Prestwich; the Somerset House Records; and the Rev. F. J. Jones, Rector of Prestwich.

† Another William Sturgeon also enlisted about the same time, and was better known as "Fighting Billy," on account of having been in more battles in the Peninsula than any other man in the ranks.

Joule was intimately associated with Sturgeon, and was able to speak definitely regarding his character. He says (*Mem. Lit. and Phil. Soc.*, Manchester, 1857, p. 83): "Mr. Sturgeon was of a tall and well-built frame of body; his forehead was high, and his features were strongly marked. His address was animated, and his conversation, as it generally is when the mind is stored with knowledge, pleasing and instructive. His style of writing was at once vigorous, lucid and graceful. In friendship he was warm and steady, in domestic life affectionate and exemplary. He had a noble mind and a generous heart. . . . He was a close and sagacious reasoner and an unsparing exposer of error. He detested quackery and false pretensions, sought diligently for truth, and loved it for its own sake. A diligent accumulator and observer of facts, eager in the pursuit of information of whatever kind, and in communicating his store to others, under more fortunate circumstances he would probably have left a name unsurpassed in the scientific history of his time; as it is, he will always be remembered as a distinguished cultivator of natural knowledge." Another friend, Dr. Leigh, in an obituary notice (*Manchester Examiner and Times*, December 14, 1850) says: "As a lecturer he was distinguished by a plain but manly and vigorous style; he never aimed at effect, but, thoroughly master of his subject, delivered himself with such clearness and perspicuity that it was impossible to mistake his meaning. . . . He was in all respects a fine, frank, manly fellow." Inquiries have been made from several persons now living who remembered Sturgeon, and from their letters the following extracts will be worth quoting:—Mr. Leo H. Grindon, the botanist, says: "I remember him well; he was very quiet and self-contained in manner; his countenance was inclined to be roundish, very calm and placid, of no particular line." Mr. J. Taylor says: "I was present at Sharp and Roberts' works, Great Bridgewater-street, about the years 1841-2, when Mr. Sturgeon, whom I should suppose would stand 5ft. 10in. high, and appeared to be of rather robust build, and of a healthy appearance. He had a locomotive engine, with 'steam up,' in the erecting shop, raised on blocks of baked wood, and while standing on an insulated stool held an ordinary spade in the steam, which was escaping at high pressure from the safety valve. The spade was connected by a copper wire to a gold-leaf electrometer, and when brought in contact with the steam the gold leaves separated, as usual, thus proving the presence of electricity in steam on its escape from the boiler." Alderman Harry Rawson, one of the oldest public men of Manchester, says: "I remember Mr. Sturgeon, heard him lecture, and visited the Victoria Gallery several times. He was a tall, big man, with a strongly marked face that is commonly considered plain. I should not say he was of clumsy build, but certainly he was not an elegant figure."

Sturgeon was a most industrious writer. I have prepared, as far as I have been able, a list of his published works. Some of these are now but rarely to be seen :—

[1830.] "Experimental Researches in Electro-Magnetism, Galvanism," &c. This is a pamphlet describing an extensive series of original experiments. He points out the advantage of amalgamating the zinc plates of voltaic cells in preventing local action.

[1836.] Sturgeon establishes a monthly periodical—"The Annals of Electricity, Magnetism and Chemistry; and Guardian of Experimental Science." Owing to the want of financial support the publication ceased in 1843, after 10 volumes had been issued. It is a valuable work of reference, relating more especially to the progress of electricity. Many of the articles were written by Sturgeon.

[1842.] "A Familiar Explication of the Theory and Practice of Electro-Gilding and Electro-Silvering"—"By means of which any person may be enabled to gild or silver coins, medallions, trinkets, ornaments, or household ornaments such as spoons, knives and forks, candlesticks, plates, covers, or any other metallic article whatever at a very trifling cost, and with the utmost facility. The instructions for gilding and silvering are preceded by descriptions of a great variety of voltaic batteries, and all that is necessary to be understood by the operator in the theory of voltaic electricity."

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[1842.] "Lecture on Electricity," delivered before the Royal Victoria Gallery, Manchester, during the session 1841-2. Dedicated to the proprietors and annual members of the Royal Victoria Gallery. He thanks them for their constant attendance, and although each lecture was delivered twice in the same day, the attendance was unremitting and in increased numbers. To the annual members he was particularly indebted for their unanimous vote of thanks at their last meeting in the lecture room.

[1843.] "A Course of Twelve Lectures on Galvanism," illustrated with upwards of 100 engravings of experiments and apparatus. In the preface, which is dated Institute of Natural and Experimental Science, Manchester, July 20, 1843, Sturgeon says that the lectures are arranged nearly in the same order in which he was in the habit of delivering them.

[1843.] "The Annals of Philosophical Discovery and Monthly Reporter of the Progress of Practical Science." According to the advertisement "This periodical, to commence July 1, 1843, price 1s. per month, will represent clearly and intelligibly the most important Philosophical Discoveries and the Application of Science to the Arts, without loading the description of them with those redundant Introductions, Intercurrences, and Terminations with which many scientific papers are frequently clogged, and which in most journals occupy many pages to which a great diversity of matter, of much higher interest to the generality of readers, might be introduced. The work will be printed on good paper and with a neat type, and, where necessary, engravings for explanation will be inserted." Six numbers were issued; the last, December, 1843.

[1843.] "The Whole Galvanoplastik Art or Method of forming Electrotypes of Medallions, Coins, Statuary, Bronzes, Ornaments, &c." Translated from the German of Prof. Jacobi. With a large folding lithographic plate. "This is the best work hitherto published on this interesting branch of the fine arts, and ought to be in the hands of every family in the kingdom who have any desire to become acquainted with these beautiful productions of voltaic electricity."

[1843.] "Sturgeon's Edition of Barlowe's Treatise on Magnetism." With Notes by the Editor. This is a reprint of a rare old work, "William Barlowe's Magneticall Aduertisements; or, Diverse Pertinent Observations and Approved Experiments concerning the Nature and Property of the Loadstone, very pleasant for knowledge and most needful in practice of travelling, or for the framing of instruments fit for travellers both by sea and land." "I am not aware," says Sturgeon in the preface, "that any apology will be required for undertaking to resuscitate a good old scientific book, otherwise entirely lost to the greater part of the present generation of philosophers."

[1846.] "Practical Instructions for the Protection of Persons and Property from the Effects of Lightning."

[1850.] "Scientific Researches, Experimental and Theoretical, in Electricity, Magnetism, Galvanism, Electro-Magnetism, and Electro-Chemistry." With copper plates. Published by subscription by Thomas Crompton, Bury, Lancashire. Quarto of 563 pages; 19 plates by Bradshaw and Blacklock, Manchester. This was Sturgeon's last work, and collects all his published papers. It is described as an ornament of provincial printing. John Just, of Bury, his old friend, was particularly instrumental in having it printed in Bury. Two other editions appeared, that of 1852 being published by Longmans and Co., to ensure a wider circulation. This appeared after his death, and the profits arising were given to his widow.

The Experimental Researches contain a list of about fifty original Papers, the titles of which were printed in *The Electrician* of July 5, 1884. Dr. Joule has examined Sturgeon's claims as a scientific discoverer, and in a letter* says that after sifting Sturgeon's claims to the utmost he finds without doubt that he was the originator of the electro-magnet, of the improved electromagnetic machine with a commutator, and of the first rotary electromagnetic engine. The first electromagnet was described in the *Proceedings* of the Society of Arts for 1825. It consisted (*see* Figs. 1 and 2) of a bent iron rod, about a foot long and one inch in diameter, varnished over and wound with a single layer of stout uncovered copper wire, the ends of which dip into mercury cups. The circuit was completed through a wire, *d*, which could be lifted out of the cup Z when it was desired to break the circuit. A weight, *y*, of about 9lb.

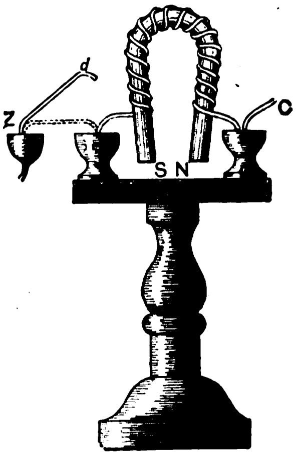

Fig. 1.

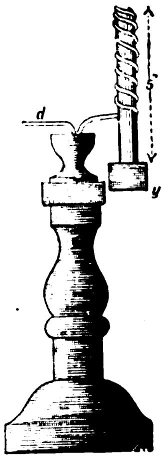

Fig. 2.

could be supported. An arrangement for magnetising straight bars is shown in Fig. 3.* The use of amalgamated zinc plates for primary batteries was due to Sturgeon. His researches on thermo-magnetism and magnetism of homogeneous bodies are of value. By means of 500 kite observations he added to our knowledge of atmospheric electricity, and he has shown how ships might best be protected from lightning; but his inventions in electro-magnetism must be always regarded as the most important part of his work. Sturgeon's claims and history

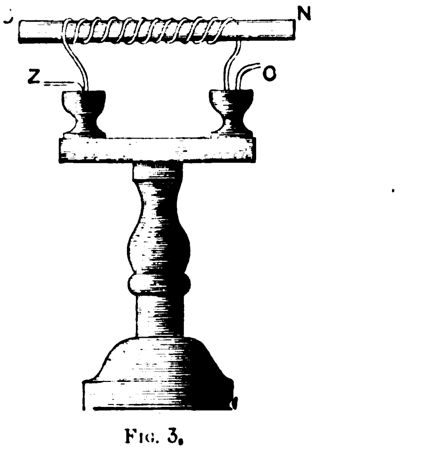

Fig. 3.

are well summarised on a marble tablet in the parish church of Kirkby Lonsdale:—

IN MEMORY OF

WILLIAM STURGEON,

Who was born at Whittingham, A.D. 1783, and buried at Prestwich, Lancashire, on the 8th day of December, 1850.

He was the son of parents in humble life, and served as a private in the Royal Artillery for nearly 20 years. After completing his term of service he successfully devoted himself to the study of the Physical Sciences.

With powers of originality and industry rarely equalled, besides contributing numerous works to the Scientific Literature of his country, he was the discoverer of

The Soft Iron Electromagnet,
The Amalgamated Zinc Battery,
The Electromagnetic Coil Machine, and
The Reciprocating Magnetic Electrical Machine—

Inventions of the highest value, and which along with many others he freely gave to the world.

His name will be perpetuated as long as the Sciences he cherished continue to exist.

* See *Manchester Guardian*, August 18, 1847; also "A Centenary of Science in Manchester," by Dr. Angus Smith.

† These blocks have been kindly lent to us by Messrs. E. and F. N. Spon the publishers of Prof. Silvanus Thompson's work on "The Electro-magnet."

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This is the only public memorial of a man to whom electrical science owes so much. It is to be hoped that before long the Royal Artillery Institution may possess (as suggested by Major Murdoch), a portrait of Sturgeon, and that in some public building or institution of Manchester we may have a suitable memorial of his connection with the city as a teacher, author and investigator.* W. W. HALDANE GEE.

THE ELECTRIC ARC.

BY HERTHA AYRTON.

(Continued from page 421.)

Before proceeding to compare my equation (4) (p. 420, *The Electrician*, July 26th) connecting P.D., current and length of arc with the equations found by previous experimenters, it seems to me that it may be useful to others if I give, in Table IX., a list of the actual values that were used in plotting the curves in Fig. 33 (page 419, *The Electrician*, July 26th) :—

Table IX.—*Means of the Experimental Results used in Plotting the Curves in Fig. 33.*

Current in amps.	$l=1$. P.D. in volts.	$l=2$. P.D. in volts.	$l=3$. P.D. in volts.	$l=4$. P.D. in volts.	$l=5$. P.D. in volts.	$l=6$. P.D. in volts.	$l=7$. P.D. in volts.
1·96	50·25	60·0	67·0	79·5	84·6	...	...
2·46	48·7	55·75	62·75	67·7	75·1	82·0	85·9
2.97	47·9	53·5	59·75	65·0	71·7	76·1	81·0
3·45	47·5	52·0	58·5	63·0	67·7	72·4	77·0
3·96	46·8	51·2	56·0	61·0	65·9	69·6	75·1
4·46	45·5	50·6	54·5	59·0	64·45	67·5	71·25
4·97	45·7	49·8	53·5	58·25	62·6	65·9	70·25
5·47	...	...	52·75	57·25	61·4	64·6	68·2
5·97	45·0	49·0	52·0	56·25	59·75	63·1	67·3
6·47	...	...	...	...	59·4	62·4	66·55
6·97	44·0	48·1	51·4	55·1	58·5	61·4	65·65
7·47	...	...	...	...	...	61·1	64·65
7·97	43·6	47·4	50·6	51·3	57·4	60·5	64·2
8·48	...	...	...	...	...	...	63·25
9·0	43·5	...	50·2	53·5	56·3	59·5	62·6
10·07	42·8	46·0	49·8	53·0	56·0	58·8	61·5
11·07	...	...	...	...	55·0	58·2	...
12·07	42·35	45·5	48·5	51·75	54·8	57·6	60·35
14·06	42·2	45·0	...	50·6	54·0	56·8	59·5
16·05	...	...	...	...	52·5	56·0	58·75
16·55	...	44·5	...	...	...	...	...
16·85	*32·0*	...	...	...	...	...	...
17·54	...	*33·4*	47·5	...	...	...	...
17·64	...	...	...	49·4	...	...	...
18·03	...	*35·0*	...	...	53·5	...	...
18·53	...	...	*38·5*	...	...	...	...
19·0	...	...	*38·0*	...	...	...	...
19·22	...	...	...	50·0	...	...	...
19·42	...	...	...	...	...	55·5	...
20·0	...	*34·5*	*38·0*	...	53·0	...	...
20·5	...	...	...	*39·5*	...	55·5	...
21·0	..	...	...	...	...	...	56·9
22·0	...	...	...	...	*43·0*	*46·5*	...
23·0	...	...	...	...	...	...	*58·0*
25·0	...	*34·5*	*36·5*	*40·0*	...	...	...
26·0	...	...	...	...	*43·0*	*47·0*	...
29·97	...	...	...	*40·5*	...	*46·0*	*48·0*

The numbers in italics refer to hissing arcs.

As already explained, the values used in plotting the curves in Fig. 33 were the means of the results obtained on *different* days with *different* pairs of 11mm. and 9mm. solid carbons, and, in order to indicate to what extent these means differed from the actual observations, I append, as a sample, in Table X., the actual results that were obtained when the arc was 5mm. in length :—

Table X.—*Specimen of the Actual Daily Results obtained when the Arc was 5mm. long.*

Current in amps.	Potential Difference between Carbons in Volts. I.	II.	III.	IV.	V.	VI.	VII.	Mean of the 7 days' results.
1·96	84·4	...	...	...	...	...	84·9	84·65
2·45	77·1	...	...	73·1	...	...	...	75·1
2·95	73·1	...	...	70·2	...	...	...	71·65
3·45	67·7	...	...	...	...	...	...	67·7
3·96	66·3	65·5	...	...	...	...	...	65·9
4·46	64·8	64·5	...	...	64·8	63·7	...	64·45
4·97	62·8	63·0	62·8	...	63·0	61·6	...	62·64
5·47	61·3	...	61·7	...	62·0	60·7	...	61·4
5·97	58·9	...	60·7	...	...	59·7	...	59·77
6·47	...	...	59·9	...	...	58·9	...	59·4
6·97	57·9	...	59·2	...	...	58·4	...	58·5
7·97	57·4	...	58·0	...	...	57·0	57·2	57·4
9·0	56·0	...	57·0	...	...	56·0	56·5	56·4
10·07	...	...	56·4	...	...	...	55·5	56·0
11·07	...	...	...	...	...	...	55·0	55·0
12·07	...	...	55·2	...	...	...	54·3	54·8
14·06	...	...	54·4	...	...	...	53·5	54·0
16·04	...	...	...	...	...	..	52·5	52·5
18·03	...	...	53·5	...	...	...	...	53·5
20·0	...	...	53·0	...	...	...	...	53·0
22·0	...	...	*43·0*	...	...	...	...	*43·0*
26·0	...	...	*43·0*	...	...	...	...	*43·0*

The numbers in italics refer to hissing arcs.

The numbers in any one column in Table X. are the results of the experiments carried out in a single day with this particular length of arc, and, although the carbons did not require to be changed each day, sometimes a new positive and sometimes a new negative carbon had to be inserted, so that, on the whole, about three different positive carbons and three different negative carbons were used in obtaining the numbers given in Table X.

Many people have from time to time experimented on the arc with the object of discovering the true relationship connecting the P.D. between the carbons, the current flowing, the length of the arc, and its resistance; and, in order to compare their results with my equation (4) (p. 420, *The Electrician*, July 26th), I have prepared the following abstract of their work and of the deductions drawn by the authors. Such an abstract appeared to me to be particularly desirable, as some of the writers on the arc appear to have misunderstood the results obtained by others.

ABSTRACT OF THE PRINCIPAL PAPERS BEARING ON THE PHYSICS OF THE ARC.

The first quantitative experiments were, I believe, made by Edlund* in 1867. In spite of the disadvantages under which he laboured—for he had no dynamo, and at that time there were no recognised units of current, P.D., or resistance—Edlund discovered one of the fundamental conditions of the arc, namely, that with a *constant current* the apparent resistance is equal to a constant resistance, plus a resistance which varies directly with the length of the arc.

Edlund's method of experimenting was as follows: he used a battery to send a current through an arc of definite length, then, putting out the arc and pressing the carbons tightly together, he measured the distance by which he had to separate the plates in a copper voltameter so as to bring the current to the same value as before. Doing this for various lengths of arc he found that, *as long as the current was kept constant*, the length of the copper voltameter which represented the arc could be expressed by a constant length plus a length which varied directly with that of the arc.

Hence, putting his result in the form of an equation, he found out that

$$r = a + b\,l,$$

* During the last few years considerable interest has been aroused in the history of Sturgeon. For this we have chiefly to thank Prof. S. P. Thompson, who has written a short biography of Sturgeon, and in his work on the "Electromagnet," has shown that Sturgeon was undoubtedly the inventor of the soft iron electromagnet, and that the claims of Arago could not be maintained. This recently has been made perfectly clear by Mr. Ernest Boistel, who has examined all the records of the work of Arago. A number of gentlemen in Manchester have been most assiduous in collecting information relating to Sturgeon. Among these I must especially mention Mr. C. Roeder. Many of the facts ascertained have been embodied in this article, but the complete biography of Sturgeon has yet to be written.

* Poggendorff's *Annalen*, 1867, Vol. CXXXI., p. 586.

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where r is the apparent resistance of the arc, l its length, and a and b constants *for a constant current.*

When, however, the current was varied, he found that a and b both diminished as the current increased, so that the apparent resistance of the arc for a given length was the smaller the greater the current. The numbers which he obtained justified him, he considered, in concluding that a varied inversely as the current, but those for b were too small to enable him to arrive at the law connecting b with the current.

Edlund started his experiments with the idea that there was a back E.M.F. in the arc caused by the disintegration of the carbon particles, and therefore, having obtained several values of a and b with different currents, he calculated the back E.M.F. in the arc when each of those currents was flowing.

From these calculations he concluded that the *back E.M.F. in the arc had a constant value equal to that of about 23 Bunsen's cells for all the currents he used*, and that *the true resistance of the arc was directly proportional to its length, increasing, however, as the current decreased.*

He next considered the question theoretically, and gave what he regarded as a proof that the back E.M.F. in the arc must be independent of the current, and also that the work performed in the arc by the current was proportional to the current as long as the E.M.F. of the battery remained constant.

He then made a new series of experiments to determine whether the back E.M.F. depended upon the E.M.F. of the battery used to produce the current, and decided that it did not.

Edlund's next series of experiments* was undertaken to find out whether the back E.M.F. was constant with smaller currents than had been used in the first series. The deflections produced by the currents in the tangent galvanometer used were not published in this case, as they had been before, but Edlund considered that his results showed that, in the case of small currents, the back E.M.F. *diminished* as the current was decreased. He used copper, brass, and silver pole points for these experiments, as well as carbon.

Edlund's third series of experiments† was very striking. He found that when an arc was produced with a somewhat large current between *carbon* poles the arc continued for a short time after the circuit was broken, so that, if the circuit were closed again fairly quickly after the break had been made, the arc was not put out. But, on the other hand, when *silver* poles were used the arc did not continue for even one-eightieth of a second after the circuit was broken.

From this he concluded that if carbon poles were used, and if immediately after opening the circuit the carbons were switched on to a galvanometer, a momentary current would be sent by the arc through the galvanometer, and the existence of the back E.M.F. in the arc thus made certain. A series of experiments carried out in this way with and without a battery being switched with the arc into the galvanometer circuit, led Edlund to conclude that the back E.M.F. existing in the arc *after* the main circuit had been broken could not be less than that of from 10 to 15 Bunsen's cells. Further, from the momentary current being increased when the negative carbon was warmed by a Bunsen's burner, and not diminished as might have been expected had the back E.M.F. been a thermo-electric one (set up by the positive carbon being hotter than the negative), he concluded that the back E.M.F. in the arc was *not* due to thermo-electric action.

Mr. Schwendler,‡ during the course of an investigation on "The Electric Light," carried out in 1878 for the Board of Directors of the East Indian Railway Company, gave the following conclusions in a *précis* of his report :—

"There appears to be no doubt that an appreciable E.M.F. in the arc is established, which acts in opposition to the E.M.F. of the dynamo machine. This E.M.F. of the arc *increases* with the current passing through the arc. The resistance of the arc for constant length is also a function of the current passing through it, *i.e.*, the resistance of the arc *decreases* with the current (*see* the following table)."

Current in webers.	Resistance of the arc in Siemens units.	E.M.F. of the arc in volts.
28·81	0·91	2·02
23·87	1·72	1·91
16·27	1·97	1·86

Mr. Schwendler goes on to say that he considers it highly probable that the resistance of an arc of constant length is inversely proportional to the current. No details are given in this *précis* regarding the way in which the E.M.F. of the arc was measured.

In a Paper on "The Resistance of the Electric Arc" * Profs. Ayrton and Perry in 1882 described experiments made with Grove's cells to test the accuracy of Mr. Schwendler's conclusion, and they found that, when carbons 0·24in. in diameter were used and the length of the arc kept constant, the current could be varied from about 5 to 15 amperes without much change being produced in the P.D. between the carbons. They also used a Brush machine to produce an arc up to 1·25in. in length, and gave as the equation connecting V, the P.D. between the carbons in volts, and a, the length of the arc *in inches*

$$V = 63 + 55\,a - 63 \times 10^{-10a},$$

and this equation they regarded as being true for currents between 5·5 and 10·4 amperes with the carbons employed.

In 1883 Frölich† desired to find out whether Edlund's equation $r = a + b\,l$ were true for the larger currents that could be obtained with dynamos, and, in order to obtain an equation connecting the P.D. between the carbons with the length of the arc, he used the results of experiments made by various people, at various times, for the purpose of testing the dynamos constructed by Messrs. Siemens and Halske. In the table given in his Paper the P.D. corresponding with different currents for the same length of arc showed wide variations, yet he took it for granted that the P.D. was really independent of the current and so he deduced the equation

$$V = a + b\,l$$

as the relation that would connect the P.D. between the carbons with the length of the arc, *whatever the current*, if there were no errors of observation in the experiments.

He even found what he considered to be the numerical values of a and b, and so he put his equation connecting V. the P.D. in volts between the carbons for an arc l millimetres in length produced by *any current from 1 to 100 amperes* in the form

$$V = 39 + 1{\cdot}8\,l$$

From this formula he calculated what he considered ought to have been the P.Ds. for the various currents and lengths of arc in the 47 measurements, the results of which he quoted; and the differences between the results given by his formula and by experiment he put down to errors of experiment.

By dividing by A, the current in amperes, Frölich's formula became

$$r = \frac{39}{A} + \frac{1{\cdot}8\,l}{A},$$

and this he considered was the formula which gave r the apparent resistance in ohms of an arc l millimetres long produced by a current of A amperes. He used the latter formula to calculate a table of 273 resistances of arcs, varying from 0mm. to 20mm. in length, and produced by currents of 1, 5, 10, 15, &c., up to 100 amperes; but no experiments are adduced giving results agreeing with his calculated values.

He then proceeded to inquire if his "newly-discovered facts" threw any light upon the question whether there was a back E.M.F. in the arc or merely a contact resistance, and he concluded that either explanation was consistent with the facts provided that the cross-section of the arc was directly proportional to the current, which he considered likely.

* Poggendorff's *Annalen*, 1868, Vol. CXXXIII., p. 353.
† Poggendorff's *Annalen*, 1868, Vol. CXXXIV., p. 250.
‡ *The Electrician*, Vol. II., 1879, January 18th, p. 107 ; and 25th, p. 117.

* *Proc.* Phy. Soc., Vol. V., 1882, p. 197.
† *Elektrotechnische Zeitschrift*, Vol. IV., 1893, p. 150.

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Multiplying both sides of his equation by A, he obtained the following equation giving W, the power in watts expended in the arc:—

$$W = (a + b\,l)\,A;$$

and, therefore, he concluded that the power expended in an arc of fixed length was directly proportional to the current.

In 1885 Peukert* published an account of some experiments he had made with constant currents and varying lengths of arc, for the purpose, as he said, of "eliminating one of the three possible variables, P.D. current, and length of arc." In order to avoid having a crater, and thus complicating the measurement of the length of the arc, which was made by projecting the distance between the carbons on a millimetre scale, he had the carbons filed flat before each experiment, and the determination made before the carbons had had time to burn away much.

Having obtained the P.Ds. needed to send currents of 10, 15, 20, 25 and 30 amperes through various lengths of arc, he plotted curves connecting resistance and length of arc for each current, and found that they were all straight lines, so that Edlund's equation,

$$r = a + b\,l,$$

was proved true for large as well as for small currents.

Peukert, like Edlund, found that a varied inversely as the current, but b, Peukert pointed out, diminished more quickly than the current increased. This latter fact, he thought, was partly explained by the air surrounding the arc becoming very hot when the current was large, and so acting itself as a conductor.

He considered the question of a back E.M.F. in the arc, and showed that the mean value of $A\,a$ was about 35 volts. He considered, however, that an E.M.F. of this large value could not be set up by the disintegration of the carbon as Edlund had supposed, and that a back E.M.F., if so produced, ought to increase with the current. He also considered the possibility of the back E.M.F. being produced thermo-electrically, or by the combination of the carbon points with the hydrogen gas liberated by decomposition of vapour in the air, but both these suggestions he rejected also.

Peukert finally concluded that most probably the resistance of the arc was really composed of two parts, one that of the arc proper, while the other, and much the larger part, was a mechanical, or contact, resistance between the arc and the carbon. And he added that a certain minimum P.D. being necessary to maintain an arc, which fact had been adduced as a proof of the existence of a back E.M.F. might arise from a certain P.D. being necessary to tear off the carbon which formed the conducting medium between the two carbons.

In 1885 Von Lang† endeavoured to measure the *true* resistance of the arc, as distinguished from the *apparent* resistance, which alone had been determined by previous experimenters. To do this he used a battery, $B_1\,B_2$ (Fig. 40), to produce two arcs, L_1 and L_2, in series, each ⅓mm. long, formed with carbons 5mm. in diameter; and between the arcs there was placed a resistance, R R. A point, A, in the resistance was then found, having the same potential as B, the middle point of the battery. Then, since these two points of the quadrilateral were at the same potential, the parallel resistance of the two halves of the quadrilateral between A and B could be measured with a Wheatstone's bridge, exactly as if there were no E.M.Fs. in the quadrilateral.

This resistance Von Lang found to be 1·82 ohms, and therefore the resistance right round the quadrilateral was 4 × 1·82, or 7·28 ohms. Next the arcs were replaced with equal resistances of such a value that the current flowing round the quadrilateral, as measured by the ammeter, C, was the same as before, viz., 4·32 amperes. The parallel resistance between the points A and B was now found to be 6·29 ohms, and consequently the resistance right round the quadrilateral was 4 × 6·29, or 25·16 ohms. Hence the E.M.F. of the battery $B_1\,B_2$ was 4·32 × 25·16, or 108·7 volts. And, as the quadrilateral had a resistance of 7·28 ohms when the two arcs were in the circuit, a P.D. of 4·32 × 7·28, or 31·4 volts, must have been employed in sending the current of 4·32 amperes round this quadrilateral as far as its resistance was concerned. Consequently a P.D. of 108·7 − 31·4, or 77·3 volts, must have been employed in overcoming the back E.M.F. of the two arcs, or the back E.M.F. of each arc, was 38·6 volts.

* *Zeitschrift für Elektrotechnik*, 1885, Vol. III., p. 111.
† *Wiener Akad.*, 1885, Bd. 91, § 844, and *Centralblatt für Electrotechnik*, 1885, Vol. VII., p. 443.

Shortly afterwards Edlund* summed up the results obtained by himself, Frölich, Peukert, and Von Lang, and proceeded to consider Peukert's view that the term a in the equation $r = a + b\,l$ represented a resistance of transition at the surface of contact of the electrodes and the arc. Edlund concluded that, since the value of the back E.M.F. of the arc—39 volts—obtained by Von Lang's method, which depended on the measurement of the true resistance of the arc, did not differ much from either the values obtained by himself, 41·97 volts, or by Frölich, 39 volts, or by Peukert, 35 volts, it followed that *there was no resistance of transition in the voltaic arc, and that, therefore, the entire diminution of the strength of the current which resulted from the production of the arc light was caused by the resistance of the arc $b\,l$ and by the E.M.F. contained in it.*

In 1886 Messrs. Cross and Shepard† made experiments with both silent and hissing arcs to determine whether the apparent resistance of the "whistling" arc was a linear function of the length for a constant current, as had been shown by Edlund and others for a silent arc. They used currents varying from 3·27 to 10·04 amperes, and lengths of arc from 0·25/32 to 16/32 of an inch, and found that for a given current the resis-

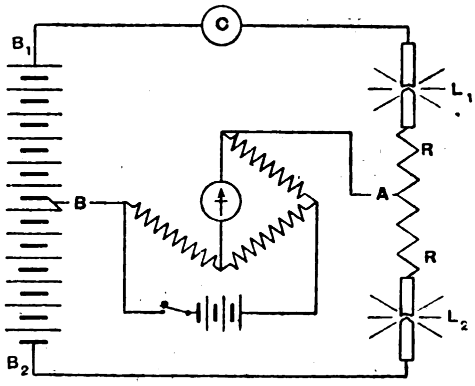

Fig. 40.

tance of the whistling arc could also be represented by a straight line in terms of the current, but that this line was steeper than that representing the resistance of a silent arc for the same current.

Without expressing any opinion as to the existence of an inverse E.M.F. in the arc, they gave this name, for convenience, to the product $A\,a$, where A was the current and a was given by the resistance equation

$$r = a + b\,l,$$

and they found by experiment that both with silent and with whistling arcs this product $A\,a$ diminished as the current increased, having a mean value of 39·33 volts for a silent and 14·98 volts for a whistling arc. With very long arcs, however, and with long arcs in which metallic salts are volatilised, the apparent resistance tended to become abnormally small.

Next they experimented with an inverted arc, and although it was much less steady than before, the results obtained were practically the same.

The arc having been restored to its original position, they surrounded the positive carbon with a deep cup-shaped shield of fire-clay in order to retain the heat, and found that this increased the inverse E.M.F. both for silent and for whistling arcs, as well as the length of the arc at which whistling occurred for each particular current. On the other hand, b, the coefficient of l, was diminished.

Cooling the positive carbon with a water jacket, on the other hand, caused the E.M.F. to fall to 11·7 volts for a silent and to 5·6 for a whistling arc.

* *Wiedemann's Annalen*, 1885, Vol. XXVI., p. 518.
† *Proceedings* of the American Academy of Sciences, 1886, p. 227.

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Finally, a few experiments were made on an arc under a pressure of 4in. of mercury. The equation $r = a + b\,l$ still held, but the arc hissed for all the lengths and currents tried, and the lines connecting resistance and length were less steep than those for hissing arcs under normal pressure for the same currents respectively.

Arons* found the *true* resistance of the arc by placing it with the battery, producing it in one arm of a Wheatstone's bridge. One of the diagonals of the bridge contained the stationary coil of a dynamometer, while the other contained the secondary coil of an induction apparatus. The three arms of the bridge were adjusted until this inductor sent no current through the stationary coil of the dynamometer, as proved by there being no deflection of the movable coil of the dynamometer, which was traversed by an independent alternating current produced by an auxiliary induction apparatus.

Next the arc was short-circuited and a resistance put in its place of such a value that, without making any alteration in the resistances of the other three arms of the bridge, no current was sent through the dynamometer-diagonal of the bridge by the secondary coil of the first inductor which formed the other diagonal. Under these circumstances this added resistance was equal to that of the arc. With a current of 3·4 amperes, Arons found the true resistance of the arc to be 2·1 ohms, and therefore the back E.M.F. 40·6 volts, while with a current of 4·1 amperes he found the true resistance of the arc to be 1·6 ohms, and therefore the back E.M.F. 39·6 volts. The length of the arc is not stated in his Paper.

In the same year Von Lang† repeated his method illustrated in Fig. 40, and now found 37 volts as the value of the back E.M.F. between carbons. This method he also employed with electrodes of other materials, and he found that when they were both composed of one of the following substances, arranged in the order indicated—platinum, nickel, iron, copper, zinc, silver, cadmium—the back E.M F. on the arc fell steadily from about 27 volts for the platinum electrodes to about 10 for those of cadmium.

Von Lang expressed V, the P.D. between the carbons, as

$$V = a + b\,l\,A\,;$$

but a, the back E.M.F., is, for no one of the pairs of electrodes used, given with a probable error of less than + or − 3 per cent., and in some cases it is as high as + or − 34 per cent.

Uppenborn,‡ in 1888, found from experiments with a constant current of 7·7 amperes, producing an arc with 10mm. carbons, that

$$V = a + b\,l,$$

where l was the length of the arc. a, however, in this equation varied from 35·4 to 45·4, and b from 1·74 to 3·2.

When the current was increased he found that *a increased*, while *b diminished*. a, he considered might be replaced, by $x + y\,A$, where A was the current and x and y depended on the carbons. He concluded that, since a increased both for increase of current as well as for increase in section of the arc, the effects were probably due to surface resistance rather than to a back E.M.F.

Dubs,§ in 1889, found that if two carbon plates were placed one above the other with a distance of 1mm. between them, and a blowpipe flame was directed on the lower so as to carry carbon particles to the upper, a galvanometer connected with the plates showed a weak current flowing against the blast. Also that if a carbon plate were heated on a oxyhydrogen flame and laid on a cold carbon plate, a current flowed from the cold to the hot plate. With copper plates the effect was less, and was *nil* with iron. Dubs regarded the effect as analogous with the back E.M.F. in the arc, and considered that that depended, at any rate in part, on the mechanical action of the current.

In 1892 Stenger‖ sought for evidence of a back E.M.F. in the arc thus: A shunt-dynamo sent a current through an arc, 5 accumulators and a tangent galvanometer in series. The accumulators were joined up so as to oppose the current, and the needle of the galvanometer was pressed against a stop so that it was not deflected by the dynamo current, but could move freely in the opposite direction. On short-circuiting the shunt-dynamo the conduction of the arc lasted long enough for the accumulators to send a current and produce a deflection of over 90deg. in the galvanometer; but, when the experiment was repeated with the accumulators removed from the circuit, a deflection of only about ¾deg. occurred, produced by the spring of the stop. Hence any back E.M.F. in the arc either ceased with the main current, or was very small compared with 10 volts.

* *Wiedemann's Annalen*, 1887, Vol. XXX., p. 93.
† *Wiedemann's Annalen*, 1887, Vol. XXXI., p. 384.
‡ *Beiblätter*, 1888, Vol. XII., No 1, p. 83.
§ *Beiblätter*, 1889, Vol. XIII., p. 197.
‖ *Wiedemann's Annalen*, 1892, Vol. XLV., p. 33.

In a Paper read before the British Association in 1892, Prof. Silvanus Thompson* gave an approximate formula connecting V, the P.D. in volts between the carbons, l, the length of the arc in millimetres, and A, the current in amperes, viz. :—

$$V = a + \frac{b\,l}{A},$$

where the constant a, however, had to vary between 35 and 39 volts and the constant b between 8 and 18. The constant part of the voltage which was independent of the current for an invariable length was sometimes called the apparent back E.M.F., and, although Dr. Thompson did not affirm that there was an actual back E.M.F., the arc, he considered, acted as though it were the seat of a back E.M.F.

He described his experiments, made with an auxiliary exploring carbon, which showed that the drop of potential in the arc itself was small, and that the main drop was at the positive carbon. The latter, he considered, was accounted for by the volatilisation of the carbon at the crater, and that this idea was confirmed by Capt. Abney's discovery that the brilliancy of the same quality of carbon per square centimetre was a constant. Mr. Crookes's experiments, which showed that the flaming discharges produced by very high-pressure very short-period alternating currents were endothermic flames of nitrogen and oxygen, had led him to try whether the combination of nitrogen and oxygen produced by the high temperature of the arc had anything to do with the E.M.F. observed there. To test this he had surrounded the arc with a glass tube, and introduced successively oxygen, nitrogen, carbon dioxide, hydrogen, &c., but with a normal arc taking 10 amperes not one volt difference in the P.D. was observed. When chlorine or carbon monoxide surrounded the arc the positive carbon was flattened over the end, and the end of the negative became a very obtuse cone, while with hydro-carbon gas the crater was very deep; and, lastly, when the arc was formed in oxygen the carbons burnt away very rapidly. The gases had to be introduced quietly, since blowing on an arc in ordinary air Dr. Thompson found raised the P.D. to 75 volts.

In August, 1893, just before Prof. Ayrton read his Paper at Chicago on the arc, Messrs. Duncan, Rowland and Todd† published an account of the effects they had obtained on producing an arc under pressure and in a vacuum. They began their Paper by stating that the two causes alleged for the back E.M.F. in the arc—the vaporisation of the positive pole and the thermo-electric effect produced by the carbon vapour in contact with the unequally heated carbons—must both be operative; but that the first must cease to exist directly the main current ceased to flow, and could not therefore be detected even immediately after the circuit was broken, while they considered it must be possible to detect evidence of the latter for a short time after the main current had been stopped.

The first part of the back E.M.F., viz., that due to the volatilisation of the carbon, they considered must be a constant a, while the second part must be a function of the current and the length of the arc. From these considerations they suggested that the complete equation connecting P.D., current, and length of arc should be

$$V = a + f(l)\,f(A) + b\,f'(l)\,f'(A),$$

where V was the P.D. between the carbons, l the length of the arc, and A the current.

* *The Electrician*, Vol. XXIX., August 26, 1892, p. 460.
† *Electrical Engineer* of New York, August 2, 1893, p. 99.

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They next called attention to the fact that the P.D. between the carbons diminished as the current increased, and gave the results of experiments supporting this. The following they suggested as an explanation of the phenomenon. If V be the P.D. between the carbons, *a* the *constant* back E.M.F. due to volatilisation of the carbon, and *a'* the back E.M.F. due to thermo-electric action,

$$A = \frac{V - a - a'}{b\,l};$$

$$\therefore \quad V = a + a' + b\,l\,A.$$

Now, *a'* diminishes with increases of the current, since the temperature of the negative carbon increases while that of the positive remains constant. Hence V diminishes as A increases.

Keeping the current constant at six amperes, and the arc of a fixed length, they found that, starting with the atmospheric pressure, V increased as the pressure was increased, but at a slower rate. When, on the other hand, the pressure of the surrounding air was reduced below that of the atmosphere, V also increased except in the case of the $\frac{1}{16}$th-inch arc, when V diminished on reducing the pressure. This exceptional result, however, arose probably from the arc hissing. Hence, for a given current and length of silent arc, V has a minimum value for atmospheric pressure. The increase of V as the pressure was reduced below that of the atmosphere they considered was caused by an increase of *a'*, for they say that *a*, the constant counter E.M.F., was probably lower in a vacuum, and the positive carbon not so hot, but the negative carbon seemed to cool proportionately faster than the positive.

The counter E.M.F., they concluded, increased apparently with the pressure above one atmosphere, while the ohmic resistance of the arc did not greatly change. As regards the formula their experiments showed that *a* varied with *l* for each pressure employed, and they failed to arrive at any exact law connecting V, *l* and A, even for one pressure, the equation that most nearly fitted their results being, they thought,

$$V = a + \frac{b\,l}{A^{0.7}},$$

but this, they remarked, was only approximately correct.

The latest measurement of the *true* resistance of the arc was made by Mr. Julius Frith* with the Wheatstone's bridge seen in Fig. 41. Two of its arms, P, Q, consisted of the two halves of a stretched platinoid wire each having a resistance of 5·35 ohms. The third arm was composed of a battery of 26 accumulators, E, which, together with a shunt dynamo D_1, sent a current through a resistance, R_1, an ammeter C and the arc X in series, the arc being 2mm., formed with carbons 11mm. in diameter. The fourth arm consisted of a shunt dynamo, D_2 exactly similar to D_1, only at rest, together with resistances R_2 and R_3 and a coil L, whose self-induction could be varied by moving an iron core.

The resistances of D_1 and D_2 were each 0·04 ohm; of R_1 and R_2, each 8 ohms; of E, 0·25 ohm; and of R_3 0·3 ohm.

Before closing the switch S the speed of the dynamo D_1 and the length of the arc were varied until the potential of the points A and B were equal, as tested by the voltmeter V, which, by means of the switch K, could be connected either across the accumulators E or the arc X.

An alternator D_3 sent an alternating current through a wire, any two points of which could be tapped to supply the alternator P.D. to the bridge, and after closing the switch S the resistance of R_3 and the self-induction of L were varied until the sound in the telephone T became a minimum, the condenser M inserted in the telephone circuit cutting off from the telephone any direct current effect that might be caused by want of perfect equalisation of the potentials of the points A and B.

The best results were obtained with R_3, having a resistance of about 0·6 ohm and an alternating P.D. of 5 volts supplied to the bridge. This makes the resistance of the arc about 0·6 ohm, which, together with the readings of the ammeter C and the voltmeter V, give the back E.M.F. in the arc as 39 volts.

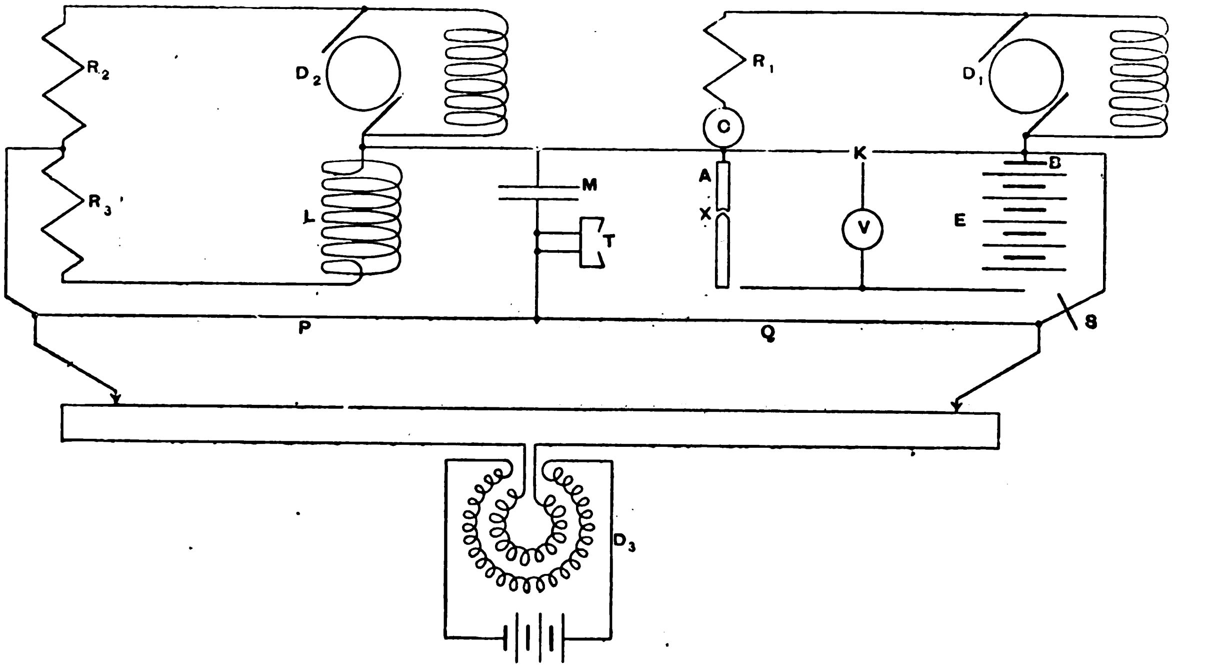

Fig. 41.

Other methods of testing were employed by Mr. Frith, and results were obtained agreeing with the above.

Mr. Wilson* has recently experimented on the electric arc under considerable atmospheric pressures. As the pressure was increased, and the current kept constant, he found that the apparent resistance of the arc increased. When the pressure had been raised to five atmospheres the temperature of the crater had fallen, while at 20 atmospheres the brillancy of the crater fell to a dull red colour. Diminishing the pressure, on the contrary, increased the brightness.

Mr. Wilson therefore concludes "the temperature of the crater, like that of the filament in an incandescent lamp, depends on how much it is cooled by the surrounding atmosphere, and not on its being the temperature at which the vapour of carbon has the same pressure as the surrounding atmosphere." Hence the temperature of the crater is *not* that of boiling carbon as has been asserted.

(To be continued.)

* *Memoirs and Proc. of the Manchester Lit. and Phil. Soc.*, 1895, Vol. IX. Series IV., p. 139.

* *Proc. Roy. Soc.*, 1895, Vol. LVIII., p. 174.

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The Oldest Electrical Journal, 1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "*THE ELECTRICIAN,*" Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to "*THE ELECTRICIAN*" Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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MAGNETIC UNITS.

In summing up the correspondence which for some weeks has been actively pursued in our columns, we are impressed by the sense that these letters, many of them from men the best qualified to judge (at least so far as Great Britain is concerned) as to the practical value of a system of magnetic units, have done much to clear the air of cobwebs. Whatever, therefore, the British Association, or its Committee on Electrical Standards, may decide to adopt or to leave aside, they cannot be ignorant of the strong drift of opinion which has made itself known in these letters.

For the last four years the question of fixing a "practical" set of magnetic units, or at least of finding names for them, has been in the air. At the rather informal Electrical Congress at Frankfort in 1891, the American delegates presented a proposition suggesting certain names and definitions, which, however, were barely considered. The opinion there seemed to be, though no formal vote was recorded, that no other units than those of the C.G.S. system were required. Again, at the Chicago Congress, the subject was brought up, only to be again put off. Subsequently the American Institute of Electrical Engineers took independent action, and definitely proposed a number of practical units, based on the C.G.S. system; and to them they assigned names derived from those of notable men in magnetic science: WEBER, GAUSS, GILBERT and OERSTED. The name of GAUSS seems to have a special attraction for unit coiners. It was used already in different senses by Prof. FLEMING and by Mr. HEAVISIDE; and had been used again in a different sense, so far back as 1884, by Prof. SILVANUS THOMPSON. The Committee of the American Institute are quite frank as to their aims. They did not propose any units other than those of the C.G.S. system. What they did propose was names for units which exist. So far their idea was simple. But when one comes to consider the names themselves the selection does not seem a particularly happy one. For the unit of magnetic flux (which is one C.G.S. "line") they proposed the name *weber*. So far so good. But for that of the magneto-motive force they proposed the name

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gilbert, and for the unit of field and of flux density (in air or metal) the name of *gauss*. It would have been distinctly better to have reversed the use of these. The word *volt* is of one syllable, the word *ampere* of two; so that the two magnetic names that correspond should preferably be of one syllable and two syllables respectively. Like the word *volt*, which easily lends itself to the allied distributive *voltage*, so the word *gauss*, a one syllable word, lends itself to become the distributive *gaussage*, while the word *gilbert* does not. Just as an electric circuit of unit resistance requires an electromotive force of one *volt* to produce one *ampere*, so in a magnetic circuit of unit reluctance it requires one *gauss* to produce one *weber*. That is, if we use *gauss* for the unit of magnetomotive force, as now proposed by Prof. Lodge. If we mistake not, the term *gauss* has also already been so used at the Central Institution for some time.

Quite other are the radical proposals of Mr. Oliver Heaviside. He wants, once and for all, to get rid of the difficulty that crops up in the ever-recurring symbol 4π—a heritage of the fate that caused our present electromagnetic system to be based on the old notion of surface units of magnetism, and the law of inverse squares as applied to poles at a distance. Instead of defining the unit of magnetism as that which, at the distance of one centimetre (in air) repels its fellow pole with a force of one dyne, he would define it as that which (in air) repels it with a force of 4π dynes. He would then draw one line for each such unit of magnetism, which would consequently be greater than our present C.G.S. unit by $\sqrt{4\pi}$, or 3·544 times. This gets rid of the 4π difficulty by stuffing it into a new corner. But Mr. Heaviside does not stop here. He proposes to perform a like transformation upon our electric units, with the result that he brings us face to face with a new ohm equal to 1·257 of the old ohm, a new ampere equal to 2·24 of the old ampere, and a new volt equal to 3·544 times the old volt. The practical man, who has at last grown familiar with ohms and amperes and volts, holds up his hands in horror. Had it been proposed to make both ampere and volt ten times their present value, so as to bring them into agreement with the respective C.G.S. units of current and pressure, he would have protested vehemently. But to "rationalize" them by the use of such irrational multipliers—No: it shall not, must not, cannot be!

And yet we are not sure that Mr. Heaviside is not right, even though it be a case of Heaviside *contra mundum*. Some day, when point poles, and surface units, and action-at-a-distance shall have vanished into the limbo of mediæval absurdities, and when electricians have learned to think of *action in the medium*, we shall wonder how that foolish old B.A. Committee of 1862, and that feeble International Congress of 1881 ever blundered into the C.G.S. system. And then we shall turn to our Heaviside, who tried to save us from ourselves. But in a world of practical issues, of commercial interests, and of men of business, not even for the sake of the more enlightened generation that will follow, can we afford to contemplate such revolutionary measures. To recommend them piecemeal, even by the inspired voice of a British Association Committee, would only have the effect of indefinitely shelving more pressing, though moderate, reforms. We therefore, and with a genuine regret, set them aside as too good for this unheroic age.

But though we set aside these drastic proposals, we are by no means of opinion that absolutely nothing ought to be done. The correspondence in our columns is a proof that, while there exists a strong feeling against tampering with old units, or coining needless new ones, there apparently is some need for names to fit those actually in use. The fact that one dynamo designer uses "kilo-lines" and "mega-lines," that another uses "thoms," and a third "kapps," in describing the amount of magnetic flux in a magnetic circuit may perhaps be taken as a sign that a name is wanted. Incidentally it also tends to show that the thing for which a name is most wanted by designers of dynamos and motors is not **H** or **B**, but the total flux or total induction **N**. While objecting to the wholesale creation of fantastic names, and units of more than doubtful utility, we are ready to admit that someting like a case has been established for recognising by a definite designation the unit of magnetic flux. As to the magnitude of the unit itself, the only question that can arise is whether we shall take the C.G.S. unit itself—namely, one (magnetic) *line*, or some multiple of it, such as 10^8, to correspond with the *volt*. The suggestion of Dr. Sumpner to call 10^8 *lines* a *volt-line*, the advantages and disadvantages of which we discussed last week, has this further objection: it gives to the word *volt* a new and purely numerical meaning. Better, far, to use "megaline" as the term for a million *lines*; for if the unit is fixed so large as 10^8 we shall occasionally require to talk of a *centi-micro volt-line* when we mean simply one magnetic *line*. Why not take the *line* itself as unit—whether it is called the *weber* or simply the *line* is a detail—and apply the usual prefixes for multiples?

Our correspondents who are engineers are also nearly agreed amongst themselves in another point—namely, that as unit of magnetomotive force the *ampere-turn* should be taken as the unit. The $4\pi/10$ factor must needs come in somewhere, either here or in the definition of the third quantity, which, whether considered as a reluctance or a permeance, comes in as the ratio of the two others. Engineers who have to deal with construction prefer to take *ampere turns* simply. As Mr. Snell puts it, both the *ampere* and the *turn* are shop quantities; and the relation between *ampere-turns* and the resulting flux-density is in practice habitually taken off from a graphic curve that embodies the result of pure experiment. In that case no new name is wanted for the unit, as the *ampere-turn* is itself the name. To call it one *gauss* does not help matters; the name is only wanted in case something more complex than the ampere-turn, and needing therefore a short designation, is decided upon.

If the *line* and the *ampere-turn* are thus fixed, the third unit—whether regarded as reluctance or permeance—is fixed in magnitude, being the ratio of the other two. It can be defined materially as a property of a definite prism of air, the permeance or reluctance of which will be a standard, just as the material *ohm* is a standard both for resistance and conductance. There will be time enough to devise a name for it when we shall have decided on its magnitude.

Amongst Prof. Lodge's suggestions is one for a unit of magnetomotive force per-unit-of-length, or *gauss-fall*. Again, we remark that the only desirable unit is that which already exists—namely, the C.G.S. unit of fall of magnetic potential per centimetre; in other words, the familiar **H**, measured by the mechanical force it exerts on a unit pole. Our trans-Atlantic friends, in their eagerness for progress, have suggested that the same unit that serves for flux-density will serve for this, because of the accident that in air they are numerically (in the C.G.S. system) alike. But one is the cause, and the other the effect. Though we may express by similar numbers the effect **B** of applying a cause **H**, it does not follow that the quantities are of the same order, or should be expressed in terms of the same unit. Unfortunately we have dropped into applying the notion of lines per square centimetre to express both the effect and the cause. Let us now discriminate; but before we proceed to christen the unit let us

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think when, by whom, and how often, such a unit is likely to be used. Hardly one of our correspondents has so much as noticed the existence of this quantity. Obviously it is little used by them. If the hydrographer to the Admiralty is anxious to give up his ridiculous foot-grain-second unit, and yearns to express the values of H at different points of the earth's surface in C.G.S. measure, by all means encourage him to do so, even at the price of inventing a new name for it. Thenceforth the value of H at London will be 0·18 *somethings*.

Ours is no mere policy of *laissez-faire*. The criticisms we have passed from time to time on the proposals of our American friends, and of our correspondents, have been written in no spirit of captious carping. We are above everything desirous that our progress should be solid; and that therefore we must be willing to proceed slowly, and on the lines which the actual working pioneers in the ranks of the profession indicate as lines of utility. And thereafter, to whatever is once settled we must doggedly adhere. There must be no more idea of changing the *henry* than of altering the *ampere* or the *ohm*. It may not be much use now that we have got it; but there it is, and we will not consent to tinker with either the unit or its name. New units, if and when they are really wanted. New names only if old ones do not already exist. But no jerry-building of fancy units, and no tinkering.

MOLECULAR ELECTRICITY.

The logical outcome of FARADAY's law of electrolysis is that every active atom in an electrolyte has a definite quantity of electrical charge—a sort of natural unit, or a simple multiple of such unit—invariably associated with it, and that fractions of such unit charge are not known. These are precisely the kind of data which in the sphere of matter led DALTON to his atomic theory of its constitution; and in accordance with this analogy there have been no lack of suggestions that perhaps electricity is atomic too,—indeed it may have been noticed that leaders like MAXWELL and HELMHOLTZ have, though with some reserve, coined and employed the extraordinary and impressive phrase "one molecule of electricity." The unit charge is now better known by the more cautious appellation, given to it by Dr. JOHNSTONE STONEY (who indeed was one of the first to emphasise this deduction from FARADAY'S laws) of an "*electron*," and these electrons are evidently going to play a great part in the theoretical developments of the immediate future.

"The hypothesis with which we [now] start is that electrical and chemical forces are identical; that electrification is a manifestation of unsatisfied chemical affinities, and that chemical union is a binding together of oppositely-charged atoms or groups of atoms." Such are the luminous words of Prof. POYNTING in our issue of to-day, and no doubt they express the view to which modern thought has been tending for some years past. Every electrostatic field has long been known to consist of a state of etherial strain which may conveniently be mapped and expressed as consisting of a region of lines of force each of which begins at one piece of matter and ends at another. The material atoms being known to be themselves intrinsically charged, it is natural to picture every line of force as beginning at an electro-positive atom and ending at an electro-negative one. Further, if these atoms are put into a state of locomotion, as in electrolysis they certainly are, it is natural to picture the phenomena of the current as due to, or at least accompanied by, a travelling of these lines of force through space. Recent researches in electro-convection in gases have led Prof. CHATTOCK, Prof. J. J. THOMSON and others to regard gas conduction as an essentially similar process, and the latter philosopher has further supposed that probably metallic conduction is but a modification of the same sort of process as goes on during electrolytic conduction, although at first sight the two processes appear very different. We find plenty of indications in these directions in Prof. LODGE'S "Modern Views of Electricity," especially in its second and fuller edition published in 1892; while in Prof. J. J. THOMSON'S "Recent Researches in Electricity" the attempt is made to work out nearly all the phenomena of electricity and magnetism on such an electrolytic basis.

In the articles of Prof. POYNTING, which we feel sure will be generally welcome, this attempt is made in a still more vivid and simple manner, and we think no one can fail to be impressed with the beauty and essential simplicity of a great part of what he has brought before us. It is not a very ambitious attempt: it does not seek to give us a hydro-dynamical theory of the ether and the universe, as the recent work of Dr. LARMOR does; it does not seek to find any *ultimate* explanation of electric and magnetic facts, it leaves fundamental dynamics alone, and by assuming some of the best-known facts of electrostatics without at present seeking to account for them, it presses them into the service of explaining most other electrical phenomena. Prof. POYNTING does not assume that electrons can exist detached from matter: every line of force with him is, as it were, an elastic connection between two atoms of matter, and only differs from a gravitational line in that it possesses an opposite sign at its two ends, —an exceedingly momentous difference, however. We are asked to picture these atoms mixing and separating, interchanging their lines of force according to the law of electrostatics; and we are asked to think of these same lines as flashing along laterally with the speed of light, and thereby giving rise to the phenomena which we associate with the term "electric current." The main idea is, of course, not new, but some of the details of its working out are very suggestive. Perhaps it may be useful if we rapidly call attention to a few of the less entirely satisfactory features of Prof. POYNTING'S treatment, leaving any detailed study of the matter for more leisurely consideration.

Our author seems to object to the statement that two gold leaves repel each other. Now undoubtedly, if attention is concentrated on the electrostatic field, as is most profitable at the present time, it is necessary to think of the lines of force as reaching from each leaf to the outer case, and the two leaves are truly pulled apart. That is the proximate explanation. But, then, how is this pull, or any pull, to be explained in a more ultimate manner? Can there really be any force in Nature other than a *vis a tergo?* Do we not expect that when the ultimate hydro-dynamical or etherial theory is fully fledged it will be found that by vortices or by some such mechanism the leaves are really being pressed apart? If so, then denunciation of language expressive of repulsion should be guarded as having only a convenient practical and immediate application.

Again, Prof. POYNTING complains that the earth is usually treated as if it were a return circuit in telegraphy, whereas it is really a "parallel outgoing circuit for the opposite charge, enabling the two electricities to travel in company and to join each other." Now, admitting not only the truth but the desirability of emphasising this mode of regarding the facts, we demur to its being denied that the earth is a return circuit, for we would ask Prof. POYNTING whether in any ordinary return circuit the same thing cannot be equally well said. It is well to explain the true meaning of the idea of a "return circuit" in terms of the particular hypothesis or

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proximate explanation under consideration, but it does not assist matters to discriminate between the earth and a metallic wire return-circuit. The phrase "return circuit" undoubtedly savours of a unitary, or "one-fluid" view of electrification, while Prof. Poynting has boldly launched himself on a dual view—every line of force has two ends, and they usually both travel in opposite directions at rates nearly equal; hence it is that the phrase "return circuit" no doubt strikes him as altogether unsatisfactory and obsolete.

His remarks concerning the figure which comes first among his illustrations are very luminous, and he might have added to their force by calling attention to what could happen, on any of the three alternative hypotheses mentioned, if the discharge key were only depressed momentarily, so as to leave a large fraction of the charge still in the condenser. There can be no question but that the lateral flashing out of the lines of electrostatic strain—the running of their ends along the wires, and the running of their energy into the wires—is the only satisfactory mode of regarding the phenomena of the discharge-current from this point of view: and a certainly helpful, though as certainly a very partial and incomplete, mode of regarding an electric current it is. The magnetic concomitants of the current are assumed but not explained, by Prof. Poynting; they are supposed to follow somehow from a lateral transfer of the electrostatic line, and, indeed, to be the condition without which no such transfer can occur; but the mechanism whereby the lines travel, and whereby the magnetic effects are produced, is not touched upon.

Hence we say that the theory is by no means an ambitious or fundamental attempt to grapple with the difficulties of the ether; it is merely a timely and helpful representation, suited to people accustomed to dealing with chemical and electrostatic forces, of a mode of extending their ideas to embrace a whole range of fresh territory, which otherwise might seem foreign and inaccessible. No doubt the main difficulty in the complete identification of chemical and electrical forces is that connected with the mode of combination known as "molecular," in opposition to atomic. So long as we attend to a simple electrolyte everything goes swimmingly, but when the ions have to deliver up their charges at an electrode, unite with each other, and rise as gas, it is difficult in the first place to suppose that they have really parted with their charges, and it is still more difficult to see why, if they have so dis-electrified themselves, they are still able to combine with each other. That H and Cl can hang together seems natural enough, but that H should also be able to combine with H, and Cl with Cl, is a puzzling fact. Some have suspected that the mode of combination in these cases was more analogous to gravitation or cohesion than to chemical affinity or electrostatic force, and that for this reason molecular compounds were insusceptible to electric influence. It may be so; but that is not the way Prof. Poynting regards it. He boldly surmises that although the charge of a monad atom cannot be gradually diminished or altered in magnitude, yet it may be reversed—he even conjectures a kind of mechanism for such reversal;—and granting the fact of reversals, so that half the atoms become positively and half negatively charged under the stress of the action going on at an electrode, there is, of course, no further difficulty about their entering into combination with each other just as if the two ingredients were entirely different elements at opposite ends of the chemical scale. Perhaps this is the simplest way out of the difficulty, but it raises questions as to whether a negatively-charged hydrogen atom is really hydrogen, or whether a positively-charged oxygen atom is to be supposed to have the normal properties of oxygen. Perhaps the solution of this sort of question lies in the statement that no single atoms can have the properties of the substance in bulk, and that the substance as we know it *always* consists of these oppositely-charged atoms in equal numbers. But then why is such an elementary substance not an electrolyte, and why can we never coax the constituents of such an elementary molecule to travel as ions towards opposite electrodes? For answer we have to call attention to the fact that such a substance *is* a dielectric, and that when rarified its properties become more or less nearly electrolytic.

Prof. Poynting is the first to admit that his treatment of these matters is tentative and unsatisfactory, but nevertheless the whole mode of treatment adopted in his article is one eminently suited to be helpful towards forming some kind of consistent mental image of a part of what is going on in that mysterious commonplace, an electric current; and whatever may be the ultimate fate of the hypothesis as he has presented it, there can be no doubt that it will repay much careful thought, and there is always the possibility that it may be fertile in results.

REVIEWS.

Polyphase Electric Currents. By Prof. S. P. Thompson, D.Sc., F.R.S., &c. Finsbury Technical Manuals. (E. and F. N. Spon.)

In the autumn of 1894 Prof. Silvanus Thompson delivered a course of four lectures at the Finsbury Technical College on Polyphase Currents, and it is certain that the interest shown in those lectures was as much a surprise to the lecturer as it must have been to others. Not only was the lecture room packed to an uncomfortable degree, but among those present might be seen many to whom studentship had long been past, men who in various departments of engineering were themselves masters. Prof. Thompson, in fact, as is his wont, had hit the psychological moment. "Magnetism in rotation" was the question of the time; coherent literature on the subject, with the exception of Mr. Kapp's "Electric Transmission of Energy," then just published, did not exist, though many valuable scraps lay buried up and down in cosmopolitan journals and magazines. It is fitting, then, that these lectures, expanded, in some respects remodelled, and amplified with valuable historical and index matter, should find a more permanent form in the shape of the present volume. It is right also that the reader should realise that this is the origin of the work now under notice, for a form which is natural to a lecture or series of lectures is not necessarily the best for a treatise, and probably this will be the first feeling in the mind of the reader. To be really appreciated the work wants reading carefully at least twice, bearing in mind the second time what there is after as well as before. Thus the first chapter, after a little preliminary matter deals at once with the principle of alternate-current generators for producing alternating currents of two and three phases, and the second chapter with the method of combining these differently-phased currents, without any hint or reason being given of why such apparently complicated means should be adopted of producing or transmitting power, and this procedure goes on till Chapter IX. is reached. This commences: "Alternate-current motors may be classified as follows:" Then follows a classification, and a chapter which with a little expansion would have formed a true groundwork for this book. Few electrical engineers who have not studied this question in detail grasp why it is that multiphase-current motors have in recent years eclipsed every other form of alternating motors. It really has nothing whatever to do with rotating magnetic fields. The reason may be thus stated briefly: An alternating motor is like a continuous-current motor made up of two parts, a part (the armature) having a small amount of self-induction, a part (the field magnet) having a large amount of self-induction. With alternating E.M.F.'s the phase of the current depends on the ratio between

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the self-induction and the resistance, and hence if we supply the magnetising circuit and the armature circuit from one source of E.M.F. the phases of armature current and magnetic field are different and the result small; if we supply them from sources differing in phase, the phases of the magnetic field and armature current may be made the same and develope power. That really is the underlying reason for polyphase currents for motive power. Motors embodying these ideas have recently made the strides they have for a mechanical reason. English engineers would never have accomplished what has been done, probably American engineers never would; it needed a nation of watchmakers—the Swiss—for no other training would ever have made it possible to make motors with "rotors," as Dr. Thompson names them, 12in. in diameter, running at 1,200 or 1,500 revolutions per minute with a clearance of one-fiftieth of an inch. And yet in these two facts lies the secret of alternating-current motors as of to-day: (1) supply phases which shall bring field and armature currents into phase, (2) magnetic resistance reduced as near zero as possible so that the electro-kinetic momentum of the magnetic field circuit is as small as possible. How far the small clearance necessary will eventually prove a drawback in practical work it is too early yet to decide.

Returning, however, to the book before us, and assuming that the reader has read the ninth chapter, and has examined the interesting examples of modern polyphase generators in the first chapter, Chapter II. deals with the methods of combining circuits carrying alternate currents of different phases, the most important part being that which discusses the economy of copper, with various combinations of phases and circuits. This part is perhaps not quite as clear as it might be made, but the principles which govern the various cases are gone into and elucidated. Then follows a discussion of the method of geometrically combining alternating magnetic fields, and showing how the conception of a rotating magnetic field arises. Chapter III. deals with the properties of rotating fields. Chapter IV., on the early development of the polyphase motor, is important. Dr. Thompson, as is well known, is in his element as the historian; but in view of the importance the historical aspect of this question is likely to assume, this chapter requires a little careful discrimination. Bailey's motor of 1879 was undoubtedly a true lineal ancestor of the modern induction motor, but among all the other early motors described there are none that really bring us any nearer to the modern motor until we come to Ferraris', whose first publication was in March, 1888, and Tesla's American application for a patent for an induction motor dating November, 1887, and published in May, 1888. The motor of Borel (1887) would work if the rotor were laminated to prevent eddy currents, and therefore cannot be classed with modern induction motors, whilst the three-phase motor of Coerper (Helios Company), 1887, is a synchronous motor, and was intended to work with a magnetic field magnetised in one direction. So that in Bailey, Ferraris and Tesla we have all the early history of the modern polyphase induction motor, as distinguished from the polyphase synchronous motor.

Chapter V. deals with the structure of polyphase motors, and gives a description of some experiments by Brown, in 1890, on the results of different forms of notches and windings for inducing and induced windings. It was the result of these experiments which determined Brown in the use of hole-wound inducing and induced windings, a practice which, notwithstanding, is likely to be abandoned in the near future in favour of wholly or partially open notches in order to diminish the local self-induction of the windings. Chapter VI. is on the elementary theory of polyphase motors, the treatment being based on that of Kapp, the substance of this chapter was given in *The Electrician*, November 23, 1894, whilst Chapter VII. gives an analytical theory, based on a memoir of M. Potier in *Bulletin* de la Société Internationale des Electriciens, of which it is only necessary to say that whilst accurate for the case it deals with, viz., a motor without magnetic leakage, for any purpose of design it is useless.

The next chapter (VIII.) introduces us to "monophase" motors, and we may congratulate the author on having escaped from that theory, apparently originated by one of Brown's patents, which considers, as Mr. Kapp has put it, "that self-induction in the armature (*rotor*) is an essential condition of its working," notwithstanding that he himself gives the test of a motor in which the power factor reaches 93 per cent., a result indicating a remarkable absence of self-induction.* This is not the place to give a rational theory of monophase motors, but surely the mathematicians are running riot when a motor receiving its energy from a single oscillating field is explained (!) by two imaginary magnetic fields revolving in opposite directions. Chapter IX. we have already alluded to. Chapter X. gives a useful and practical idea of polyphase transformers for transforming pressure, phase and period by stationary and revolving transformers, in which we see that pressure and phase may be transformed by stationary or revolving transformers, but period by the latter only. Measurement of polyphase power is briefly dealt with in Chapter XI., whilst Chapter XII. ("Notes on Design") is of a practical nature, but it really tells us more of what has been done than serves to guide us forward. Chapter XIII., on the mechanical performance of polyphase motors, with examples from modern practice, is admirable. The last chapter deals with the distribution of polyphase currents from central stations, of which there are some half-a-dozen examples in practice. Following these is an Appendix, "Bibliography of Polyphase Currents and Rotatory Field Motors," of which it is sufficient to say that if the book contained nothing else it would be worth possessing. Appendix II., "Schedule of some British Patents bearing on Polyphase and Alternate-Current Motors," is helpful, but is hardly sufficiently complete to be trustworthy by itself.

"I would like to say that I have no great love for alternating currents," said Prof. Thompson in 1888,† but, like so many others fighting against the stormy waves of the single-phase current, he has been drawn in by the vortex motion of the rotary field, and is a convert. The author of this book has rendered service to engineers and students before, in his "Dynamo-Electric Machinery" and his "Electromagnet," and not less in the present work. It contains a mass of research condensed into readable form, and if the theories are conventional rather than real, they are at least the current theories, and if in parts the work has the appearance of haste, we may forgive it in that it is absolutely up to date.

MOLECULAR ELECTRICITY.

BY J. H. POYNTING, SC.D., F.R.S.

In a Paper in *The Electrician* of October 13, 1893, after some criticism of the "wheelwork" hypothesis of electro-magnetic actions, I concluded by saying that I believed that "the time has hardly come for ultimate mechanical construction, and that at present progress is more likely to be made if we are content with an electromagnetic explanation—if we merely carry down to the molecules and their interspaces the electric and magnetic relations which we find between large masses, and round large circuits and leave the ether out of account."

I propose to follow out this idea, to see where it leads us, and what difficulties we have to face. The idea is in many minds, and we have examples of its use in the papers of Prof. J. J. Thomson and in the articles by Mr. Chattock in Dr. Lodge's "Modern Views of Electricity" and the *Philosophical Magazine.* The fullest account yet published is, I think, in Prof Thomson's "Recent Researches," Chapter I, but there are some difficulties not there brought to the front. I believe there will be some advantage in a new statement, starting with the very alphabet of the subject, and following it up by full examination of the consequences. In the belief that some way may yet be found to remove the difficulties, and that even now it gives us a valuable picture of some electrical actions, I venture here on a full description of the shape it has taken in my own mind.

* *See* "Electric Transmissions of Energy." Kapp. Fourth edition, p. 359.

† *Journal* Society Telegraph Engineers and Electricians, Vol. XVII., p. 225.

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The hypothesis with which we start is that electrical and chemical forces are identical; that electrification is a manifestation of unsatisfied chemical affinities, and that chemical union is a binding together of oppositely-charged atoms or groups of atoms.

Before descending to the atoms, let us briefly consider what we observe on the large scale coming within the range of experiment. The foundation stone of our electrical knowledge is the experimental result that the two kinds of charge are always found in equal amounts with opposite or neutralising mechanical properties, and that they always face each other on the two sides of the insulating matter between them. We add to this the idea that the energy of the charges accompanies some kind of strain—alteration, perhaps, of atomic or molecular configuration—in the insulating medium. The two charges, in fact, always join hands through the dielectric; or, putting the same idea in another form, the charges are manifestations on the bounding surface of a state of strain within the dielectric, somewhat as hydrostatic pressure is a manifestation on the surface of the vessel containing a liquid of a strain to which the liquid is subjected. When this idea of strain was enunciated by Faraday and rendered precise by Maxwell we had only the variation of inductive capacity to support it. But now the double refraction of dielectrics in the field discovered by Kerr, and the wave phenomena discovered by Hertz, give as near a positive proof of the existence of the electric strain as we can ever hope to get.

In a system at rest the electric strain ends at the surface of a conductor and the electric stress or pull on the surface $2\pi\sigma^2/K$ per sq. cm. is resisted on the other side of the surface by ordinary mechanical stress accompanying ordinary mechanical strain in the matter of the conductor. Some day, perhaps, we may be able to manufacture a hypothesis identifying mechanical and electrical strain; but at present we are obliged to separate them and think of them as different in kind, since mechanical strain in moving off or dying away does not give rise to the magnetic or chemical actions which characterise the moving off or dying away of electric strain.

We symbolise the relative value of the strain at different points of the field by unit tubes of induction each beginning at $+1$ and ending at -1 of electrification. The strain varies inversely as the cross-section of a tube, and we regard the reciprocal of the specific inductive capacity $1/K$ as a kind of modulus of electric elasticity. Though tubes of induction give us a better description of the imagined physical condition of the dielectric, it is easier to use lines of induction, one for each tube, when we have to draw figures.

These ideas of duality of charge, and of strain between them, which we owe to Faraday and Maxwell, though now accepted by everyone, have hardly yet so saturated our minds that we instinctively use them in every case. We still too often find descriptions of elementary phenomena which entirely leave them out of account. Like charges are still described as repelling each other, as when the gold leaves of an electroscope diverge, without a hint that the apparent repulsion is really a pull on each body along the lines of induction stretching out to the opposite charges induced on the surrounding conductors. The earth is still looked upon as a big conductor which will hold any reasonable amount of electricity without showing signs of it, and we speak of discharging a body into it instead of saying that the opposite charge is usually on the earth or the walls of the room in which we work, and that when a conducting bridge is made the two charges can come together so that the inductive strain is relieved, and its energy is dissipated. Or to take another example where common language and thought lag behind the more precise ideas given to us by science: the earth, as the "return" circuit of a telegraph wire, is still described as a reservoir from which, say, + can be pumped up at the sending end and into which it can be emptied out at the receiving end, just as if a telegraph wire corresponded to a pipe running above a water reservoir with a pump at one end and a spout at the other. Sometimes even we find the process described as if the charge going to earth at the receiving end knew its way back through the earth to the particular battery from which it started. Whereas the earth is really not a return circuit at all, but a parallel out-going circuit for the opposite charge, enabling the two electrifications to travel in company and to face each other—one on the wire, the other on the earth—whether the earth be the bare ground under an aerial line or the sheath of a cable in the bed of the ocean.

This travelling of opposite charges to meet each other is to be regarded, I am convinced, as the essential electrical part of the ordinary current. The lines of induction connecting the charges sweep through the air or other surrounding insulator, and this motion of the induction, or travelling onwards of the electric strain, is accompanied by—indeed, is rendered possible by—the magnetic induction which surrounds the conducting wire. The only case of current without motion of charge is the gradual cessation of charge in an imperfectly insulating condenser. Here the charges simply die away *in situ*—their strain decays and their energy is dissipated; and as there is no motion of induction there is no magnetic field.

To realise how ordinary current may be described in terms of motion of lines of induction let us suppose that, instead of the more usual dynamo or battery as source, we have a charged condenser with the − terminal to earth and the + terminal insulated, but capable of connection by a key with a wire earthed at the farther end. Up to the instant when the key is put down the two charges are almost entirely in the condenser, joining hands in the dielectric between the plates. The still prevalent mode of describing the current on contact at the key is equivalent to supposing that, as soon as the + found a door open to it, it freed itself from the embrace of its −, put its hands in its pockets, ran along the wire, setting all the neighbouring magnetic machinery spinning as it rushed past, and finally plunged into the earth at the farther end. The −, no longer kept up or "bound" by the +, sank into the earth at the condenser end, and both were lost in that vast electrical abyss, the globe.

But let us see what is really implied in the process of discharge if we keep to our fundamental principle that + and −

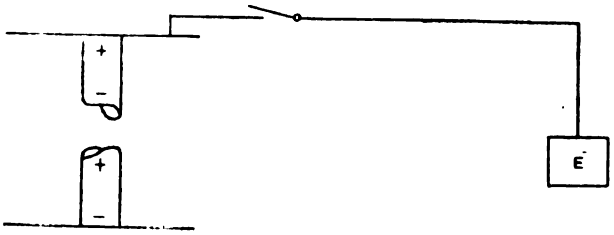

FIG. 1.

always have induction tubes or lines between them. Let us try the various suppositions which seem open to us, and let us first imagine as a possibility that the charges are able to start on their travels by breaking their induction tubes somewhere in the dielectric between the condenser plates, as in Fig. 1. At the broken ends we must have opposite charges (just as in a broken magnet we have opposite poles), for a charge is the end on matter of an induction tube. If each + unit setting out along the wire drags the broken half of its tube after it into the wire, we shall have on the whole equal + and − travelling in the same direction along the wire and no external magnetic effect. Indeed, as soon as the leading + has drawn its piece of tube completely into the wire there does not appear to be any reason against the union of the + and − at opposite ends of the piece, and then nothing need occur in or around the rest of the wire. But as we have magnetic and other effects in and around the whole length of wire, and everything is against the passage of + and − in the same direction, we are bound to reject this supposition of breaking tubes. As another supposition let us imagine the tubes as remaining in the dielectric of the condenser but growing longer where they stand, and as it were pushing their end charges before them, the one through the wire, the other into the earth. But this will leave the tubes still in full strength in the dielectric, and when the disturbance in the wire has died away the condenser will still be fully charged, which is absurdly at variance with experience. The only possible supposition still left to us is that the tubes of induction spread out sideways from the dielectric of the condenser into the

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surrounding air, connecting the + and − charges as these move respectively along the wire and the earth. The induction—that is, the condition we call electric strain—is propagated by the working machinery from point to point through the air, and the motion of this machinery is manifested as magnetic induction, symbolised by lines of magnetic force which form closed circuits round the wire. We cannot explain this mode of transfer, but the mechanical models of Maxwell and Lodge and Fitzgerald help us to accept it as possible.

We must now introduce the idea that conductors are dielectrics—of a special kind, no doubt—admitting of electric strain, though allowing it to decay rapidly and dissipating the energy they receive in the form of heat. We may take as a helpful analogue to this behaviour of a conductor the behaviour of a liquid under ordinary elastic shear strain. A liquid can receive shear strain just as much as a solid, but the strain decays, that is, rapidly loses its energy, and the lost energy is transformed to heat. But the still undecayed strain remaining at any instant gives a tangential resistance to shear, which we recognise as viscous resistance to the motion of one layer relative to the next. So in a conductor such as a wire, electric strain may be produced and electric energy may be taken in; but the strain decays almost as fast as it is received and the energy is changed to heat. The E.M.F. along the wire is proportional to the strain remaining still undecayed at any instant, and this E.M.F. corresponds to the elastic stress—the viscous resistance—of a sheared liquid.

In the case of the condenser which we are considering, as the induction tubes spread out from it their end portions are continually moving sideways into the wire, and to a less extent into the earth, and there melting away and dissipating their energy as heat. New ends are continually being formed at the junctions of the decayed and undecayed portions, and these ends travel further and further along the circuit until the tubes are entirely propagated into the conductors, when the discharge is complete.

A full account of this mode of regarding current, and the relations involved between electric and magnetic induction, with an attempt to show that it applies to the voltaic circuit as well as to such a circuit as we have here considered, was given in the *Philosophical Transactions* for 1885. Prof. J. J. Thomson has modified and elaborated the theory in the *Philosophical Magazine* for March, 1891, and in his "Recent Researches in Electricity and Magnetism," Chapter I. The full theory shows that if we assume that the magnetomotive force round a closed curve is equal to $4\pi \times$ number of electric tubes cutting the curve per second, then the magnetic field is accounted for. If, then, we make the electric tubes move so as to account for the right electrical quantities, the magnetic properties will follow as a matter of course, and we may therefore concentrate our attention on the electric tubes, as we have done in the preceding account of one case of current. I have given this case at length, by way of introduction, to show that here at least the only way in which we can think consistently of current in a wire is in terms of motion of + and of −, and of tubes of electric induction connecting them and sweeping through the surrounding medium into the wire. We shall see later how such tubes may be supposed to be furnished by the recombinations which occur in the voltaic circuit, and I have no doubt that in all other cases of current the same kind of explanation may be given.

There is another reason, perhaps, for giving here the foregoing account of a condenser discharge, in that the hypothesis which I am going to describe may not inaptly be termed a condenser hypothesis of electricity. The properties which we find in condensers will be carried down to the molecules, which we shall suppose to be small condensers with equally and oppositely-charged atoms forming the two plates. Of course, this will not explain electricity. It is a purely electrical hypothesis, and it shifts all responsibility of further explanation on to the shoulders of whatever atomic hypothesis we adopt, just as Weber's magnetic hypothesis gives no explanation of magnetism, but assumes the molecules to be ready-made magnets, and leaves to them the burden of accounting for themselves.

We are naturally led to make the hypothesis from the consideration of the chemical action of current. When a voltameter is included in a circuit a perfectly definite quantity of electrolyte is decomposed for a given number of induction tubes moving sideways into it. All parts of the liquid between anode and cathode are concerned in what goes on, and there are two opposite processions of ions. This is all experimental fact. Representing the action atomically we may obtain the net result by the old Grotthus chain method of picturing the process, and each atom set free requires the supply of a definite constant amount of electric induction, calculable if we know the number of atoms per gramme of the substance.

Let us now consider how electrolysis may occur. We shall imagine a somewhat abstract kind of electrolyte, one consisting of molecules, each with a pair of atoms, an abstraction, a simplification, which we shall have to discard later. To account for the exact chemical equivalence of electrolysis in different cases we shall have to suppose each atom to be supplied with the same amount of electric induction, to have the same minute fraction of an induction tube starting from it if it is of one kind, ending on it if it is of the other kind. To

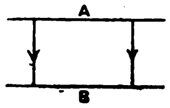

Fig. 2.

bring the induction up to a thinkable size we must choose a new unit—I suppose millions of billions of times less than the ordinary unit, and it will be convenient to picture the atom as supplied with two, four, or some such small number of tubes in terms of this new unit.

Here, then, is our molecule, represented in Fig. 2. A is the positive and B the negative atom. The molecule is, in fact, a little condenser with fixed charges, and the distance between A and B is usually small compared with their distances from neighbouring molecules. But we must suppose that in general A and B do not come in contact, perhaps through motion of vibration or of rotation relative to their centre of gravity.

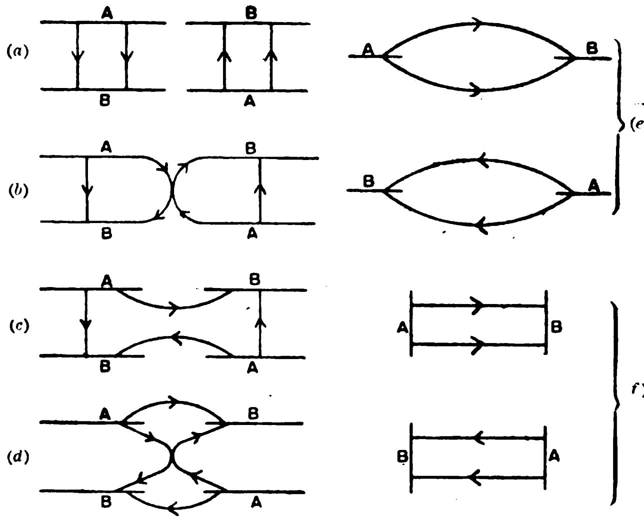

Fig. 3.

There is therefore persistence or conservation of their tubes. The electrical attractions symbolised by these tubes are absolutely identical with the chemical attractions of the molecules and the electrical energy they contain with the chemical energy of the molecule. It is easy to see, however, that two molecules colliding may become connected, and form a more complex group, and may even effect an exchange of atoms.

Thus, in Fig. 3, (*a*) to (*f*) represent successive stages in the process of exchange. Just as, when two condensers are brought near with their tubes of induction running in opposite directions, cross-connections are formed by the coalescence and neutralisation of parts of the tubes, so here we may suppose that in a molecular collision the tubes straying out coalesce, and the parts which run in opposite directions destroy each other. In (*c*) we have a more complex molecular group. If the process is

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continued we may arrive at (*f*), which gives the original molecular configuration but with exchange of partners. If we are ever to attempt an electrical hypothesis of elasticity and cohesion we shall have to suppose that straying of tubes is always going on in solids and liquids, and that complex groups like (*c*) are always being formed, so that each molecule is attached to its surroundings. In gases not in an electric field the molecules may be regarded as much more self-contained.

(*To be continued.*)

ISLE OF MAN ELECTRIC TRAMWAYS.

Snaefell, the highest of the mountains in the Isle of Man, has recently been brought into closer communication with the civilised world by an electric tramway ascending nearly to its summit from Laxey, the nearest town. The summit of this mountain is destitute of every residence, excepting a small hotel recently built; there is, therefore, no ordinary inducement, as was the case with the Douglas-Laxey electric tramway, to carry a tramway to it. Neither is there any great attractiveness in the bleak rugged mountain-mound itself, for its height is far below that of its Icelandic namesake, and but little exceeds 2,000ft. There is, however, ample justification for the construction of nearly five miles of double railway up this mountain, in the fact that tourists regard the magnificent view which is to be obtained from the summit as unequalled by that from any point in the world at the same moderate altitude. Hitherto the ascent has been made with difficulty, or at considerable expense, by few people; but now that the electric cars are running, a stream of some 600 to 1,000 visitors per day is maintained.

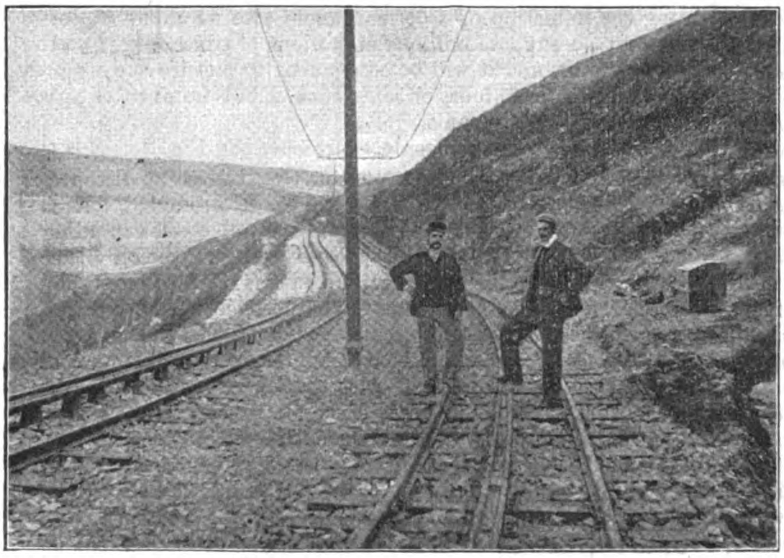

FIG. 1.—Snaefell Mountain Electric Tramway. View from steep gradient, on cutting, showing level track beyond.

The summit of Snaefell is 1,860ft. above the level of the Laxey terminus of the line, and the mountain terminus is but 44ft. below the highest point. The route chosen, after careful surveys by Messrs. McKerrow and Fell, extends along a length of 4·7 miles of track. There is, therefore, a ruling gradient of about 1 in 12. The surface of the mountain side is extensively covered with thick peat, and below this there is a deep stratum of contorted shale, the stratification principally being at a steep angle or else vertical. The greater part of the track, which is doubled throughout, lies in cuttings in the face of the steep sides of the mountain; and an immense number of curves, of from 10 to 20 chains in radius, have been rendered necessary. There is, however, no tunnelling, and the view is uninterrupted. Heavy retaining walls are occasionally erected against the cuttings; the advisability of these being emphasised by the fact that the recent storm swept away a portion of the outer part of the track, at a place where it had not been so retained.

The general character of the track may be seen in the accompanying illustration, Fig. 1. This view shows in the foreground a steep gradient, with a dead level portion (apparently, however, on a reverse incline) in the distance. Both tracks are laid with three rails, spiked to cross sleepers of creosoted timber. The two outer rails are of the Vignoles flat-bottom type, of steel weighing 50lb. per yard. They are fished at the joints in the usual manner, except that extra provision for heavy pounding is made in the use of Grover spring washers at the fish plates. The ends of the rails are everywhere fang-bolted to the sleepers; and the rails themselves are electrically bonded with copper strip, copper riveted. The gauge adopted is 3ft. 6in., this being 6in. wider than the standard gauge in the island, and equally wider than the gauge on the Douglas-Laxey electric line. This departure from standard practice was adopted in order to ensure greater steadiness and safety on the steep gradients and sharp curves. The accompanying diagram of gradients (Fig. 2) will enable the reader to form an idea of the almost persistent steepness of this line from start to finish.

The middle rail is constructed on the "Fell" system. Its purpose, in the Snaefell line, is to serve as a guide, to prevent the cars from leaving the track, and to provide a surface for the grip of the powerful emergency brakes, with which every car is fitted in duplicate. In other places where the "Fell" middle-rail system has been introduced—notably, in the temporary light railway up Mont Cenis, before the completion of the tunnel—the centre rail has also been used to provide extra adhesion for the driving wheels. But, at present, on the Snaefell tramway, all the adhesion necessary is obtained with the four pairs of bogey wheels on which the cars are mounted. The middle rail is of rolled steel, double-headed, weighing 65lb. per yard. It is supported in the centre of each track, upon light wrought-steel ⎍ shaped chairs, spike-bolted to the cross sleepers, there being one of these chairs at every sleeper on each of the tracks. The security of the track as will further be seen by a glance at the accompanying views, is therefore fully assured.

To understand the more completely in what way this middle rail serves its double duty of guiding and braking, we will now turn to consider the cars and their equipment. At present there is a rolling stock of six motor cars, together with one or two trailer freight trucks for occasional use. Unlike the Douglas-Laxey line, there is in this tramway no passenger trailer behind the cars, but we understand that it is intended further to equip the line with a number of freight motor trucks. Each car is 35ft. long, and will seat 48 passengers. The cars are substantially built of timber, and are roofed over; but at present they are open, though it is intended to fit them with sliding windows. They are entered at the rear and front ends through the motorman's cabin, which is separated from the main part of of the car by a sliding door. Each car is mounted upon two four-wheel bogey trucks, each of which has a wheel base of 7ft., the diameter of the wheels being 24in. To each of the four truck axles a 25 H.P. Mather and Platt series-wound motor is geared. Thus every wheel of the car is a driving wheel, and the entire load is utilised for adhesion. There is, underneath each end of the car, a sand-box, provided with a system of distributing pipes for increasing the grip of the wheels on occasion. Every wheel is provided with a steel-shoe hand brake, controlled from both ends of the car; and during the descending journey the brake-handle demands constant watchfulness and plenty of muscle from the brakesman, both driver and conductor engaging themselves in this work. By the side of the ordinary brake-handle there is a similar arrangement for controlling the emergency brakes, one of which is fitted at each end of the car. These emergency brakes are kept slightly in action throughout the descending journey, but when fully in action they will quickly destroy the highest speed which the car might attain on the track. These brakes consist of two steel blocks or jaws, which grip the middle rail on either side, and which are actuated by a stout toggle connected to the brake screw.

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Nearer the centre of the car, and on the same level as the emergency brake blocks, there are two pairs of horizontal flanged idle wheels, mounted on stout spindles so as to hang downwards from the frame of the truck. The wheels of each pair of these guide wheels roll on either side of the double-headed guide rail; and their flanges pass underneath this rail. In this way the truck is prevented from mounting, being held down by the stout flanges of the guide wheels.

An effective tractive effort of 2,840lb. is required to run a fully-loaded car up the track at the usual speed of nine miles per hour; and a proportionately greater tractive force would be required on starting, were it not that the line is constructed so that all the normal starts will be made on the level. In the event of the cars requiring to be started up the stiffest gradient —about 1 in 12—a much larger effort would be necessary. It will be seen, then, that a considerable margin of power must be provided in the motors, to meet these conditions. The motors are geared to the car axles by single-reduction 4 to 1 spur gear. The wheel and pinion are of hard cast steel, with the teeth carefully machine cut, to give smooth and silent running and a minimum wear. Normally the four motors will together develop a torque equivalent to a tractive force of 3,500lb. The motor armatures are surface-wound Gramme rings, with copper strip winding of ample section to stand heavy starting currents. The system is worked at 500 volts, and the four motors are connected together two-in-series and two-in-parallel. A normal current of from 120 to 160 amperes will pass through the car, thus, from 60 to 80 amperes through each motor.

Fig. 3 gives a view of the Laxey terminus, and shows the system of overhead conductors, and the type of motor car in use.

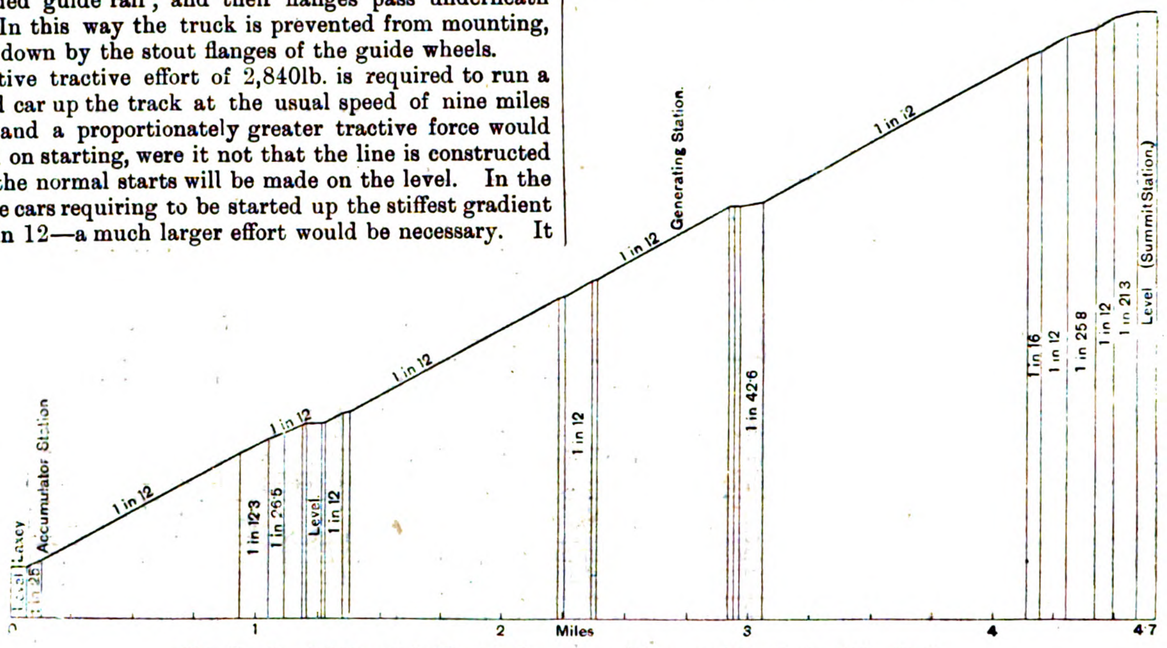

Fig. 2.—Snaefell Mountain Electric Tramway. Diagram of Gradients of the Route

Fig. 3.—Snaefell Mountain Electric Tramway. View of Cars, &c., at the Laxey terminus.

Power is supplied to the cars on an overhead system introduced by Messrs. Mather and Platt, and identical with that used by them on the Douglas-Laxey line. The general features of this system will be apparent from the accompanying illustrations. It differs essentially from the trolley system in the absence of the trolley. Between the two tracks, at distances of about 150ft. apart, light steel poles are grounded. Each pole carries a double bracket, or cross-tree, of steel, extending horizontally across both tracks. From each bracket on either side the conductor is suspended, by means of a riveted clip suspended from a bell insulator. The position on the bracket, of this suspension, depends on the curve of the line at each place; but there is nowhere that need for exact adjustment of the position of the overhead wire that is necessary with the trolley system. The conductor is of No. 0 hard-drawn copper wire, and at its lowest part it is a clear 16ft. 4in. above the track. Both up and down tracks are fitted with an overhead conductor, although, as a matter of fact, the down journey is performed entirely under gravity.

Upon each car there are fitted two sliding collectors, one at each end, which consist of flat steel bars extending transversely across the entire width of the car. These are mounted on the car roof, and are pressed against the overhead conductor by an arrangement of steel spiral springs. The two collectors are cross connected inside the car. By this system of collection the current is taken from the overhead conductor with an insignificant amount of sparking, a reasonably small wear of the conductor, and very little noise. Indeed, the sparking is only visible at night; the wear has been found on the Douglas-Laxey line to be remarkably small, a "flat" of only $\frac{1}{500}$th inch having been worn during the two years of running; while, as to noise, there is nothing of which the running of these cars reminds us more than a steam locomotive with steam slightly escaping from the safety valve.

The cars are started without altering the relative connections of the motors; or, in other words, the series-parallel system is not in use. Beneath the car bodies, well exposed to the air, are a couple of slate-framed sets of iron-wire resistances; and a start is made in a very simple manner, by throwing these into circuit, and gradually cutting out resistance as the speed rises. On the Snaefell line, the cutting out of resistance is left to the discretion of the motorman; and the only piece of interlocking is that which prevents the motorman from reversing his motors without previously switching them out of circuit.

There is but one actual feeding point in the entire length of the line, if we except the storage batteries which are connected to the lower extremity. This feeding point is at the point in the line contiguous to the generating station, at a distance of

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2¾ miles from the Laxey end, and some two miles from the terminus at the summit. At this almost mid-point the overhead system is divided into two parts, an upper and a lower, each of which is separately controlled and fed from the main switchboard. The line may, however, be subdivided into smaller sections by means of switches in the lightning-arrester boxes along the route, and this will be done when it may be necessary to repair any section.

The generating station is a substantial stone structure, situated about 50ft. from the line on the under side of the mountain. Its chimney, of wrought iron, is on the upper side of the mountain; the furnace gases being carried beneath the tramway through a horizontal flue.

The building is divided into two parts, on slightly different levels. The higher and more spacious of these is the machinery room; the other is used as a boiler house. Within the

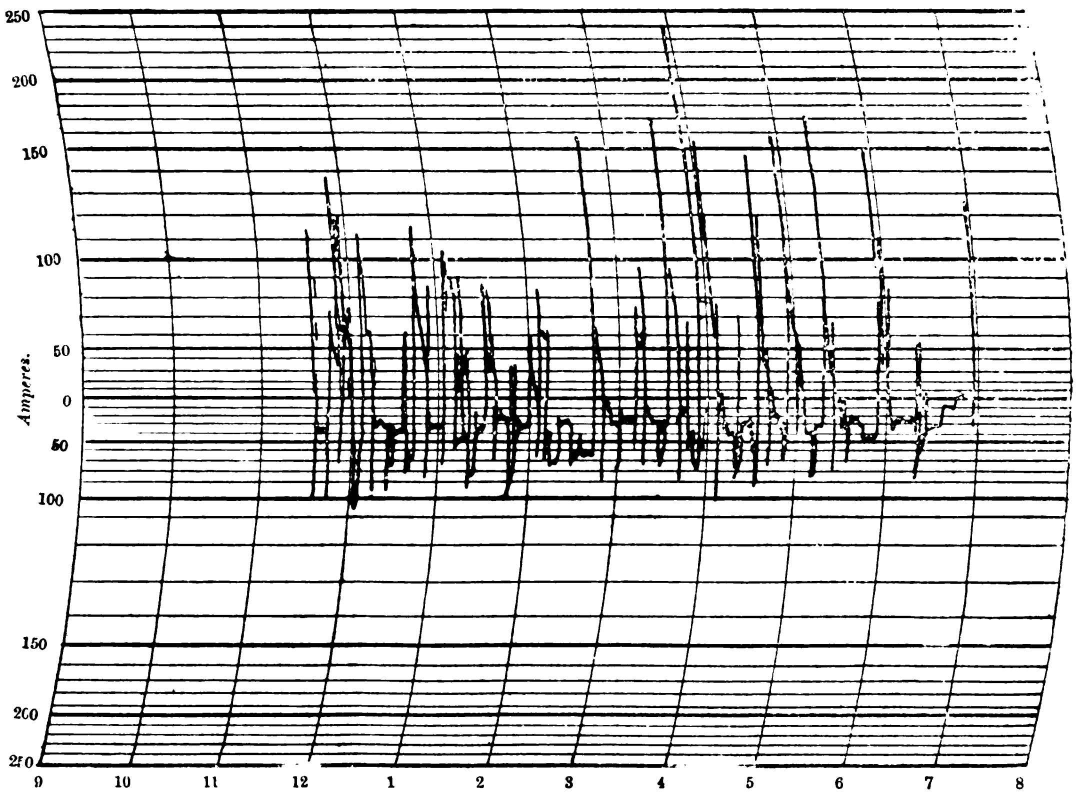

Fig. 4.

The choice of the site for the generating station involved many considerations. The centre of the route evidently was advantageous from the distribution point of view, but the fact of its being at an altitude of nearly 1,400ft. above the sea, and on the steep face of a mountain, was certain to increase the cost of running a steam station there, by augmenting the cost of carriage of coal. However, to locate the station anywhere

machinery room are five generating sets, each comprising a Mather and Platt 120 H.P. horizontal compound steam engine, belt coupled to a two-pole shunt dynamo by the same firm. The dynamo field-magnets are of the Hopkinson type, and the armature is Gramme wound with copper strip. Each machine, running at a normal speed of 900 revolutions, will develop a normal output of 120 amperes at 550 volts. The machines

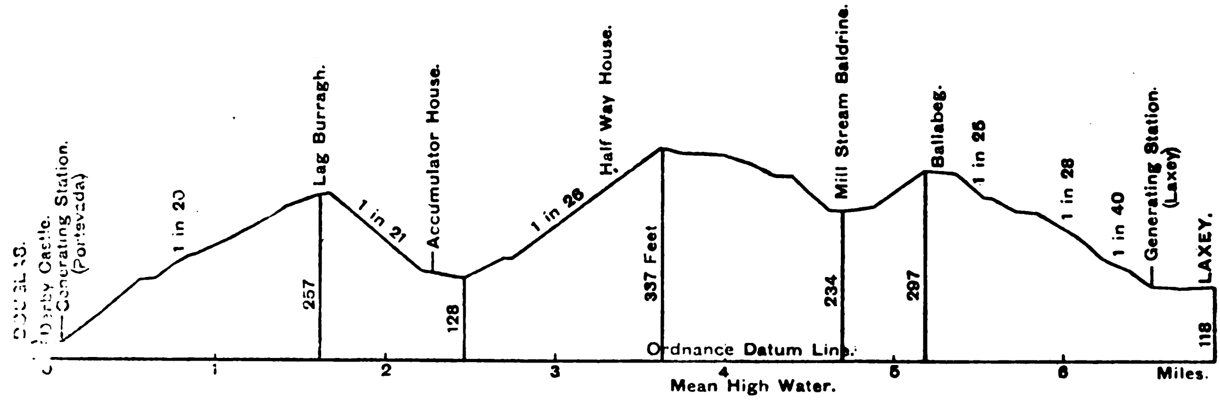

Fig. 5.—Douglas-Laxey Electric Tramway. Diagram of Gradients of the Route.

near Laxey town was rendered impracticable, owing to the impossibility of securing water rights. Accordingly, the site was fixed at the place already named, in order that water might be obtained for the boilers. Even here, however, water is not directly to hand; and some 800 yards away, beside a mountain brook, a small pumping station has been erected to raise water to a capacious tank just outside the generating station. This tank is capable of holding three days' supply of boiler feed.

are coupled to the engines by means of link leather belting running under adjustable jockey pulleys.

The steam engines are built on the horizontal, compound side-by-side plan, with outside flywheels. The cylinders are 20in. and 12in. in diameter; the stroke is 16in.; and the speed varies from 160 revolutions at full load, to 164 revolutions at light load. Each engine is provided with a Pickering throttle governor and a hand cut-off regulator. We noticed that the

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Pickering governors were not belt-driven in the usual manner, but were driven by bevel gear from a light governor shaft, which was itself bevel-geared to the crank shaft. This modification happily obviates any calamity on the line, due to the governor suddenly ceasing to do its duty. The hand cut-off regulator is a modification of the Meyer slides. Instead of the usual hand wheel at the rear of the steam chest, there is a pawl and ratchet motion attached to the valve rod just outside the steam chest on the eccentric side. This obviates the extra gland on the further side of the chest, there being no valve tail-rod. The engines are of the "receiver" type, with cranks at 90deg., and the receiver, which consists of a cylindrical vessel placed behind the engines a little above the floor level, is provided with a re-heater in the form of a live steam coil passing through it. The flywheels are each 8ft. 6in. in diameter. Each engine is provided with a system of lubricators connected to one central oil tank.

Steam is generated in four Lancashire boilers, each 26ft. in length and 6ft. 6in. in diameter. The internal flues are fitted with Galloway cross tubes. This battery of boilers will generate steam, at 120lb. pressure, for about 700 H.P. The boilers can be fed either by means of a steam pump or by live steam injectors.

At one end of the machinery room is the switchboard, which, while simple and unpretentious in appearance, is well adapted to its duties. The board is built, in the usual manner, some little distance from the wall, with a passage-way behind it to enable the connections to be reached. The face of the board is fitted with two Kelvin multicellular voltmeters, one for each section of the line, *i.e.*, the portion above and the portion below the feeding points; it also is provided with an ammeter for each machine, a magnetic blow-out lightning arrester, and an automatic cut-out apparatus which will come into action in the event of a "dead-short" occurring anywhere on the system. By the side of the switchboard is the telephone box, which is in communication with both ends of the line and with the battery house at Laxey. The telephone wires are at present, by-the-bye, carried on the tops of the conductor poles; but we understand it is intended shortly to place them on separate poles.

Situated near to the lower extremity of the line, and electrically connected to the very extremity, is the storage battery. This comprises 246 of the "S.P." type of chloride storage cells; the "S.P." signifying that these are specially protected by means of asbestos cloth packing and by special arrangement of the grid, to withstand a very high rate of discharge, such as is inevitable in traction work; or even, for a short period, a complete short-circuit. The rated capacity of these cells is:—

176 amperes for 3 hours.	84 amperes for 9 hours.
112 „ „ 6 hours.	72 „ „ 12 hours.

The cells are contained in strong clear glass vessels, mounted in sawdust trays upon glass insulators, the whole of the battery being supported on a stout timber staging—on one level—set upon an asphalte floor. They are contained within the greater part of a neat wooden building, the lesser portion of which serves the purpose of a switch room, and is separated from the battery room by a wooden partition. We were particularly struck with the absence of acid fume and unpleasant gas from both these rooms, which are well ventilated and lit by means of two skylights running along the length of the roof.

The purpose of the cells is simply to serve as an electrical regulator of the pressure on the line, by which means the variations of supply to the cars might be made without undue fall of pressure and without imposing a sudden great increase of load on the generators. In regard to the steadiness of the pressure, the scarcely perceptible change in the brilliance of the car lights—which are run off the overhead system—when a car is started, shows what success has been attained. And, as to the sudden load on the engines, the gradual creeping-up of the dynamo ammeter readings, and the absence of serious drop in engine speed, show how useful are the cells in this respect.

The flux of energy into and out of this storage battery regulator is well illustrated by the sample of the battery ammeter records which is shown in Fig. 4. The parts of the record above the zero line represent current going out from the battery to the cars; the parts below zero represent charging current. It is a fact worth mentioning that hitherto the amount of charging from the line has practically balanced the discharge, so that the initial charge has been kept up. However, the switching arrangements at the battery house allow of the entire battery receiving a replenishing charge when necessary, and to effect this the entire battery of 246 cells is divided

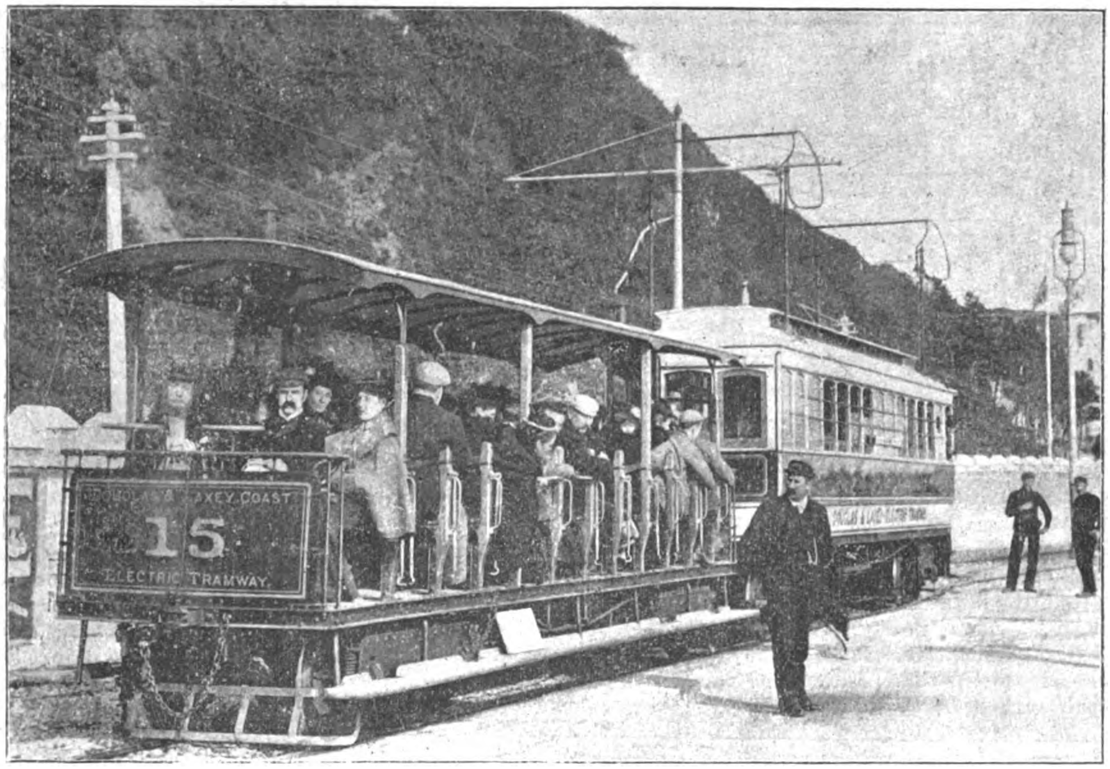

FIG. 6.—Douglas-Laxey Electric Tramway. View of Douglas Terminus, showing Overhead System. Motor Car, Passenger Trailer, and Arrangement of the Arc Lamps. N.B.—The *wooden* poles and wires strung to them are not connected with the tramway system.

into two equal portions, which are temporarily coupled in parallel across the system, these half batteries being charged at the requisite charging pressure by reducing, for the time being, the generating pressure. It may be mentioned, also, that it is not intended to run cars solely by means of the cells, as is done on the neighbouring line.

The contractors for the whole of the generating, storage and other electrical equipment have been Messrs. Mather and Platt, of Salford, who have departed from the lines of their former contract—the Douglas-Laxey tramway—only where experience has dictated or modified conditions have demanded. It is to their great credit that success has crowned their recommendation of the overhead system, and the adoption of the middle rail, in place of rack gear, on the steep gradients of this mountain line. We have mentioned that the civil engineers of this tramway have been Messrs. McKerrow and Fell, of London, by whom operations were commenced last January. The engineering operations throughout have been carried forward in the face of great difficulties; first, in the earlier stages, on account of the appalling winter; and later, owing to the earlier delays having made it necessary to work against time, so as to have the line ready for the tourist season. Some idea of these difficulties may be gathered from the facts that the whole of the generating and electrical equipment has been erected within seven weeks, and the entire overhead system of poles and conductors occupied no longer than eight working days for its erection. The credit for this enterprising piece of prompt working is to be given to Mr. R. H. Willis, the resident engineer appointed by the contractors; and its value is enhanced by the fact that the system started work in perfect order and without a hitch.

Our thanks are given to Messrs. Mather and Platt for permission to publish the illustrations and other particulars of the Snaefell mountain tramway; and they are extended to Mr. R. H. Willis and Mr. Cartner, in whom the charge of the generating station has been placed, for the kind courtesy with which they assisted us to survey the system while in operation.

While spending a few days in the Isle of Man, for the purpose of visiting the Snaefell line, we devoted some time to a further examination of the Douglas-Laxey line. As this last-named tramway is constructed upon a similar system to that at Snaefell, we have appended a few illustrations of it, and will conclude our account of the Isle of Man electric tramways with a few remarks upon it.

The Douglas-Laxey electric tramway was opened to the public on July 28, 1894, and some account of the system, as it then existed, will be found in *The Electrician*, Vol. XXXIII., p. 449. The particulars of the route are contained in the accompanying diagram of gradient (Fig. 5), an interesting comparison between which and Fig. 2, the section of the Snaefell line, may be made. The Douglas-Laxey system has two-fifths of its generating plant at the Laxey end and three-fifths at the Douglas end, and it is provided with a battery station at about one-third of the distance from Douglas, and a feeding point—connected by buried Callender cable to each generating station—at the middle of its length. The rolling stock consists of 13 motor cars, each equipped with two 30 H.P. motors and 12 passenger trailers, in addition to which a number of goods trailers are occasionally called into requisition. A view of one of the motor cars, coupled to a passenger trailer, is shown in Fig. 6, in which also the overhead system and the arrangement of the collector bars will be seen. It will be noticed, too, that upon some of the conductor poles arc lamps have been suspended. These are in use only at the Douglas end of the line, the lighting at the other end, as well as in the cars, being by means of incandescent lamps connected in series to the overhead conductor.

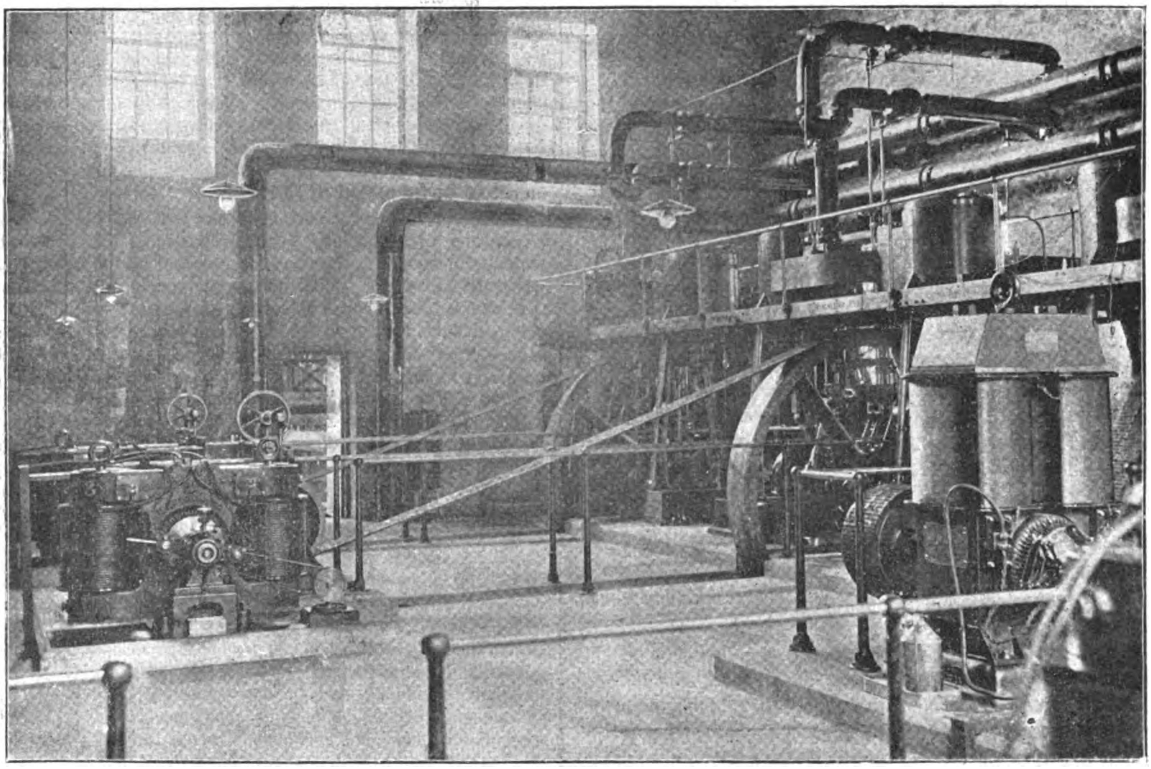

Fig. 7.—Douglas-Laxey Electric Tramway. View showing a portion of the Generating Plant at the Douglas Generating Station.

The rails are bonded with riveted copper strip, and but one per cent. of the total current normally returns to the stations through the earth itself. We noticed at the Douglas station an ammeter on which the actual earth-return current was being indicated.

There are five generating sets, each comprising a 100 H.P. Galloway vertical compound engine, coupled by means of a link leather belt drive to a Mather and Platt 500-volt dynamo. Three of these sets are situated at the Douglas station, a view of the machinery room in which is shown in Fig. 7. The remaining sets differ from these only in being placed on a shorter drive, and in being non-condensing, while the Douglas sets are condensing; and they are situated at the bottom of Laxey Glen, somewhat near the terminus at that place.

The battery station at Groudle Glen consists of a neat wooden structure, in one portion of which is a battery of 240 chloride storage cells, and in a separate room a continuous-current motor-generator for supplying the hotel, &c., with light. The cells have a capacity of 140 amperes for 3 hours, or 70 amperes for 9 hours. During winter occasional cars are

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run on the batteries alone, these cars being rendered necessary partly because the line carries all the mails. There are no special mail cars, however.

Our thanks are due to Mr. J. Shaw, the resident engineer at Douglas, and to Mr. Aldworth, the general manager, for the courteous and genial kindness with which they showed to us their generating stations and line, as well as for permission to publish the illustrations of their tramway system which accompany this article.

It will be of interest to state that the principle and details of the electrical equipment of these two electric tramways in the Isle of Man were adopted and designed by Dr. Edward Hopkinson.

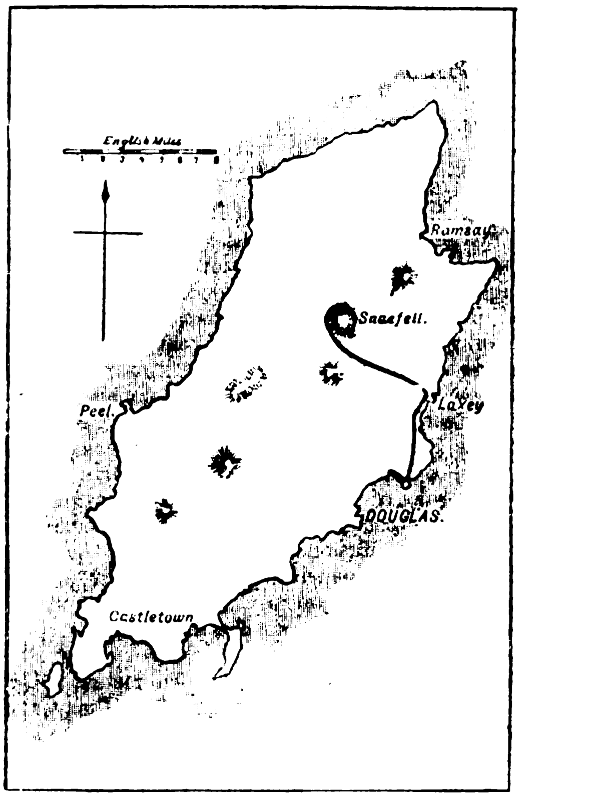

FIG. 8.—Isle of Man Electric Tramways. Routes of the two lines, shown thus ————

The accompanying map of the Isle of Man (Fig. 8) shows the routes of the two electric tramways. It will be observed that the one from Douglas does not join that from Snaefell at Laxey, there being a distance of some 200 yards or more between their respective termini.

We hope soon to see other parts of this interesting little island connected together by electric tramways; and judging by the enterprise of the Manxman in the past, we scarcely think we shall be disappointed.

THE INVENTION OF THE ELECTROMAGNET.*

BY E. BOISTEL.

In a recent article† with the above title my good friend M. G. Pellissier thought it his duty to call attention to a mistake made by Prof. S. P. Thompson in his well-known work "The Electromagnet and Electromagnetic Mechanism," and even to accuse him somewhat sharply of distorting the truth. As mere translator of of the book in question, I am personally in no way concerned in this controversy. I do not wish, however, to be considered as having accepted without inquiry or comment a statement that, according to M. Pellissier, disagrees so entirely with the irrefutable documents which may be found inscribed on the pages of history. I shall go somewhat deeply into the matter, although keeping myself within the limits of the article by M. Pellissier. Far from blaming his chauvinism, in which there is nothing unbecoming, I only ask M. Pellissier to allow that I am myself as careful as he of the glory of our great men and equally desirous to give to each his due; but I entreat M. Pellissier to moderate his youthful ardour. He who proves too much, proves nothing.

That being settled; to the question at issue. M. Pellissier, to make good the belief in which he, in common with so many others, has been brought up, appeals to the testimony of all writers who have written on this branch of electric science. Now, without stopping to search right through these works, I will admit that the discovery of the electro-magnet was formerly, at any rate, attributed to Arago (one only lends to the rich). But I have also discovered, much to my astonishment, that the best recent works, in which I hoped this point would be in some degree cleared up, are absolutely silent about the matter. Is this to be regarded as the consecration of a widespread belief, or is it an act of prudence, the motive for which is the often exceeding difficulty of settling these questions of priority and the well-grounded fear lest an idle dispute without profit to science or to practice should be started? I cannot tell, and merely content myself with recording the fact. As to what may have been stated in early writings, it is enough to call Montesquieu's saying to mind :—"There are things which all the world says, because they have been said before."

I will confine my references solely to the documents quoted by my friendly opponent, which are, as a matter of fact, the most authentic. These are the reports of the Bureau des Longitudes (1820); the communications made to the Académie des Sciences, taken from the *Moniteur* of that year, the *Annales de Chimie et de Physique*, also of 1820, all collected in the complete works of François Arago, published in 1854, and in Vol. IV. of which I find, in Scientific Notices II., under the heading "Electro-Magnetism" (posthumous work), p. 405, *et seq.*, the complete history of the question, and the general principle enunciated on p. 429 by Arago himself: "I maintain as a general proposition that publication, be the mode of it what it may, is the only evidence which ought to be admitted in the history of science."

Here we certainly read that the voltaic battery *magnetises soft iron;* but we must further inquire iron of what shape and under what conditions. The first communication to the Académie des Sciences tells us: "The junction (straight) *wire* which establishes communication between the two poles of the Volta pile becomes covered with *iron filings* like a magnet. The wire does not, therefore, merely act on already magnetised needles, but it also develops magnetism in iron which has not previously been subjected to magnetisation. Further, *non-magnetised compass needles* are deflected under the influence of the junction wire." I have carried the quotation further than M. Pellissier. The detailed account of the discovery, in which the question is always of *iron filings*, follows, until we come to a junction wire of the size of an ordinary pen tube. Arago certainly says: "Oersted only discovered the influence exerted by the voltaic current on a previously magnetised needle. Repeating the 1819 experiments of the Danish physicist, I observed that the same current develops magnetic virtue in *strips of iron and steel* which to start with were entirely without it." The matter in hand here, however, is only a repetition of Oersted's experiment applied to iron, and although the phrase "strips of iron" is used, no mention is made of them in the experiments, and non-magnetised compass needles must necessarily have been of steel. Arago observed, moreover, in this first experiment that the junction *wire* only communicates a *momentary* magnetisation, ceasing with the current, to the soft iron. But it is solely *the wire* and the *straight* wire with which he is occupied. He tries or proposes to try metallic *wires* of different mass, shape, and diameter. "The junction *wire* of copper," he says in conclusion, "is endowed, as we see, with a very powerful magnetic virtue, so long as it is in communication with the two poles of the battery. I have even succeeded more than once in finding traces of this property in *it* some moments after complete interruption of communication between the two poles; but this phenomenon is very transient. . ." In this memorable experiment the illustrious academician therefore only investigated and observed a single fact; the property possessed by a *straight* metallic *wire*, traversed by a current, of magnetising steel and momentarily magnetising and attracting particles or fragments of iron, a property belonging to the wire and not at all to the iron. But let us go on, book in hand.

In the following chapter—The Magnetisation of a Needle by means of the passage of the Electric Current through a Helix—it is no longer in any way a question of soft iron but only of *steel* needles in which, as Arago himself states, he had not succeeded in attaining constancy of the polar points, and which he had only succeeded with some difficulty in magnetising at all. Ampère had as yet only made his important discovery of the mutual and reciprocal action of two rectilinear wires traversed by currents, from which he had deduced by analogy his theory of the elementary constitution of magnets. It was at the very moment when he was carrying out the experiments which Arago had just shown him that his genius suddenly inspired him with the idea of winding the wire in a helix and placing the *steel* needle inside. "He hoped in this way to attain a more powerful magnetisation and a constancy

* From *L'Éclairage Électrique*, July 20th.

† *L'Eclairage Electrique*, June 8th, p. 472.

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of the polar position, which was not obtained by Arago's method." The experiment was straightway carried out in the presence of the two *savants*; it is classical. Arago states that "after a sojourn of a few minutes within the helix the *steel* needle received a tolerably strong dose of magnetism, the positions of the north and south poles being, moreover, in exact accordance with Ampère's forecast, based on the direction of the elements of the helix and on the hypothesis that the electric current traverses the junction wire by going from the zinc end of the battery to the copper end."

The *solenoid* was from that moment created by the genius of Ampère, to whom Arago did ample justice by giving him all the credit of the experiment and trying to explain the relative failure of his own first attempts.

From this the two physicists passed on to the investigation of the action of two consecutive helices, coiled in opposite ways, and to the formation of consequent poles in *steel* needles. The magnetic action of the solenoid was so well understood that Arago recognised that in his first experiments he had only polarised his knitting needle with the rectilinear wire, owing to his having rolled the wire round its ends in order to support it the more easily.

Apart from this last, thrown out by the way, I do not think one could find in the above quotations, which are a faithful summary, anything of a nature to make good for Arago the discovery or the claim to the discovery of the electromagnet. He only had in view the magnetic properties acquired by a metallic *wire* traversed by a current and showing itself by *the momentary attraction of iron filings*, and the constant polarity given to *steel* needles subjected to the influence of *a helical current due to Ampère*, and nothing, it seems to me, justifies the following assertion of M. Pellissier: "The electro-magnet was by these researches created in its fundamental essentials—namely, the temporary magnetisation of *soft iron* by a conducting wire wound in a helix several times *round the iron, in order to increase the intensity of the magnetisation.*" Nor the following either: "The experiments of Sturgeon only differ from those of Arago in that he employed *a larger core.*"

Neither in Ampère's nor in Arago's experiments is there any question of *core*, and everything depends on that. They discovered and clearly defined the magnetic properties of the *solenoid*, which are also to be found in the electro-magnet, but they had no idea of *reinforcing* its external magnetising influence *by the insertion of an iron core*, an essential feature of the electro-magnet. That they did much to open up the path no one denies, but they did not invent the electro-magnet. As far as they were concerned, the iron was *passive*, at the most it was the armature of Ampère's solenoidal magnet, since *steel alone was subjected to the current in the helix.* These two great *savants* invented, if one likes to say so, the *air-core* electro-magnet, but not the iron-core one we know to-day. This great advance would suffice to ensure their renown had they made no other discovery. The renown of Archimedes, Lavoisier, and Faraday is not affected by the numerous applications of the lever which have been made since the days of antiquity, or by smokeless powder, or by Pixii, Pacinotti or Gramme machines; but it would never do to attribute the latest inventions to the earliest men. The successive labours of the *savants* of the entire world lead us day by day towards new discoveries, but, whatever M. Pellissier may say, to my mind the *invention* belongs to him who, possessing possibly much less genius, and profiting by the progressive investigations of his predecessors, puts the thing into a shape which makes it immediately utilisable, and points out its true value.

Finally there is an argument (not *ad hominem* but *ex homine*) which we will only introduce at this stage, and which has its worth. It is drawn from the character of the man. If Ampère was modest, Arago did not willingly allow people, and quite rightly so, to tread on his heels. He objected very vigorously to any encroachment on his domain, witness his famous controversy about the Barlow wheel a few years later. He was aware that: "Those who observe a fresh scientific fact must expect to have it denied at first, then later on to have its importance and utility disputed. Next comes the chapter of priority, when obscure and insignificant passages, unnoticed until then, crop up in crowds as manifest proofs of the antiquity of the discovery" (Arago *loc. cit.*), and whether provoked or not, he would not have failed to have had justice done to himself before his death could he have claimed on any grounds whatsoever priority in the invention of the electromagnet, which had by then become widely used.

After referring to Arago's and Ampere's experiments de la Rive moreover remarks: "*Later on* people tried to wind *a bar of soft iron* bent into the shape of a horse-shoe with a silk-covered copper wire helix. . . ." As to Arago's note on "The Principle of Electric Telegraphs," it must not be forgotten that it is posthumous, that it does not refer to experiments of certain date, and that by reason of the very subject it must have been written at a very advanced age when the electromagnet had come into practical use.

M. Pellissier is perfectly right as to the little noise made by Sturgeon's experiments; even Faraday, in his "Experimental Researches" (1831), attributes the electromagnet to Prof. Moll, of Utrecht, who had simply bought one of Sturgeon through the London instrument maker Watkins. But the same may be said with regard to the supposed invention by Arago, to whom Faraday might, with equal reason, have attributed it, and who, we may feel sure from his nature, would not have failed to have made good his claim of priority.

Let us, my dear M. Pellissier, console ourselves for the loss of our illusions by the hope that we have jointly assisted in the elucidation of an interesting point of scientific history. Arago, or rather Ampère, may be the grandsire of the electromagnet, but he certainly is not the sire, *since he seems never to have introduced iron into a magnetising helix*, and we may yield to Prof. S. P. Thompson, the promoter of this courteous polemic, the same confidence that you rightly give to his usually very well-founded science. The labours of our two great *savants* will suffice to render their genius immortal. Let us shake hands and admire them.

CORRESPONDENCE.

MAGNETIC UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Before the Ipswich discussion—if there is to be a discussion—a few additional lines (not megalines) may be useful in calling attention to a few aspects of the matter which might possibly get overlooked, judging from your "Correspondence" columns of this week. It is easy to exaggerate the oddness of a new name so long as it is unfamiliar, and once upon a time I suppose *ohm* and *megohm* suffered under this disadvantage—in fact, I myself remember that time; but the term ohm now sounds homely enough, although it does not convey its meaning on its surface so clearly as the equivalent term *volt-per-ampere* may, for the sake of illustration, be supposed to do; and this fact, so far from being an objection, is a positive aid towards its free and easy diffusion among operatives and line-testers. Again, the term *volt-ampere* would do instead of *watt*, yet the latter term has come into use; and, similarly, the term joule is simple and handier, although less self-explanatory, than volt-sec-ampere.

If compound words, like ampere-turn instead of gauss and volt-line instead of weber, are enforced for very simple and fundamental quantities, it seems to me that the policy, though plausible for the moment, will be a short-sighted one; because it will then be difficult to proceed further with the formation of compounds, such as weber-per-gauss, which is a unit of permeance, and weber-gauss, which is a unit of energy (and may easily be made a joule). Again, the term *weber-turn* seems to me likely to become in the future nearly as useful as *ampere-turn* has proved itself to be, but it cannot be introduced unless a single name (no matter much what) is affixed to the C.G.S. unit of N or to some multiple of it.

But some of your correspondents appear to hold that no unit names at all are wanted; because if asked hastily for a boiler-pressure the reply "80" is amply expressive. Similarly it might be truly said that when asked in casual conversation for the length of a lease or the age of a man, the reply "99" is completely intelligible; but surely it would be inconvenient not to be able to add the term "years" whenever for precision or completeness it was desirable? And such a term, though meaningless in itself, may be legitimately employed without always having to think what a *year* precisely means; nor would the ordinary man feel grateful if told that he might employ the more expressive phrase *earth-orbital-period* instead. Surely those who doubt the usefulness of names for units (of course introduced in moderation, and after thorough consideration, by collective authority) can hardly remember the vague era before the terms *volt* and *ampere* existed, an era when no one had any instinctive "feel" of what current they were getting out of their Grove or Bunsen cells, which were then almost the only available large-scale source of electromotive force.

And one more point I must reiterate, though it is admittedly a matter on which a precisionist and a teacher must feel more strongly than practical men and engineers, the reason for adding "pounds per square inch" in a specification of pressure is in truth *not solely* because other countries use kilogrammes

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per square centimetre; part of the reason is of a much more fundamental character, lying at the basis of the whole idea of absolute measure; nor would it be at all satisfactory silently to assume the C.G.S. system in every case and record only the numerical portion of quantities, although this may be often conveniently done in colloquial haste. Perhaps it has not been clearly noticed by everybody that the unit is just as important a portion of the specification of a concrete quantity as the numerical portion. The height of *anything whatever* is 360 if the appropriate unit be chosen; the figure applies equally well to the solar prominences, to a fly's proboscis, and to St. Paul's Cathedral, only the units are different.—Yours, &c.,

Sept. 6, 1895. OLIVER J. LODGE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Being so far from the centre of civilisation, I am afraid the remarks you have asked me to make on the subject of the correspondence on magnetic units in your columns will be late, and fall rather flat after the British Association Committee have had their say.

I never can understand the objection to having authorised names for any units at all. Nobody need use them unless they like. Even Mr. Ravenshaw in his own works may, for instance, use the unsystematic units he has accustomed himself to without doing anybody else any harm. As Mr. Esson very sensibly says, "By all means let the scientists invent names for units." The proposal that they be allowed to grow, which has been made by several sensible men, has not in the past led to satisfactory results. We have ounces and grammes and leagues and versts as the result, and, though we are an insular nation, it is to be hoped that the question at issue will be viewed from the international standpoint. Even in the one matter of magnetic force we have names galore growing up. "Lines" and "scots" and "gausses" and "thoms" and "hops" and "mags." There is evidently a preponderating preference for a monosyllable, and yet several consider that the names "magnetic line" and "ampere-turn" are short enough for convenience. There are, no doubt, objections to personal names, but as this has been a matter of international agreement, it will probably be best to abide by that decision, and continue the system. Questions of jealousy between nations as to the name to be chosen are so amusing it would be a pity to lose these disputes. On the other hand, it is a very good rule to avoid the names of living men, especially when they themselves object.

As regards this question of giving names to units, I think the consensus of opinion is that names should be given to them, and are as a matter of fact being invented by engineers for their own convenience, and so far the appeal for help in deciding this question has been helpfully responded to by engineers, and has led to a valuable contribution to the discussion.

In respect of the much more difficult questions as to the coefficient of induction and of magnetic permeability, hardly any help has been given by engineers, or indeed by any of the correspondents. Mr. Heaviside is in favour of $\mu = \frac{dB}{dH}$. Most of the correspondents, including Prof. Ewing, to whom Mr. Heaviside appealed, *assume* that no other definition than $\mu = \frac{B}{H}$ is possible. The matter is essential complicated. The phenomena themselves are very complicated, and there does not seem any prospect of making them simple. Personally, I am rather inclined to $\mu = \frac{dB}{dH}$, but we really want two different names for the two different quantities, and the only serious question is, to which shall the name "permeability" apply, and what name shall be given to its unit. From the almost universal agreement apparent from the answers it would seem that $\mu = \frac{B}{H}$ has been up to this always called the permeability, and if so some other name should be invented for $\frac{dB}{dH}$; for it is dreadfully confusing to have the same name for two different quantities, especially to students, whose claims in a matter of the kind are certainly deserving of consideration. Those who find it unnecessary to distinguish between $\frac{B}{H}$ and $\frac{dB}{dH}$ may stick to one or other of them, and it is pure dog-in-the-manger for them to object to another name for a quantity that they never use.

As regards the coefficient of self-induction, I think it would be a very great misfortune if the British Association were to set itself up in any degree in opposition to the Chicago International Congress. May be the "henry" is not the absolutely best unit, but a confusion of tongues, a new babel of names, would be far worse than any little inconvenience from using the "henry," and when once accredited representatives of a large number of civilised nations have settled upon a term it is most important that all civilised nations should submit to the result and substitute, in science and manufactures at all events, arbitration and agreement for war.

As regards the great 4π question, I entirely agree with Mr. Heaviside in thinking that it is a great misfortune that our units have been founded on the present definitions of a unit pole instead of upon the one he advocates, but I do not at all agree with him in thinking that a change is now possible. The existing inconvenience arising from 4π is not really very serious, and when one considers the enormous difficulty that exists in changing our really terribly inconvenient weights and measures, which costs our country so many years of the life of each child, and so many millions of money in keeping calculators at work who might be employed in something useful, I see no possible prospect of changing our present very seriously inconvenient system of electromagnetic units. There are so many other things better worth doing that I would be very sorry to see my scientific friends engaged in putting their shoulders to this wheel with that expenditure of time and energy that would be required to accomplish anything, especially when the prospect of accomplishing anything is so very minute.—Yours, &c.,

Fernbank, Howth, GEO. FRAS. FITZGERALD.
Co. Dublin, September 10, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: When anyone presumes to offer an opinion on such a subject as this, either he should be a well-known man whose views already have weight in the estimation of others, or he should present some credentials to show that although his qualifications may not be generally recognised, yet he has entered into the matter sufficiently and done enough work in the field to show that he ought to know what he is talking about.

Although I have written a good deal on electrical subjects, it has been almost entirely on what is called the practical side, and, therefore, when attempting to say anything publicly on a theoretical question, it is perhaps desirable to mention briefly the grounds on which my opinions are formed, and the nature of the practice which has led me on to form those opinions. This is my apology for entering rather more fully into personal matters than modesty would dictate under other circumstances. I also think that often general truths are better conveyed in a personal narrative, particularly when they are of a complicated and debatable nature.

Bell's discovery of the telephone was almost contemporaneous with my leaving school, and I immediately made a telephone and Hughes's microphone, and did a good deal of experimenting with them. Four years afterwards I was an engineer in the service of the United Telephone Company, and at once began to take great interest in the construction of telephonic apparatus and the propagation of telephonic currents. During 1885 and 1886 I had charge of their trunk line and testing department, a period during which the Brighton being the first long-distance line in England, was established, and which was a crucial period in the history of telephony in many ways. During these two years I was almost constantly at work experimenting on cables, the influence of capacity and self-induction, and also endeavoured to read all I could on the subject of alternating currents. Late in 1885 I brought out, with Mr. Ferranti, a closed circuit translator coil, which has since been employed

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largely by the Telephone Company. In order to experiment on these coils I made a quadrant electrometer and other apparatus, and spent most of my spare time for nearly six months in working at the problem. Afterwards I joined Mr. Ferranti at the Grosvenor Gallery, and was there while his first high voltage machines were built. Since then I have been more or less intimately connected with alternating current work. The growing importance of this work during the last two years, coupled with an increasing feeling of the crude and unsatisfactory character of much of the alternating plant at present in use, has led me to pay much attention to the principles governing the design of such plant. During the last eighteen months I have gone through calculations of most forms of alternator in use, with a view to ascertaining their relative efficiencies, strong and weak points, and to ascertain how nearly calculations would bring one to the results of practice. I have also carefully studied the effect of capacity and induction in distributing systems with a view to make up my mind which was the best. Although, therefore, I may not occupy the recognised position as a designer of plant which everyone concedes to several of those who have written deprecatingly of Dr. Lodge's proposals, from what I have said above, it may at least be allowed that I have not been inattentive to the subject, and therefore, whatever my competence to express an opinion, which I do with much diffidence, at any rate my views have not been formed without careful consideration and without a pretty extensive and practical knowledge of the subject.

Now, as I do not pretend to be an original thinker, I have had to go for my knowledge to standard works, and of them I have found none which can bear comparison with Dr. Lodge's "Modern Views of Electricity" and Mr. Oliver Heaviside's "Electromagnetic Theory" for giving clear and comprehensive views on theory, and no work on the practical side to compare with Mr. Kapp's two volumes. The great value of other works, such as Dr. Fleming's, I also thoroughly recognise, but the above works I have gradually come to constitute my standards, as I have found them the most helpful in case of need and difficulty. In speaking thus I do not for a moment wish it to be understood that I understand everything Dr. Lodge, and especially Mr. Heaviside, say. I only wish to have it inferred that, so far as I have been able to understand them, I have found their views and explanations reliable and of the greatest value, and having fully ascertained this, I naturally am ready to accept their lead and guidance in further developments, which in some measure may be beyond my scope.

Now, in all my work in this field I have felt more and more the absolute necessity of a clearer understanding and definitions of electromagnetic quantities and actions. It is possible to wade through the design of an alternator by the use of various 10^8ths or 10^9ths, plus or minus as the case may be, and with the aid of that horrible mystifier the "coefficient of self-induction," which has played such a conspicuous part the last few years; but it is not the right way to go about it, and it is all the more roundabout and difficult when one tries to explain results to others. Things must have names if they are there, and the simpler ones the better, and the magnetic units have just as firm and as sound a basis as the physical ones.

Most alternating work is now designed in a rough manner, and without attention to the finer points, and this is why the efficiency of alternating plant is not as good as it should and might be. Again, to this confusion about electromagnetic quantities, and the basis on which they rest, is due the fact that people not clearly grasping them cannot measure them accurately, and do not feel proper confidence in the results even when they are properly measured.

To introduce certain units which define these quantities, and allow them to be explained clearly, is, therefore, not to add to complication, but to get rid of it, and besides that the everyday problems of electricity would be much better treated by the use of such units and the banishing of that miserable term "lines," and the inaccurate and misleading ampere-turn, into the background.

I must own that I found so many new terms very confusing when I commenced to read Mr. Heaviside's work, but then I put this down to my own ignorance, and not to want of lucidity on Mr. Heaviside's part, and in time I came to see that that was the correct view. Having found Dr. Lodge and Mr. Heaviside sure and reliable guides in this difficult but interesting and most important field; having found that they understood and could explain problems which I see will soon be of the greatest practical and commercial importance, and they having found certain names and units desirable in order to explain and deal with these problems, it, to me, savours rather of ignorance and insufficient acquaintance with the subject than of anything else to say that such terms are not needed, and that the old ones are good enough.

As to the precise values which are to be taken as units, I am perfectly content to leave this to those who have made theory a special study, particularly as I think it probable that in another ten or fifteen years it will be found advisable to make a fresh start with a complete new set of electric and magnetic units, arranged on such a basis as Mr. Heaviside has indicated. Consequently I am not prepared to split hairs over the question of dimension, but there is no reason why the quantities themselves should not be defined in some definite and understandable unit as soon as possible, so that they can be thought, talked and written about with facility.

I trust, therefore, Dr. Lodge will not be discouraged at the cold reception he has met so far. It appears to me that his work is not only a good one, but has been exceedingly well done, and although I do not quite agree with him, especially on the 4π question, on which I side entirely with Mr. Heaviside, particularly from an educational point of view, yet I consider such matters of secondary importance as compared with the necessity of quickly and intelligibly defining magnetic relations and quantities. Apologising for the length of this letter,—Yours, &c., G. L. ADDENBROOKE.

LEGAL INTELLIGENCE.

Pembroke Town Commissioners v. Dublin Southern District Tramways Company (Limited).

This adjourned application for an injunction to restrain the defendant Company from breaking up or excavating the roadway between the tram-rail and the footpath in the township of Pembroke came before Mr. Justice Murphy, at Dublin, on Tuesday last. Full particulars of this case were given in our last issue, and Mr. White, Q.C., who now appeared in support of the application, said the Tramway Act of 1893 gave no power or right to the defendants to place electric wires underground. The only power which the defendants had was that of putting down poles to carry the overhead wires. The defendants proposed to dig up the township roads and lay down wires and cables, although an undertaking had been given by them that only an overhead system would be adopted. An affidavit made by Mr. J. C. Robinson, the secretary and manager of the defendant Company, stated that the overhead wires were insufficient to carry a continuous current along the whole line, but this difficulty would be got over by underground feeders of much larger dimensions and less resistance. His Lordship here said that, though it was a serious matter to interfere with the rights of the Commissioners, it would be equally serious to interfere with and prohibit the execution of the Company's works. Messrs. Sullivan, Q.C., and O'Shaughnessy, Q.C., appeared for the defendants, and resisted the application, but stated that they were willing to enter into an undertaking to hold themselves responsible for any loss, damage or injury caused by the opening up of the streets or to take up the wires again if the Court so directed, and on these terms his Lordship refused the application.

Roumanian Petroleum.—According to the *Journal* of the Society of Chemical Industry the Austrian Vice-Consul at Plojest reports a decreased production of petroleum in Roumania last year. The best results are still obtained from shafts, bored wells being too narrow to permit the ready removal of sand, and being also liable to silt up. In Glodeni—Dambovitza district—over 900 tank-wagon loads of crude oil were obtained. The Campina wells yielded over 800 car-loads, and the production in Doftaneti and Bustenari was increased to some 700 to 800 car-loads by the sinking of new shafts to depths of 40 to 120 metres. About 200 loads in all were obtained from various scattered districts. The employment of residuum for heating purposes, as well as of refined oil and benzine for motors, is on the increase.

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s.

The Edition for 1896 is in active preparation, and orders for Advertisements and Subscriptions can now be sent in.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices :—*

LABORATORY NOTES AND FORMS.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett ; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett *(now ready)*. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. nett, is now ready.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming. M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

TENDERS INVITED.—The Urban Sanitary Authority of the Borough of Chepping Wycombe (Bucks), invite applications from public companies for working their Electric Lighting Order for a term of years. Tenders must be sent in by noon of October 14th to the office of the Town Clerk, High Wycombe, where a copy of the Order can be seen and all further particulars obtained.

——— The Electric Lighting Committee of the Harrogate Corporation require tenders for the supply and erection of the following plant :—(*a*) Lancashire boilers, economiser, feed pumps and accessories ; (*b*) steam alternators, condensers, fittings, &c., steam exhaust feed and sundry pipes, valves, &c. ; (*c*) switchboard and instruments ; (*f*) transformers and accessories ; (*g*) meters ; (*h*) overhead travelling crane. Specifications may be obtained from the Borough Surveyor, Harrogate, and tenders, addressed to the Town Clerk, Municipal Offices, Harrogate, must be delivered on or before the 30th inst.

——— The Building Committee of the Harrogate Corporation are prepared to receive tenders for wiring the new Montpellier Baths for the electric light. Specifications, &c., may be obtained from the architects (Messrs. Baggalay and Bristowe), 66, Victoria-street, London, S.W., and tenders, addressed to the Town Clerk, Municipal Offices, Harrogate, must be in by the 30th inst. Some particulars will be found in our advertisement columns.

——— The Huddersfield Industrial Society invite tenders for lighting by electricity their boot and shoe and confectionery departments, &c., in John-street and Albion-street. Tenders by the 16th instant to the Society, Buxton-road, Huddersfield.

——— The Board of Control, Dublin, require tenders for the supply and erection of two direct-coupled steam engines and dynamos, a battery of accumulators, main switchboard, &c., for the lighting of the Purdysburn Asylum, Belfast. Tenders to Secretary, Board of Control, Custom House, Dublin, by 10 a.m., 28th inst.

——— The Vestry of Shoreditch invite tenders for insulated electric mains, conduits, and drawing-in boxes, to be laid in the parish. Tenders by four o'clock on *Tuesday next.*

——— The Gravesend Town Council invite tenders for supplying and fixing a telephone and connections between the Sanatorium and the office of the sanitary inspector and the police station. Tenders by 20th inst.

——— The Gas Committee of the Manchester Corporation invite tenders for about 15 tons of copper strip. Tenders by the 20th inst.

——— The Dundalk Town Commissioners invite tenders for the erection and maintenance of the necessary plant for lighting the town by electricity from July 1, 1896. Tenders by October 7th.

——— The local authorities of Vilich, Obercassel, Oberdollendorf, Niederdollendorf and Königswinter have decided to construct an electric railway from Bonn to Königswinter or to Honnef. Plans and projects by 21st inst. to the Bürgermeister, Vilich, Germany.

TENDERS INVITED.—The Corporation of Eccles invite tenders for the supply and erection of Lancashire boilers, alternating-current dynamos and engines, cables, street boxes, &c , and transformers. Plans, specifications, &c., may be seen at the offices of the Town Clerk, or of the Consulting Engineer (Mr. S. V. Clirehugh), Temple Chambers, Brazennose-street, Manchester, on and after the 18th inst. Tenders must be sent in to Mr. Geo. Wm. Bailey, Town Hall, Eccles, by 12 o'clock noon on the 30th inst. Additional information is given in our advertisement columns.

——— The Asylums Committee of the London County Council invite tenders for the erection of fire alarm and telephone systems at their asylums at Banstead, Surrey, and Colney Hatch, London, N. Tenders by 12 o'clock, 30th inst.

——— The Manchester Town Council invite tenders for the laying of a system of underground telephone pipes, with inspection pits, service boxes, &c., in certain streets of the city. Tenders by *Tuesday next.*

——— The Queenstown Town Commissioners require tenders for the erection of works and the necessary plant for generating electric current for the public and private lighting of the town. Tenders by September 26th.

TENDERS ACCEPTED.—The Town Council have accepted the tender of Messrs. W. G. Higgs and Co., Glasgow, for wiring the municipal buildings, public library and police offices for the electric light. The amount of the tender is £280. 4s.

——— The Guardians of St. Giles's and Bloomsbury, London, W.C., have accepted the tender of the Brush Company for wiring and fitting up the electric light at the Board room and offices, for the sum of £45. 15s.

——— The Town Council of Taunton have accepted the tender of the British Thomson-Houston (Limited) for the supply of an alternator and a Willans engine for the sum of £1,058.

——— The Great Yarmouth Town Council have accepted the tender of the British Insulated Wire Company for the supply of cable for their electric light extensions for £1,031. 1s. Messrs. Crompton and Co.'s accepted tender for transformers was as follows :—1 kilowatt, £9 ; 2 ditto, £12. 15s. 6d. ; 5 ditto, £19s. 10s. ; 10 ditto, £31. 15s. ; 15 ditto, £42. 2s. 6d. ; and 25 ditto, £59. 11s.

——— The Selby District Council received 13 tenders for the erection of three lightning conductors at their waterworks, the prices ranging from 1s. 2d. to 2s. 8d. per foot. The tender of Messrs. W. Bowker and Co., of Huddersfield, has been accepted conditionally.

TENDERS RECEIVED.—The Hammersmith Vestry received 14 tenders for the erection of an electric light installation for public and private lighting. A tender from a Glasgow firm, received after the time appointed, is, it is stated, also to be considered.

SALE.—Our advertisement columns contain particulars of a quantity of electric lighting plant for sale by Messrs. Henry Lea and Thornbery, 38, Bennett's-hill, Birmingham. Included in the sale are three Elwell-Parker dynamos, three gas engines, switchboard and instruments, gas and exhaust pipes, shafting, &c.

APPOINTMENTS.—At the last meeting of the Hanley Town Council it was decided to appoint the assistant electrical engineers (Messrs. C. A. Cowell and C. J. Sutherland) joint electrical engineers and managers of the electricity works pending the further installation and during the expenditure of capital account thereon. Messrs. Cowell and Sutherland will be under the direction of the borough engineer (Mr. Joseph Lobley), and will each receive a salary of £150 per annum.

——— The Ayr Town Council have appointed Mr. E. G. Pink, who has superintended the laying of the mains, &c., borough electrical engineer at a salary of £200. Before going to Ayr Mr. Pink was engaged at the Dublin Corporation electricity works.

DISSOLUTION OF PARTNERSHIP.—Messrs. Beech and Welch, telegraph instrument case makers, of Dalston-lane, London, N.E., have dissolved partnership. The business will be carried on by Mr. Welch.

LIQUIDATION.—All claims against the Electric Trust (Limited) must be sent to Mr. F. Cross (the liquidator), 9, Bridge-street, Westminster, S.W., by October 14th.

BANKRUPTCY.—Mr. Edwin B. Lumb, of 85, Gracechurch-street, E.C., has been appointed the London trustee in the bankruptcy of G. F. Rogers, electrical engineer, of 5, Great Winchester-street, E.C., and 41, Maxilla-gardens, Notting Hill, W., London.

CITY OF LONDON ARC LAMP-POSTS.—The electric light posts throughout the City of London are now being recoated by Hartmann's paint, which has, the makers state, been selected for its durability and appearance, after exhaustive trials extending over two years. This material is supplied by Suter, Hartmann and Rahtjen's Composition Company (Limited), of Billiter-street, London, E.C.

REMOVAL.—Mr. Wilson Hartnell informs us that, having removed his works into larger premises, he is now transferring his offices to the same buildings at Volt Works, Kirkstall-road, Leeds, where all kinds of electrical engineering work and the manufacture of electrical machinery and apparatus will be undertaken.

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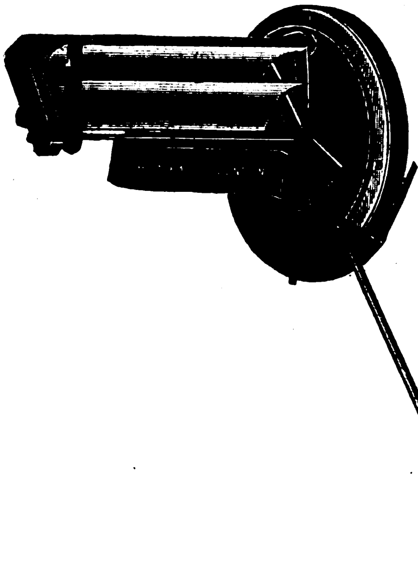
CATALOGUE.—The sixth edition of Messrs. Nalder Bros. and Co.'s catalogue and price list is as replete as ever with matter calculated to delight the hearts of intending purchasers of electrical instruments. With a view of effecting a reduction in price and of facilitating "stocking," Messrs. Nalder Bros. have, where several forms of the same instrument have previously been made, specialised and developed only the pattern found by experience to be the most efficient. Amongst the numerous items of interest in this well-arranged catalogue we note Prof. Carhart's new form of Clark standard cell, which attains its E.M.F. according to temperature exceedingly rapidly, and has a coefficient of only 0·038 per cent. per degree. Other items in the list are a very compact, workmanlike type of d'Arsonval galvanometer; the N.C.S. lamp-stand and scale, a new and very neat design, allowing for a large range of height of mirror; the Ayrton-Mather universal shunt; the N.C.S. variable standard of self-induction, a compact and useful piece of apparatus; Prof. Unwin's extensometer (Messrs. Nalder Bros. are the sole authorised makers of this, and the inventor kindly undertakes to examine and certificate each instrument); the N.C.S. form of standard resistance, in which it is claimed that the temperature difficulty has been considerably diminished; standard manganin resistances of 100 ohms carrying 1 ampere; and Trotter's portable direct-reading photometer, embodying several recent improvements, by which both the candle-feet and the candle-power may be measured without calculation. Not the least praiseworthy features of this catalogue are its handy shape and its bold, clear type.

AN IMPROVED FORM OF AYRTON-MATHER ELECTROSTATIC VOLTMETER.—The accompanying illustration shows the working parts of



an Ayrton-Mather electrostatic voltmeter now being manufactured by Mr. R. W. Paul. In this instrument, as is well known, the conducting portions are shaped into parts of cylinders, the three fixed plates being firmly connected together, while the needle, consisting of curved aluminium plates, is drawn into the space between the fixed ones. The controlling force is gravity acting on a weight attached to the needle. The advantage of the curved form of plate is that it combines strength with lightness. Dead-beatness is secured by employing a copper sector, which balances the needle, and causing it to swing between the poles of a strong permanent magnet, the swings being damped by Foucault currents. The terminals are embedded in a block of ebonite, hinged to the case and provided with ebonite-headed screws, no metal parts being exposed to the touch.

DELAWARE HARD FIBRE COMPANY.—A recent issue of the *Electrical World* of New York states that a flourishing business is reported by the above Company from their works at Wilmington, Del., U.S.A., necessitating the works being in operation day and night, notwithstanding that the manufacturing plant has been doubled. One of the recent contracts secured by the Company is for furnishing the General Electric Company (U.S.A.) with fibre, and this order is of sufficient magnitude to give regular employment for some time to a large number of hands. Mr. J. Burns, who has the management of this Company's business in all parts of the world outside the North American Continent, reports a gratifying and almost unexpected increase of the business.

PRESENTATION.—Mr. J. L. Copping has resigned his position as Manager of the Acme and Immisch Electrical Works (Limited) to take a similar position with the Blackman Ventilating Company, of which, however, Mr. M. Shillito, the managing director, continues the active management. The Directors of the Acme and Immisch Company presented Mr. Copping with a case of cutlery, while the employés of the firm gave him a gold watch.

CABLE STORIES, ANECDOTES, &c.—Mr. Roland Belfort, of 14, St. Paul's-place, Canonbury, London, N., having undertaken to prepare a volume descriptive of the career of a cable man in the various branches of his profession, is anxious to collect anecdotes embodying any curious episodes, amusing adventures, extraordinary feats, &c., performed by men in the service. Mr. Belfort thinks it likely that many cable men could furnish him with photographs, anecdotes, &c., which would interest cable men all over the world, and he would therefore be grateful if such could be sent on to him, he, of course, acknowledging their receipt, and observing strict confidence where advised. Mr. Belfort is an old telegraph man, and his book should prove both instructive and amusing.

ABERDEEN.—The Watching and Lighting Committee of the Town Council have decided, on the recommendation of the borough electrical engineer (Mr. A. S. Blackman), to introduce in certain streets overhead lights suspended from wires lodged between standards on opposite sides of the thoroughfares. Should the experiment prove satisfactory it is anticipated that the arrangement will be extended.

ALSAGER (STOKE-ON-TRENT).—A meeting of ratepayers, presided over by Mr. Rigby (Chairman of the District Council), was held last week to consider the question of adopting a system of street lighting. It had been estimated that gas would cost £142 per annum, which would necessitate an increase in the rates of 3½d. in the £. A scheme of electric lighting, prepared for the Council by Mr. G. R. Peers, placed the cost of an installation for 1,200 8 c.p. lamps, including 40 street lamps, at £4,000. The annual cost of maintenance would be £618, while the revenue was estimated to show a profit of £82. As usual, the gas interest seems to have been well represented, and an animated debate took place, in the middle of which the Chairman adjourned the meeting for 12 months.

ARKLOW.—Recently a deputation of the Town Commissioners waited upon Mr. Arthur Chamberlain (chairman of G. Kynoch and Co., Limited) for the purpose of discussing the question of the introduction of the electric light into the town. Having heard the views of the deputation, Mr. Chamberlain said that Messrs. Kynoch and Co., in the near future, purposed lighting other portions of their premises by electricity, and when the additional plant had been put down they would then meet the Commissioners in any way they could, as they would then be able to supply electriccurrent at a much cheaper rate than they were in a position to do at present.

BATTERSEA.—It is stated that the Special Electric Lighting Committee have resolved, after careful consideration, to invite competitive schemes for lighting the parish by electricity, and to offer premiums for the three best. In the meantime application is to be made for a Provisional Order. The compulsory area, in which distributing mains are to be laid within two years, includes all the principal streets in the parish. The Committee have, however, decided to recommend that the dust destructor part of the original scheme be not proceeded with.

BERLIN EXHIBITION.—In reference to the "Trade Note" on this subject in our last issue, it is stated that Messrs. Siemens and Halske have obtained the contract for electrically equipping the various railways which will be constructed between the centre of the city and the Exhibition buildings in the Treptow Park. The contractors have obtained the privilege of using both overhead and underground systems.

BOOTLE.—At the meeting of the Town Council on Wednesday it was stated that the report of the Watch Committee on the electric lighting question would be presented to the Council shortly.

BRISTOL AND KINGSWOOD TRAMWAYS.—An experimental trip was made with one of the cars over the new electrically-equipped Kingswood line on Tuesday, and a further trial was made on Wednesday from the St. George depot. Both trials were made under the direction of Mr. Philip Dawson, and were, we understand, entirely satisfactory.

BURTON-ON-TRENT.—At the last meeting of the Town Council the Gas and Electric Light Committee reported that they had instructed their gasworks manager (Mr. F. L. Ramsden) to report as to the desirability of lighting those streets where the electric light mains are already laid by electricity.

CANTERBURY.—The Electric Lighting and Street Committee recently presented their report on the lighting of the city by electricity. The report, which was presented by Ald. Mason (Chairman of the Committee), states that from information obtained, through the surveyor, from various towns and districts where the electric light is installed, and after careful consideration of the whole question, the Committee are of opinion that the time has arrived for the introduction of the electric light in the city. The report also recommends that, before any scheme is adopted, the services of Mr. Robert Hammond be retained for the purpose of advising the Council and preparing an exhaustive report, at a fee not exceeding 50 guineas, this sum to merge in the usual engineering commission in the event of a scheme being adopted and works carried out.

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CARDIFF EXHIBITION, 1896.—The metropolis of Wales is to have an Exhibition on a large scale in 1896. Owing to the intimate connection of the district with the coal and iron industries, the mining and engineering sections will, of course, be very prominent, and will doubtless prove the most attractive features of the show. Maritime industries are to be fully represented. As evidence of the leading position held by the port of Cardiff, the shipments of coal, coke, and patent fuel in 1894 amounted to no less than 15,316,165 tons. Other sections of the Exhibition will embrace latest developments in electricity, in scientific instruments, &c., whilst agriculture, horticulture, sports and pastimes are to be adequately catered for, the latter probably including a water show on a large scale. Representative men of all classes have the detail work in hand. Lord Windsor is president, Her Majesty the Queen is patron, and the Prince of Wales will be invited to open the Exhibition.

CHURCH LIGHTING.—In the September issue of the Windermere parish magazine the rector and churchwardens make an appeal for funds for lighting the church by electricity. The estimated cost of wiring, &c., is put at £75, and the appeal concludes: "During the winter months, when the church is heated and the gas also burning, the atmosphere becomes very close and stifling, and we are assured that many are hindered from attending the evening services on this account."——The Great Synagogue, London, E.C., will henceforth be lighted electrically. The work of wiring and fitting has been carried out by Messrs. D. Hulett and Co., and the total cost will exceed £300.——Wesley Church, Newport (Mon.) is to be wired and fitted for the electric light.

CHEADLE (STAFFS.).—The Parish Council have received an offer from Messrs. J. and N. Philips to light the public lamps by electricity. The firm have already erected a private electric lighting plant at their large tape manufactory, and are also able to supply current for the public lamps. The estimated annual cost would be £340 under a seven-years agreement, or £300 for a contract for 14 years. A parish meeting is to be held to discuss the matter.

COCOA FACTORY WORKED BY ELECTRICITY.—An extensive electric power and lighting plant is at present in course of erection at the factory of the well-known Dutch firm of Van Houten and Zoon at Weesp. The plant consists of three horizontal steam engines of 100 H.P. each, coupled direct to six 33 kilowatt four-pole dynamos. The distribution is on the three-wire system, and there are in all about 1,100 glow lamps, 285 arc lamps and one 30 H.P. motor.

CORK.—The Secretary to the Electric Lighting Committee has just presented an analysis of the replies received from the various town clerks of towns where the electric light is at present used. A meeting of the Committee was held on Tuesday, when it was decided to ask the Council to give them power to employ an electrical expert.

DEWSBURY.—At the last meeting of the Corporation Mr. Alderman Robinson expressed satisfaction at the fact that the consumption of gas had increased during the past year, notwithstanding the competition of the electric light. In answer to Mr. Birkhead, Mr. Robinson stated that the Gas Committee had decided to determine the agreement with Mr. Preece, their consulting electrical engineer.

DOVER.—We were in error in our Note last week in stating that the Town Council had decided to use incandescent gas lights for the next 12 months in Snargate-street, the Council at its meeting on the 27th refusing to rescind the agreement come to with the Dover Electricity Supply Company for lighting the street by arched arc lamps. The contract for incandescent gas lights was for other positions in the town.

EARLSTON (BERWICKSHIRE).—Recently a committee was appointed to consider the question of the purchase of the local gas works, but the scope of their inquiry has now been extended by adding thereto the question of the introduction of the electric light. Water power is available, and it is thought it would be more economical to establish electricity works than to purchase the gas works. The Committee are to consult with an electrical expert.

ELECTRIC TRACTION ON THE CONTINENT.—It is stated that the Union Elektricitäts Gesellschaft of Berlin has, in conjunction with the Austrian Landerbank, acquired the Linz tramways, and a system of electric traction is to be introduced. It is also reported that the same Company have received a concession to construct an underground electric railway from Brussels to the Bois de Tambre.

ELECTRICAL WATER INDICATOR.—The Weymouth Waterworks Company have instructed Mr. George Jennings, of Lambeth, S.E., to put up his patent electrical indicating and recording apparatus between the reservoir and the engine house at the waterworks. By this means the level of water from the reservoir will be shown in the engine house at all hours of the day and night. A similar apparatus is to be fixed at the Great Yarmouth Sewage Pumping Works.

EXHIBITIONS.—It has been decided to organise an exhibition of national Brazilian industries at Rio de Janeiro, and a commission is to be appointed to consider and report on the present customs tariffs, with a view to protectionist duties being imposed.

FIRE.—Messrs. Griffiths Bros. and Co., the well-known makers of non-conducting paints and varnishes, of Macks-road, Bermondsey, inform us that the fire which occurred at their works last week has in no way interfered with the business, the prompt action of the Fire Brigade having restricted the damage to one only of the buildings.

FIRE PREVENTION.—An International Fire Congress is to be held at Amsterdam from the 24th to the 28th inst., in order to give brigade officers, architects, engineers and insurance officers an opportunity to discuss every question connected with fire protection. This should prove a favourable opportunity to manufacturers of electric fire-call apparatus to place their systems before an important body of British and Continental fire experts.

THE FIRE AT THE CRITERION.—It has been stated that the electric light wires were suspected of having caused the recent fire at the Criterion Restaurant. We have authority for saying that "there is nothing whatever in the report of Messrs. Spiers and Pond's electrical engineer at the Criterion to show that the recent fire was due to electric light wires. There was no indication of any short-circuiting, and the electric lamps were all run on the evening prior to the fire."

FORT WILLIAM (INVERNESS-SHIRE).—It is stated that a company, with a share capital of £6,000, has been formed locally for the purpose of establishing works for the lighting of this town by electricity. The necessary power is to be obtained from turbines driven by the waters of the river Kinchnish, situate about two miles from Fort William.

GLASGOW.—At the last meeting of the Town Council the minutes of the Tramway Committee came up for confirmation. The question of the introduction of mechanical motors for the tramways had been remitted to a sub-committee for consideration and report. Treasurer and Gray in objecting to the appointment of this Committee, said the whole question had been carefully gone into two years ago, and they were then obliged to fall back on horse traction. They had found that the overhead electric system would cost £10,000 per mile double track, while the cable system would cost £20,000. They had spent £400,000 in purchasing horses, plant, &c., and before a penny had been returned to the Committee it was proposed to consider a new system. He held that no additional expense should be incurred until the existing method of traction had had a further trial. Mr. Walter Paton (convener) said the Committee thought the time had come when the question of applying mechanical motors to at least some sections of the line should be carefully considered. The minutes were approved by a large majority.

GREAT YARMOUTH.—The accounts of the electricity department for the month of August have just been published, and show a gross profit of £53. 8s. 11d.

HALIFAX.—The Town Council have decided to erect six arcs of 1,500 c.p. each in Crown and Silver-streets. Ornamental iron standards with curved top have been ordered for these lamps from Messrs. W. Macfarlane and Co., Glasgow.

HALSTEAD.—The question of the high price and inefficiency of the gas lighting is exciting some local feeling here just now. The Gas Company had been asked to make a reduction in the price of gas, but at the last meeting of the District Council the Company stated that no alteration could be made. The Public Lighting Committee recommend that only a temporary arrangement be entered into with the Company, and that they be empowered to make inquiries as to the cost of substituting electricity.

HASTINGS.—The Hastings and St. Leonards-on-Sea Electric Light Company have decided to make extensions to their mains in the Queen's-road.

INVERNESS.—The Caledonian Electric Supply Company (Limited) recently notified the Town Council of their intention to apply for a Provisional Electric Lighting Order for Inverness. The Company are to submit particulars of their scheme, and a special meeting of the Town Council will then be held to consider the matter.

KINGSTON-ON-THAMES.—The Lighting Committee of the Corporation have decided to adopt the "Brighton" method of charging for electric current from January 1st next.

LAMBETH (LONDON, S.E.).—A lengthy debate on the electric lighting question took place at the last meeting of the Vestry, when the several offers of the County of London and Brush Provincial Company and the Capital and Counties Electricity Company were discussed. The Lighting Committee brought up their report on the subject, and recommended the Vestry to notify both Companies that they (the Vestry) had no intention to proceed at present to put in operation their Electric Lighting Order. The adoption of this report having been moved, an amendment was proposed to the effect that, while the Vestry were not in possession of sufficient information to justify them in immediately proceeding to carry out the terms of their Order, they had no intention of surrendering it.

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This truly heroic course was not only recommended in a lengthy speech by Mr. Everett, but was seconded by Mr. W. J. Hosking. Other members described the policy of the Vestry as "laying low and waiting." The Clerk to the Vestry pointed out that most probably, if the course recommended by the Committee were adopted, the Board of Trade might prove inquisitive as to what steps the Vestry were likely to take on the applications of the two companies. Mr. Alderman Hubbard tried hard—very hard—to bring the members to a sense of the importance of the subject by pointing out that other Vestries had adopted the electric light with apparently satisfactory results. He appealed to the members of the Lambeth Vestry to follow the examples set by St. Pancras, Islington, Hampstead, Shoreditch, Hammersmith and other London Local Authorities. He strongly advocated the Vestry taking the matter up and dealing with the electric light on behalf of their parishioners. Subsequent speakers referred pathetically to the general poverty of the district, and, if these gentlemen are to be credited, Lambeth is a very nice place to live out of. The result of the discussion was that the amendment was approved, and the report of the Committee, as amended, was adopted.

Llanelly.—Some time ago tenders for lighting a part of the town by electricity were obtained, and these were referred by the Estate Committee to the borough surveyor for consideration and report. At the last meeting of the Town Council the Committee submitted the surveyor's report, which stated that the three most suitable tenders were those of the Electric Construction Company (Limited), Messrs. Siemens Bros. and Co. (Limited) (No. 2 scheme), and Messrs. J. C. Howell (Limited). The Committee further reported that the establishment of electric light works would involve an expenditure of about £10,000. After a protracted but incoherent discussion it was decided not to proceed with the matter.

Middleton (Lancs.).—The Town Council have decided to apply for a Provisional Electric Lighting Order.

Portsmouth.—The Electric Lighting Committee has received 25 applications for the position of overseer to superintend the laying of mains, &c., in connection with the electric light extensions. The Chairman was empowered to appoint the most suitable of the following four candidates to the post:—Messrs. A. F. Evans (Wolverhampton), J. A. Dixon (Margate), W. Fowle (London), and N. Staniland (Douglas, Isle of Man).

Reduction in Telegraph Rates.—The Eastern Telegraph Company announced that rates to the following places are reduced: To Pernambuco, to 3s. 6d. per word; other places in Brazil, Argentina, Uruguay and Paraguay, to 4s. 6d. per word. Similar reductions are announced by the Anglo-American and the Direct United States Companies, so far as they relate to messages from Great Britain to Argentina, Uruguay, and Paraguay.

Rotterdam.—Six electric cranes are to be erected on the new quays which are to be built in connection with the Rhine Harbour. The cranes must be capable of lifting four tons and of reaching across three sets of rails, thus allowing the processes of loading and discharging being simultaneously performed. It is also stated that, though the town has been in possession of electricity works for some time, but scant use is made of the current for private lighting. On the other hand, electricity is being applied to the cranes at the docks and quays on the left bank of the river, and loading and discharging can be performed at night by means of the electric ilght.

Runcorn.—The question of the introduction of the electric light into the town will be discussed at the next meeting of the Town Council.

Sacriston (Durham).—The Parish Council have decided to light their township, which comprises Sacriston, Witton Gilbert and Daisy Hill, by electricity. The Newcastle branch of the Corlett Electrical Engineering Company has obtained the contract for plant, &c.

Sheffield.—The Town Council have decided to expend £2,000 upon electric light fittings, &c., for their new municipal buildings.

Swansea.—The Town Council will consider at their next meeting a scheme for lighting the main streets of the town by electricity. The cost of the installation is estimated at about £56,000. The Electric Lighting Committee have had the subject before them for some years, and have at last proposed a complete scheme for the Council's consideration. The Corporation's Provisional Order was obtained in August, 1889, and in 1890 serious steps were taken with the object of carrying the Order into effect. Tenders were invited, and it was proposed to grant a concession to the contractor who should be appointed to put down plant for the installation. Ultimately, however, it was decided to abandon this plan and to await further developments of electrical enterprise. The subject which has really brought the electric lighting question once more to the front is the serious matter of the disposal of town refuse, and in January, 1894, the Committee took counsel with Mr. E. Manville, who was instructed to prepare a combined electric lighting and refuse destructor scheme. In connection with the proposed electric works Mr. Manville's report was presented in June, 1894, and was in favour of a combined scheme. The Committee have been considering this report, and have now come to the unanimous conclusion that a high-tension alternating current system would best suit the requirements of the town. The Committee's report concludes with recommendations to the effect that Mr. Manville's scheme be approved, and that application be made to the Local Government Board for powers to borrow £60,000 for electric lighting and refuse destructor purposes.

Telegraphic Delays.—The Glasgow Chamber of Commerce has resolved to petition the Postmaster-General respecting the time taken in telegraphing between Glasgow and London. This petition is to be supported by a similar one from the Glasgow Royal Exchange. It is complained that the lowest average time is 30 minutes and the longest 65 minutes, which is very reasonably considered excessive.

Torquay.—The report of the Electric Lighting Committee on the question of the electric lighting of the town is nearly ready, and will be submitted at the next meeting of the Council.

Walsall.—The electricity works are now in a forward state, and it is anticipated that current will be available at the commencement of next month.

Wellington (New Zealand).—The Town Council have adopted the recommendation of the Electric Lighting Committee to rescind their present contract with the New Zealand Electrical Syndicate for lighting the streets, at £3. 10s. per lamp, and to enter into a new arrangement whereby the Syndicate are to supply electric current at £4. 10s. per lamp. This step has been taken owing to the unsatisfactory state of the water supply of the town, and under the new arrangement the water at present utilised by the New Zealand Syndicate will be available for town purposes.

Worcester.—At the last meeting of the City Council it was decided to accept the Brush Company's offer to supply and fix two 36-kilowatt transformers for the waterworks motors in lieu of the 30-kilowatt transformers originally supplied, at £25, on condition that the Company give a written guarantee that the larger transformers will be sufficient for the purpose, and that they will maintain them in good working order for two years without charge.

Wolverhampton.—A Local Government Board inquiry is to be held into the application of the Corporation for powers to borrow an additional £5,000 for electric lighting purposes.

Worksop.—The District Council are dissatisfied with the way in which the local gas company are carrying out their contract for the public lighting, and at their last meeting several members expressed themselves favourable to the introduction of the electric light. It was stated that a company was being formed for the purpose of lighting the town by electricity. Eventually the whole matter was referred to the Lighting and Paving Committee.

Yeadon (Yorks.).—A meeting of ratepayers is to be called for the purpose of considering the lighting of this district by electricity.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

August 26, 1895.

16,008. G. Dillberg and P. Rabbidge. London. An improved telephonic instrument designed for use on poorly-insulated lines, such as the existing wires of an ordinary wire fence.*

16,019. J. Y. Johnson. London. Improvements in connection with incandescent lamps and their holders and fittings. (A. Swan, United States.)

August 27, 1895.

16,022. E. Burnet and F. F. Smith. Wigan. An improved form of cell for primary or secondary electric batteries.

16,042. H. D. Norman. Brighton. A compound electrical testing switch.

16,077. W. P. Thompson. London. Improvements in electromagnetic tools. (A. G. Fonda, United States.)*

August 28, 1895.

16,173. C. S. Newman. London. A switch formed as a handle, in which electric circuit is completed by the automatic fall of a piece of solid metal contained within the handle.

August 29, 1895.

16,218. J. R. Shearer. London. Improvements in electrical fire and burglar alarms.

16,247. H. Edmunds. London. Improvements in or connected with electric cables or conductors.

16,248. H. Edmunds. London. Improvements in electric transformers, and dynamo armatures.

August 30, 1895.

16,275. J. Finlayson. Glasgow. Improvements in instruments for making electrical and magnetic measurements.

16,287. L. Hallé. London, Improvements in dynamo-electric machines and motors.*

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SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

21,045. Hutin and Leblanc. Dynamo electric machines.

1895.

4,873. Wiggins, T. P. and G. H. Electrical insulating materials.
12,469. Müller. Electric railway vehicles.
12,772. Rowand. Electric circuits.
12,836. Dorman and Smith. Electric cut-outs.
12,954. Chloride Electrical Storage Syndicate (Limited) and Grindle. Secondary batteries.
13,207. Seibold and others. Arc lamps.

COMPANIES' MEETINGS.

Electric Construction Company (Limited).

The second annual general meeting of this Company was held at Winchester House, Old Broad-street, London, yesterday (Thursday), Sir Daniel Cooper, Bart., G.C.M.G., presiding.

The SECRETARY (Mr. James Gray) read the notice calling the meeting, the report of the Directors and statement of accounts being taken as read.

The CHAIRMAN said: Gentlemen,—The report and accounts, of which I am to move the approval, if not so satisfactory as we could wish them to be, show a considerable improvement as compared with those submitted to you last year, and they give good promise for the future, for the manufacturing profit this year amounts to £31,814. 12s. 7d., against £25,754. 10s. 5d. last year. The net profit of £12,091. 10s. 3d. we recommend should be appropriated in payment of the full Preference dividend, and the balance of £10,134. 15s. 10d. carried forward to the credit of next year's accounts. The profit has all been fairly and hardly earned, and might properly be applied in payment of a dividend on the Ordinary shares, but our available capital is barely adequate for the development of our business, and at the same time to do justice to the debentures and shares in other companies we inherited as a legacy from the old Corporation. This is the sole reason that moved the Directors to the conclusion that it would be for the advantage of the Company and ultimately in the interest of the shareholders to make no distribution of dividend at present. Some of us are amongst the largest shareholders, and no doubt would be greatly pleased to have a dividend, not merely for the sake of the money, but from the credit arising from the paying of a dividend, but we are satisfied that in the long run it will be more to our credit as Directors and advantage as shareholders to build up the business on broad, solid foundations. We ask you to have a little further patience and we are emboldened to do so by feeling confident that your forbearance will meet a due reward. The accounts seem clear and explicit, as we intend them to be, but I will invite your attention to those items which specially indicate the position and progress of the Company. If any shareholder desires further information, we will be happy to give it. Dealing first with the profit and loss account, you will note with satisfaction that we have reduced the working expenses fully £2,000. We may be able to make some further reduction, but with due regard to efficiency any further reduction can hardly be important. Our hopes of further improvement are in the direction of greater efficiency—that is, in getting better results from our expenditure. You have no doubt observed that, besides maintaining and renewing plant and buildings, the depreciation account has been credited with £5,000 out of revenue, as compared with £3,000 last year. Some of you may think that we have been rather too free in taking so large a sum out of the revenue of the year, and perhaps there may be some justification for that view; but we prefer to err, if we do err, on the safe side. We do not fix £5,000 as the amount to be appropriated to depreciation every year. After some experience, we may find that if we maintain the buildings and plant in good order and condition, and replace any tools worn out from revenue account, the allowance for depreciation may be reduced; but for the present we think £5,000 is the proper sum to be charged against revenue in this respect. Turning to the credit side of the account, the gross manufacturing profit amounts to £31,814. 12s. 7d., over £6,000 more than last year, which seems to me a very gratifying improvement in these days of trade depression and keen competition. Such profits in the circumstances seem to me strong evidence of the remunerative character of the business in which our Company is engaged. Coming now to the balance-sheet, the various liabilities explain themselves, and do not seem to call for any comment. On the assets side of the account, you will observe that £1,940. 2s. 6d. has been added to the property account for additions to plant and buildings during the year. This sum has not been expended in replacing worn out tools, but for actual additions to our plant and buildings which will enable us to turn out more work, and is thus an expenditure properly chargeable to capital. You will also note that the old property of the Company in Commercial-road, Wolverhampton, has been sold. The price obtained for the property (£2,500) has been handed over to the trustees of the First Mortgage Debentures, and has been invested by them, for the benefit of the debenture-holders. There is little change on the account "Shares and debentures in other companies." This account, as you are aware, consists of various securities taken over from the old Corporation. No interest has been charged to this account. Some small securities have been sold and a considerable amount of new added, chiefly the result of obligations of the old Corporation, and the total debit remains practically the same as last year. We consider this asset on the whole improved in value, and believe that as the various undertakings develop, the amount at debit of the account will be fully realised. I have now done with the accounts, and will refer to some matters of general import. The installations completed during the year have been entirely successful, and confirm the high reputation of the Company for first class work. Amongst the more important works in hand are the large lighting installation at Clerkenwell expected to be completed within the next two or three months, and the electrical equipment of the Hartlepool tramways which we hope to have in operation about the beginning of next year. I believe there is a great future for electric traction, and if so, those who succeed in solving the initial difficulties in the practical application of the new power may be expected to have the lead in the business. I am very confident that the electrical equipment of the Hartlepool tramways on the plans designed by our manager, Mr. Blackburn, will prove successful, not only from an engineering point of view but also in an economic and financial aspect, and lead the way to an important extension of business in this direction. The Directors are very pleased to be able to report that their relations with the workmen at Bushbury are of a highly satisfactory character. Now that the works are completely organised under the supervision of our manager, Mr. Blackburn, and the most competent staff that can be had, the outturn of work is increasing, and its quality fully maintains our previous high reputation for skill and workmanship in our manufactures. Perhaps the best evidence of this is that we are full of orders for the next six months. With our high reputation, orders in hand for six months, and improved trade prospects, you will naturally inquire why in these circumstances we do not raise prices, so as to be able to pay you at least a moderate dividend. Well, gentlemen, that is the conclusion at which the Directors have arrived, and we are now intimating a moderate advance in prices, such as is fully justified by the advance in materials and the improved prospects of trade. I believe that with electrical plant it will be found even more certain than in the case of other machinery that the best is the cheapest, and that the experience of those who are beginning to use electrical machinery will convince them that the best article is, in the long run, the most economical. Our prices will compare with those of other makers of first-class machinery, but we prefer to compete rather in quality than in cheapness, and decline to sacrifice quality for cheapness. Much advantage cannot be expected from the new prices during the first half of the year, because the interests of our customers have to be considered; the benefit will accrue later on. I have only to add that the general position of the Company has materially improved during the year, and I fully expect we will be able to submit to you next year a report and accounts showing still greater improvement. For myself, speaking as one largely interested in the Company, I have now more confidence in its management and in the profitable character of its business when prudently and carefully conducted than at any previous period of its existence. With these remarks I beg to move:—

"*That the accounts and the report and the recommendations therein contained now submitted by the Directors be approved and adopted.*"

Mr. JAMES WILLIAM BARCLAY (Deputy-Chairman) seconded the motion.

Dr. DRYSDALE asked whether it was proposed that the substitution at Hartlepool of electric traction for the steam power formerly in use should be in the form of overhead traction or an underground system.

Mr. BARCLAY said that the Hartlepool tramways were originally steam tramways, but in consequence of the excessive cost of that kind of propulsion it had been abandoned, and the Electric Construction Company was to provide an electrical equipment on the overhead system similar to that of the South Staffordshire Tramways, which was equipped by them, the only difference being that there would be considerable improvements made in the case of Hartlepool. Their manager hoped to be able to show that electric traction for tramways was a success not only from an engineering but from an economic point of view.

Dr. DALE asked for some information regarding the litigation between the Company and the South Staffordshire Tramways Company, and suggested whether some compromise could not be arrived at.

The DEPUTY-CHAIRMAN replied that there had been a suit going on between the Companies respecting the original contract; but meanwhile this Company were running the tramways under an agreement at so much per mile, which was satisfactory, yielding them, as it did, a fair return on the capital invested. They might be sure that the Directors of the Company were anxious to come to an amicable settlement.

The CHAIRMAN said that the Board did not spend a shilling in law if they could possibly avoid it, and when they did take legal advice they always took the best.

The resolution was put to the meeting and carried unanimously.

The CHAIRMAN then moved the re-election of Messrs. James W. Barclay and J. Irving Courtenay to their seats at the Board, and paid a warm tribute to those gentlemen for the zeal and ability which they bring to bear in the conduct of the Company's business.

Mr. PHILIP EDWARD BEACHCROFT seconded the motion, which was carried *nem. con.*

On the motion of Dr. DRYSDALE, seconded by another SHAREHOLDER, the auditors, Messrs. James Meston and Co., were re-appointed.

Dr. DRYSDALE afterwards moved a vote of thanks to the Chairman and Directors. He referred in terms of satisfaction to the state of the Company's works at Bushbury, Wolverhampton, which he had personally inspected.

A SHAREHOLDER seconded the resolution, which was carried unanimously; and

The CHAIRMAN having expressed his acknowledgment, the proceedings ended.

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NEW COMPANIES, STATUTORY RETURNS, &c.

ELLIOTT'S MOULDING AND JOINERY COMPANY (LIMITED).—This Company has been formed with a capital of £30,000, in £1 shares, to take over the business of Samuel Elliott, maker of electric light wire casings, timber merchant, &c., at Newbury, Berks.

INCORPORATED SOCIETY OF SCIENCE, LETTERS AND ART (LIMITED).—This Society has been registered, with a capital of £2,000, in £1 shares, to acquire an undertaking styled "The Society of Science, Letters and Art of London," and to carry on and extend the operations of the same.

PIONEER SYNDICATE OF THE CAPITAL AND COUNTIES ELECTRICITY SUPPLY COMPANY (LIMITED)—This Company was registered on September 3rd with a nominal capital of £5,000, in shares of £1 each, to generate, produce, store, accumulate and distribute electricity, electromotive force, or other similar agency, for the purpose of lighting public or private buildings, mines, ships, &c., to acquire the right to use or manufacture and put up telephones, telegraphs, electric bells, phonographs, and all kinds of electrical apparatus, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity and manufacturers of and dealers in electrical and scientific apparatus. The first subscribers, with one share each, are: P. Greville, electrician; F. Wright, C. E. Easterman, engineer; C. F. Croll, E. Mann, J. L. Higgs, and Stephen Sellon, civil engineer.

WESTRALIAN ELECTRIC LIGHTING AND SUPPLY COMPANY (LTD.).—This Company was registered on September 3rd, with a capital of £80,000, in shares of £1 each, to enter into an agreement with Westralia (Limited) to generate, produce, store, accumulate and distribute electricity, electromotive force, or other similar agency, for the purpose of lighting public and private buildings, manufactories, mines, public streets, omnibuses, tramcars, cabs, and other vehicles, ships, lighthouses, railways, and other places and things, or for plating, combining, separating, or otherwise working in metals; to carry on the business of electricians, mechanical engineers, suppliers of electricity, electrical apparatus manufacturers and dealers, &c., and to construct, establish, maintain and carry on, in Western Australia or elsewhere, electric lighting works and stations, railways, tramways, and waterways. The subscribers, with one share each, are: A. Marks, G. Mellors, R. A. Webster, L. Bulger, B. O. C. Orlebar, F. A. Thompson, mining engineer, and J. G. Macintosh.

BRITISH THOMSON-HOUSTON (LIMITED.).—The annual return to July 18th has been filed. Out of a nominal capital of £100,000, in £10 shares, 7,649 have been taken up, and £4,175 have been issued as fully paid. The full amount has been called on 3,081, £7. 10s. per share on 237, £5 per share on 106, and £2. 10s. per share on the remaining 50.

DIXON AND CORBITT AND R. S. NEWALL AND COMPANY (LIMITED).—The annual return to August 21st has been filed. The nominal capital is £120,000, in 6,000 Preference and 6,000 Ordinary shares of £10 each. The whole of the Ordinary and 1,957 Preference shares have been taken up, and the Ordinary and 250 Preference shares have been issued as fully paid. £8 per share has been called on the remaining 1,707 Preference shares.

ELECTRICAL COMPANY (LIMITED).—The annual return was recently filed. The whole nominal capital of £15,000, in £5 shares, has been issued, with £3 considered as paid, and £1 additional has since been called.

ELECTRIC MOTIVE POWER COMPANY (LIMITED).—The annual return has been filed. Of a nominal capital of £20,000, in 10,350 Preference and 9,650 Ordinary shares of £1 each, 754 Preference and all the Ordinary shares have been taken up. The latter have been issued as fully paid, and the full amount has been called on the Preference shares.

ELECTRIC POWER STORAGE COMPANY (LIMITED).—The annual return to August 15th has been filed. The nominal capital of £100,500 is divided into 20,000 Ordinary shares and 100 Founders' shares of £5 each; 18,257 of the former and 66 of the latter have been taken up, and 15,120 of the Ordinary have been issued as fully paid; £3 per share has been called on the remaining 3,137 Ordinary, and the full amount has been called on the Founders' shares: £400 has been paid in respect of 400 Ordinary and four Founders' shares forfeited.

ELECTRICITY SUPPLY COMPANY FOR SPAIN (LIMITED).—The annual return to May 14th was recently filed. The nominal capital is £100,000, divided into 19,000 Ordinary and 100 Founders' shares of £5 each. All the shares have been taken up. The Founders' shares have been issued as fully paid, while the full amount has been called on the Ordinary shares.

LANCASHIRE ELECTRIC AND ENGINEERING COMPANY (LIMITED).—In reply to requests for the filing of the returns, the Secretary (Mr. F. W. Briscoe) states that the business has been transferred to another company, and the concern has, therefore, been allowed to lapse.

SHROPSHIRE ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual returns for 1894 and 1895 were recently filed. The nominal capital is £25,100, in 2,500 £10 Ordinary shares and 100 Founders' £1 shares; 275 of the former and 44 of the latter were taken up, and £2. 5s. per share has been called on the Ordinary shares.

TELAUTOGRAPH COMPANY (LIMITED).—An agreement with the Gray European Telautograph of Chicago (incorporated in Illinois, U.S.A.) provides for the sale to this Company of certain British patents (11,032 of 1888, 17,965 of 1891, 2,696 of 1873, and 10,171 of 1894), granted to Elisha Gray, and 12,617 and 15,577 of 1886, 1,527 and 16,378 of 1887, and 1,988 of 1891, granted to T. O'Brien and assigned to F. W. Cushing. The consideration for the sale is £6,000 in cash and the allotment of 26,000 fully-paid shares (1 to 26,000) of £1 each.

THOMAS PARKER (LIMITED).—The annual return to August 14th has been filed. Of a nominal capital of £75,000, in £10 shares, 5,087 shares have been taken up, and of these 1,750 have been issued as fully paid. £8 per share has been called on the remaining 3,337 shares.

CITY NOTES.

MEMORANDA.—Bank rate, 2 per cent. (Feb. 22, 1894). Price of silver, 30$\frac{5}{16}$d. per oz. (Sept. 12th). Consols (2¾ per cent.) 107¾—107⅞ for money, 107¾—107⅞ for account (Sept. 12th); 2½ per cent. 106¼—106½. Stock Exchange Settling Days: Consols, Oct. 1st; Stocks and Shares Continuation Day, Sept. 25th; Ticket Day, Sept. 26th; Pay Day, Sept. 27th; Mining Shares Carry-over Day, Sept. 24th.

BABCOCK AND WILCOX (LIMITED).—The fourth ordinary general meeting of this Company was held on Tuesday at 147, Queen Victoria-street, E.C. The Chairman (Mr. Andrew Stewart) said they proposed to pay for the half-year ended June 30th last a dividend at the rate of 6 per cent. on the Preference and 7½ per cent. on the Ordinary shares, making, with the interim dividend paid in December last, 12½ per cent. on the Ordinary shares for the year; £10,000 was placed to reserve and a balance of £4,830. 17s. carried forward. During the past year the Company had enjoyed continued prosperity, and their prospects for the present were fairly good. In conclusion, the Chairman referred to the many improvements that had been made in their boiler and to various patents that had been taken out in connection therewith. The works and plant were being kept up in a most efficient condition, and new plant had been added with a view to work more economically in the future. The report and accounts were adopted.

BRIGHTON AND ROTTINGDEAN SEASHORE ELECTRIC TRAMROAD COMPANY (LIMITED).—A meeting of the shareholders of this Company was held on the 30th ult. at the offices, Madeira-road, Brighton, when a resolution authorising the issue of £5,000 in debentures was passed. The Chairman (Mr. E. G. Bleackley) stated that the line would be completed and ready for traffic by the beginning of next summer. The Company continue to make complaints of the measures taken by the Brighton Corporation to delay the completion of the work, but the Corporation justify their position by urging that deviations from the original plans have been made by the Company.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended September 8th amounted to £839, against £840 in the corresponding week of 1894, a decrease of £1. The total receipts for the half-year are £8,509, against £8,576 for the corresponding period of 1894, a decrease of £67.

DOVER GAS COMPANY (LIMITED).—At the annual meeting of this Company, on Monday, the Chairman (Mr. W. Mannering) reported that there had been an increase in the quantity of gas sold during the past year of 10¾ per cent., and he thought they would be able to hold their own against the electric light company by means of incandescent gas lamps. Mr. Mowll even thought the electric light would directly benefit them, as wherever the electric light was introduced adjoining shopkeepers would be compelled to have a better class of gas illumination. Mr. Mowll was on safe ground.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 8th inst. amounted to £1,324. The amount for the corresponding week last year was £1,054; increase, £270.

SHEFFIELD UNITED GAS LIGHT COMPANY (LIMITED).—At the half-yearly meeting of the shareholders of this Company, on Tuesday, the Chairman (Sir F. Mappin, M.P.), said he was a firm believer in the prospects of well-managed gas companies. He thought they had not much to fear from the electric light, and quoted certain figures as to the comparative cost of gas and electricity in support of this view. Some of the shareholders were not, however, quite so sure that the electric light would not affect their dividend of 10 per cent., as Mr. John Wilson said the Directors ought to reduce the price of gas by 2d. per 1,000 cubic feet, and thus "knock out" the electric light. He was afraid the electric light might reach them in time unless it were kept back by such a reduction.

STOCK EXCHANGE PRICES.—A correspondent of the *Financial News*, who signs himself "A Shareholder in Both Companies," points out the difference in the prices of the shares of the Edison and Swan United Electric Light Company and the National Telephone Company, of both of which Mr. J. Staats Forbes is chairman. "The former has recently distributed a dividend of 5 per cent. on the Cumulative Preference shares for the year, and, after paying the interest on the £100,000 Four and a-Half per Cent. Debentures, a sum of £3,782 has been carried forward. These £5 shares, £3 paid, are quoted in the Official List at 2 to 2½, while the Ordinary £5 shares of the National Telephone Company stand at 6¼. This means that an investor gets about 6½ per cent. interest for the former, as against 4 per cent. in the National Company."

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended September 6th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were to £3,026.

WESTERN UNION TELEGRAPH COMPANY.—The Directors of this Company have declared the usual quarterly dividend of 1¼ per cent. The accounts for the quarter ending 30th inst. show an estimated net revenue of $1,850,000, or a surplus, after providing for the dividend, of $414,555, and a total book surplus of $7,862,031.

WESTRALIAN ELECTRIC LIGHTING AND SUPPLY COMPANY (LIMITED). This Company has been formed for the purpose of acquiring the concession for the exclusive right of furnishing electric light to the municipality of Coolgardie (Western Australia) for 21 years from Westralia (Limited). The nominal capital of the Company is £80,000, in £1 shares, of which £35,000 are working capital. The shareholders in Westralia (Limited) may apply for a portion of the shares at par.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, Sept. 4.		Price Wednesday, Sept. 11.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Sept. 11. Highest	Lowest
			TELEGRAPHS								
£1,012,880	Stock	11/0	Anglo-American	48	50	48	50	4 0 0	Jan., Apr., July, Oct.	48	..
£2,993,560	Stock	22/0	Do. Preferred	89	90	89	90	5 8 0		90	89½
£2,993,560	Stock	5/0	Do. Deferred	8¾	9½	8½	9	..	" .. "	8¾	8⅝
£173,400	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 16 9	January and July ..	..	..
180,000	£10	3/0	Brazilian Submarine	13¾	14½	13¾	14½	4 11 3	Mar., June, Oct., Dec.	14½	13¾
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 7 9	June and December	..	..
10,000,000	$100	1¾%	Commercial Cable Capital Stock	160	165	160	165	4 4 10	Jan., Apr., July, Oct.	..	..
16,000	10	3/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	20⅞	20½
12,931	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 0 0	April and October ..	..	—
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10½	9¾	10½	4 7 7	" "	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	..	..	—
60,710	20	2/0	Direct United States Cable, 1877	9	9½	9	9½	4 4 3	Jan., Apr., July, Oct.	9½	9
400,000	10	5/6	Eastern	17½	17⅞	17½	17⅞	3 14 10	" "	17⅞	17½
70,000	10	6%	Do. 6 per Cent. Preference	17¾	18¼	18	18½	3 4 10	" "	18 3/16	..
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	127	130	129	132	3 1 2	May and November	130	128¾
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105	108	105	109	4 12 2	February & August	..	..
250,000	10	2/6	Eastern Extension	17¾	18	17¾	18	3 17 9	Jan., Apr., July, Oct.	18	17¾
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	126	129	127	130	3 1 8	February & August	..	..
£54,100	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	102	106	102	106	4 15 3	January and July ..	..	..
£80,600	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	102	106	102	106	4 15 3	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	105	108	106	109	3 13 7	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	113%	116%	113%	116%	3 9 10	May and November	..	—
180,227	10	3/3	Globe Telegraph and Trust	10½	10⅝	10½	10½	3 13 6	Jan., Apr., July, Oct.	10⅝	10½
180,042	10	6%	Do. 6 per Cent. Preference	16⅞	17½	16⅞	17½	3 10 1	" "	17½	16 15/16
150,000	10	5/0	Great Northern	21¾	22¼	21¾	22¼	3 16 3	Jan., April, and July	22	..
£190,000	100	5%	* Do. 5 per Cent. Debentures, 1883 issue	103	106	103	106	4 14 4	March & September	..	..
17,000	25	37/6	Indo-European	50	53	50	53	4 14 4	May and November	52	..
37,548	10	..	London Platino-Brazilian	5	7	..		..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	104	108	104	108	5 11 1	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	107	110	103	111	3 12 7	..	109¾	..
11,839	8	4/0	Reuter's	3½	4½	3½	4½	..	April and October ..	..	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	127	132	127	132	4 12 8	" "	130	..
15,609	10	2/0	West African Telegraph	5½	6½	5½	6½	..	January and July ..	..	—
£233,300	100	5%	* Do. 5 per Cent. Debentures (red.)	103	106	104	107	4 13 6	March & September	105½	..
30,000	10	2/0	West Coast of America	1	2	1	2	..	January and July .	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	104	99	104	7 13 10	June and December	102	..
88,321	10	6d.	West India and Panama	¾	1	¾	1	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10½	10¾	5 14 3	May and November	10½	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	6 13 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110	113	110	113	4 9 3	June and December	112¾	..
64,242	15	6/0	Western and Brazilian	10½	10¾	10	10½	4 5 9	May and November	10 7/16	10½
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	—	..	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4½	4¾	4	4½	..	—	4 5/16	4½
£165,200	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	101	105	102	106	5 13 9	February & August	..	..
£206,400	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	101	105	102	106	5 13 9	" "	..	..
$1,177,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	6 0 11	May and November	..	..
£164,300	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	103	100	103	5 16 6	March & September	..	..
			TELEPHONES.								
44,000	5	2/6	Chili Telephone (fully paid)	3	3½	3	3½	..	..	—	—
224,850	10/0	1½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16		May and November	..	—
171,504	£1	8·215d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly ..	9/16	..
484,597	5	2/6	National	6	6¼	6⅛	6⅜	3 18 5	June and December	6¼	6 1/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	16	18	16	18	3 6 8	" "	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	" "	..	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	6	6¼	6⅛	6⅜	3 18 5		6 5/16	..
1,100,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	106	108	106	108	3 5 3	January and July ..	107½	107
58,000	5	3/0	United River Plate	2¾	3¼	2¾	3¼	..	" "	..	..
£146,733	Stock	5%	Do. 5 per Cent. Debenture Stock (red.)	92	97	92	97	5 3 1	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	15	15½	15	15½	1 12 3	—	..	..
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15½	16½	15½	16½	3 12 9	—	16	..
£100,000	Stock	5%	* Do. 5% Debenture Stock (red.)	132	135	133	137	3 13 8	June and December	135	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	—	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	..
8,322	£5	..	House-to-House Electric	—		..		..	—	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..			—	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July ..	—	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7⅞	8⅛	7⅞	8⅛	..	—	..	..
111,000	5	..	London Electric Supply	..		..			—		
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	12	12½	12½	13	2 6 2	..	12½	12½
150,000	Stock	4½%	* Do. 4½% Debs.	117	119	117	119	3 16 1	June and December	..	..
6,452	£10	2/0	Notting Hill Electric	8½	9½	8½	9½	..	..	..	—
..	..	..	Rand Electric	..		7/16	9/16 prem.	..	—	..	..
19,980	£5	2/0	St. James and Pall Mall	8¼	8¾	8¼	8¾	..	—	8 9/16	8⅝
20,000	£5	7%	Do. 7 per Cent. Preference	9	10	9	10	3 10 10		..	..
59,900	5	2/6	Westminster Electric Supply (fully paid)	8½	9	8¾	9¼	2 19 6	..	8 15/16	8 13/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	1⅞	2⅛	1⅝	1⅞	7 16 0	—	1¾	1⅝
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	1⅞	2¼	1⅞	2⅛	5 12 11		2⅛	1⅞
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	111	114	111	114	3 19 1	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1	2	1	2		January and July .	..	—
12,139	5	1/6	Edison and Swan United	2	2½	2	2½		..	..	..
£100,000	Stock	4½%	Do. 4% Mortgage Debenture Stock	104	107	104	107	4 4 1	..	107	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		—		..	..	—	..
120,000	2	..	Electric Construction	⅝	⅞	½	¾		..	..	..
12,845	2	2/9¾	Do. 7 per Cent. Cumulative Pref.	2	2½	2¼	2¾	5 1 10	..	2⅜	..
91,195	2	10/0	Elmore's Patent Copper Depositing	¾	1	¾	1		..	—	—
20,000	5	..	Fowler-Waring Cables (fully paid)	¼	¾	¼	¾	..	..	..	..
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	19	21	19	21	4 15 3	February & August	20½	..
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 8 5	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..		—	..
16,000	£10	..	Do. 8 per Cent. Preference	..		—		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	⅛	⅜	⅛	⅜	..	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	43	45	43	45	4 0 0	March and July....	44	43⅝
£150,000	100	5%	* Do. 5 per Cent. Bonds	104	107	104	107	4 14 4	January and July	..	—
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..		..	—
41,098	£5		Do. Preference (fully paid)	..		..		..	..	..	—
£100,000	10	6/0	W. T. Henley's Telegraph Works Ordinary	11½	11¾	11¾	12¼	..	..	12⅜	12¼
£30,000	10	..	Do. 7 per Cent. Preference	15	15½	15	16	4 7 6	..	..	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock	104	107	104	107	4 4 1	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1½%	City and South London Railway	38	40	38	40	3 2 6	May and November	..	..
7,000	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 4 6	..	14¾	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	134	136	134	136	2 18 10	May and November	..	..
87,500	£10	2½%	Liverpool Overhead Railway	11	11¼	11½	11⅝	1 18 9	—	..	—
6,295	10	5%	Do. 5% Preference	15	15½	15	15½	3 4 6	..	..	..
25,000	Stock	4%	Do. 4% Debenture	111	113	111	113	3 10 10	January and July ..	—	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 905. [No. 21. Vol. XXXV.] FRIDAY, SEPTEMBER 20, 1895. PRICE SIXPENCE.

NOTES.

At the last meeting of Section A on Wednesday, the long-looked-for Report of the Committee on Electrical Standards, with its important Appendix by Dr. Oliver Lodge, on "Magnetic Units," was brought forward. The Report itself, though undeniably useful, is as dry as a mere list of figures of a year's work in testing resistance coils could make it. But in the Appendix there is matter of far-reaching interest. Long wallowing in the mire of empiricism, the result of a mistaken step at the outset of its career, the science of magnetic measurement has made one more effort to get its feet on to firm ground. Of the success which may attend this latest struggle towards an emancipation from empiricism it is not yet time to speak; and our readers will be better able to judge for themselves, when they have read the report of the discussion, which we hope to publish next week. Suffice it now to say that three main suggestions were made by the Committee; suggestions, it must be remarked—not cast-iron dictatorial laws. The humility with which they were brought forward enhances their claim to international consideration. The three suggested additions to the nomenclature of magnetic science were :—

(1) That as a unit of magnetic field 10^8 C.G.S. lines be called a *weber*.

Note.—A *weber* added per second at a steady rate to the field girdled by a wire circuit induces one volt in every turn of that circuit.

(2) That the C.G.S. unit of magnetic potential or magnetomotive force be called a *gauss*.

Note.—An ampere-turn corresponds to $\frac{4\pi}{10}$ (or 1·2566) *gauss*. Hence the number of *gauss* round any closed curve linked on an electric circuit is equal to $\frac{4\pi}{10}$ times the number of ampere-turns in the circuit.

(3) That the termination *-ance* be used in general for words expressing the properties of a definite body or piece of matter; *e.g.*, resistance, conductance, inductance, permeance, &c. And that the termination *-ivity* or *-ility* or the like be used for words expressing the specific properties of a material; *e.g.*, conductivity, resistivity, inductivity, refractivity, permeability, &c.

The most striking criticism of these proposals is that made by Prof. Silvanus Thompson, who pointed out that the term *weber* had already been adopted in America for the C.G.S. unit of flux—viz., one *line*. And, though he agreed with the proposal to name the C.G.S. unit of magnetic potential the *gauss*, he mentioned that the term *gilbert* had been proposed by the American Institute of Electrical Engineers for that which it is here proposed to call the *gauss*; while *gauss* itself suggests in American language the unit of magnetic flux density. Whether such clashing between the usages in the two countries is or is not liable to lead to confusion, our readers will not need our assistance to enable them to judge. Another important point lies in the fact that no dynamo yet built has a total magnetic flux so large as one *weber*; the consequence being that only fractions—often very small fractions—of one *weber* would be spoken of in practice. In concluding his remarks, Prof. Thompson called attention to that system of magnetic units which alone, of all systems, deserves to be called rational—namely, that proposed by Mr. Oliver Heaviside. The opinions of the speakers in the discussion were divided in regard to the practicability of adopting this system now; many feared that it was too late for so radical a change; others thought the change could be made in 30 or 40 years; while some were disposed to regard the revolution as being within the range of present possibilities, and as far less difficult a task than the revolution of a system of weights and measures, or the shifting of the standard meridian of commercial and scientific time in any country.

The cry of "Organise! organise!" is becoming almost as frequent in electrical as in electoral circles, and in face of the unqualified assertions of Lord Kelvin, Lord Rayleigh, Prof. Lodge, and others, good organisation would seem to be as much a matter of supreme importance in the one case as in the other. That being so, the Ipswich meeting of the British Association will have made a name for itself, if the Committee which was appointed after the reading of Sir Douglas Galton's Memorandum on the Reichsanstalt contributes in any appreciable way to the better organisation of English research work. As Prof. Lodge pointed out, it is not that we have not the men, nor that we lack the money; but it is that each separate man separately doing what is right in his own eyes results in a terrible lack of coherence. The elementary filaments of research require to be centralised and brought into perfectly systematic relationship with a head-quarter. But in what particular manner is this to be done? Some are inclined to think that the one and only solution of the difficulty lies in sacrificing much of our liberty of research at the shrine of the State exchequer; receiving, in return for our present right to research just what, where, when and how we individually please, the money and that amount of departmental contro

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which are necessary to enable us to research co-ordinately and in concert. If ever such a sorry state of affairs should come about, scientists are likely to find themselves in a position analogous to that of a research expert in the employ of a manufacturing company. They will be tolerated, in their investigations, only in so far as there is a prospect of the results becoming commercially and nationally useful. The idiosyncracies of a D line in the spectrum of a remote and obscure nebula will scarcely meet with the same degree of State patronage as an organic compound possessing fifty times the explosive power of cordite, or armour plating surpassing the stoutest harveyised steel. Prof. Ayrton is perfectly right when he says that scientific research stands no chance of the State aid which he and others so much desire, until it shall have shown itself to be of as great national importance as the building of warships.

Mr. Earle is to be congratulated on the great amount of information respecting storage batteries which he has compressed into the Paper on the subject which he read before the British Association at Ipswich. His remarks on the manner in which specifications for storage batteries are too often drawn up will, we hope, lead to some more uniform practice being adopted in the future than exists at present. There are many other points of interest in the Paper, both from the commercial and from the scientific point of view, but we can only call attention to one of them here, namely, the effect of the electrolyte. The author's notes on the influence of varying strengths of acid on the behaviour of cells are extremely interesting, and seem to endorse a view put forward some years ago, that it was the nature of the electrolyte employed, and the treatment which cells received *after* they left the hands of the manufacturers which mainly influenced their behaviour, for the author points out that each special type of plate has a particular strength of acid solution with which it works best. With reference to the discussion as to the influence of persulphuric acid, it is noticeable that with about 1·250 acid we get the best results both as regards capacity and voltage. Now this strength of acid also gives us nearly the best conditions for the formation of persulphuric acid, which again decreases as the strength of acid is increased, nearly ceasing at 1·500, this strength of acid also giving the minimum capacity in the case of the cells. Mr. Earle has on this occasion confined himself to a narration of facts observed in practice, and to the physical properties of the electrolyte employed; but we hope that he may extend his researches to the nature of the chemical reactions which occur in the electrolyte in storage batteries, and to the effect of change of density on these.

The view held by many, that the slow telephonic development of England is not by any means solely due to high rates and bad management, is in a large measure borne out by the valuable table published by Mr. A. R. Bennett in his British Association Paper. Five of the six lucky countries that obtain first prizes at his hands are agricultural and more or less wild. From the poverty and sparse population of the countries in receipt of Mr. Bennett's telephonic eulogies, we indeed at first concluded that he was really aiming at establishing some connection between the existence of excellent telephonic facilities and a lack of wealth and natural resources. We should certainly like to see the telephone used rurally as much as it is, say, in Norway, but we cannot help thinking that the main reason the telephone has flourished there so exceedingly is because it came into a country without an elaborate telegraphic network such as our's and where other circumstances apart from tariffs favoured it.

Although huge water-power plants such as the one at Niagara Falls, and ambitious water-power projects such as those we hear of almost daily from places as far apart as the Rhone, California and South Africa, are calculated to rivet the attention of the public and to inspire the social dreamer with visions of a regenerated, or at any rate physically cleaner, industrial community, modest little plants like the one recently laid down at the Ontario and Daly Mines in Utah give perhaps a clearer insight into the important economies and improvements immediately realisable by the electrical utilisation of waste water power. As will be seen from Mr. McKay's article, reprinted in another column, these mines were in danger on the one hand of financial submersion, if the works necessary to keep down the water were undertaken, and on the other of actual aqueous submersion unless something was done to get rid of the intruding fluid. In the end, a three-mile long drain tunnel was run, and when nearing completion the brilliant idea occurred of electrically utilising the energy of the 120ft. fall at its mouth. To-day, current is being transmitted a distance of 6½ miles, and the plant, which is looked after by two men, annually saves its owners £600 in fuel and illuminating oil, and earns a trifle besides; and before many more months are passed its capacity will be doubled, and it will be earning a handsome profit. Now, we have no wish to unduly decry other methods of power transmission, but where the circumstances are such as those just described, electricity, and electricity alone, holds the field. In this country this particular field of utility is unfortunately a very restricted one indeed; abroad it is otherwise, and we are hastening on to many unexpected developments.

Cable Interruption and Repairs:—

	Date of Interruption.
Aden-Zanzibar	September 2, 1895.

Electric Heating for Electric Cars.—The American Electric Heating Company has an order to equip with electric heaters, by November 1st, 750 of the 889 electric cars belonging to the West End Street Railway Company of Boston.

Society of Engineers.—The next ordinary meeting of this Society will be held at the Royal United Service Institution, Whitehall, on Monday, October 7th. A Paper will be read on "The Relative Value of Percolation Gauges" by Mr. Reginald E. Middleton.

Bristol-Kingswood Electric Tramway.—The electrical equipment of this line is almost complete, and, as we stated in our last issue, some trial trips have already been run. The electrical equipment of the line consists of 12 motor cars, each provided with two motors, accommodating 18 passengers inside and 25 out.

Compagnie Française des Cables Télégraphiques.—We understand that this Company's Brest-Penzance section has been repaired, and that the "Faraday" has proceeded out to

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sea for the repair of the Penzance St. Pierre section, which, as announced in *The Electrician* of August 30th, is reported to be broken in 2,500 fathoms.

The Electric Light on the West Coast of Africa.—Amongst various items of purely commercial interest that reached this country from the West Coast of Africa by the last mail we note that at Lagos the natives have taken such determined action by meetings, deputations, &c., against the Government proposal to light the town by electricity—the cost to be defrayed by taxation—that the Acting Governor has informed the Legislature that he would not proceed with the proposal for the present, and has telegraphed to England to stop further expenditure on plant.

Charterhouse Science and Art Schools and Literary Institute.—The winter session of this, one of the largest science and art schools in the United Kingdom, will commence on Saturday, September 28th, under the presidency of the Rev. Henry Swann, M.A. During the late session upwards of 1,200 students, mostly elementary teachers, availed themselves of the privileges afforded by this institution, and of this number 682 presented themselves for examination, and were successful in obtaining a large number of certificates awarded by the Science and Art Department of South Kensington.

The Raworth High-Speed Steam Engine.—We have received particulars of a new high-speed, vertical, enclosed steam engine which has recently been brought out by Mr. Raworth. The cylinders are compounded and steam-jacketed; the effect of the steam is single-acting; there are Corliss valves for admission and exhaust, and the steam valves are controlled by automatic expansion gear. The engine has been very favourably regarded by Prof. W. C. Unwin and Mr. W. H. Maw, the former of whom states that he "should expect it to be an engine which would work with great economy of steam."

Telegraphic Communication between Guernsey and Sark.—For some years past there has been a great desire on the part of the inhabitants of Guernsey and Sark that the latter should be in telegraphic communication with Guernsey. A petition, signed by over 1,000 persons, has been forwarded through the Lieutenant Governor of Guernsey to the Postmaster-General, requesting that a cable be laid down, and in the meantime a military heliographic system has been established and is in great demand. It is worked from the mill at Sark to Fort George, Guernsey, and *vice versa*, and soldiers deliver the despatches.

International Telephonic Communication.—Good progress is being made with the work of establishing telephonic communication between Brussels and Cologne. The line between Brussels and Hertesthal on the Belgian side is finished, while work on the portion on the German side between Hertesthal and Cologne is well in hand. Work is well in hand on the establishment of telephonic communication between Brussels, Antwerp and Amsterdam. When the line is completed the one between Paris and Brussels will probably be connected with it, so that it may be possible ere long to telephone from the Dutch to the French capital.

British Association.—At the last meeting of the General Committee the treasurer (Prof. Rücker) announced that the attendance at the meeting had been as follows:—214 old life members, 13 new life members, 290 old annual members, 31 new annual members, 493 associates, 261 ladies, and 23 foreign members, making a grand total of 1,324. The sum received by subscriptions was £1,236. Certain alterations in the rules as to the making of money grants were proposed by the treasurer and adopted, and the general secretary read a list of money grants appropriated to scientific purposes by the General Committee at the present meeting. The total amount, divided amongst the different sections, was £1,160, and all the grants were confirmed. The Committee then adjourned till Wednesday, September 16, 1896, at Liverpool. The 1897 meeting will take place at Toronto.

Car "Fenders."—After November 14th next, according to an order recently issued by the Railroad Commissioners of Massachusetts, the cars of every street railway in that State must be equipped with "fenders" and wheel guards capable of saving life. Horse cars and trailers are excepted, and a temporary exception is made of cars run wholly within the limits of towns having a population of less than 7,500. No special form of "fender" is indicated, but when the "fender" is designed to serve also as a wheel guard, it must not only pick up a person run into while standing, but prevent a person who has fallen or been thrown down from getting under the car and being run over by the wheels. The Commissioners say: "No one form of fender or wheel guard has as yet been proved to be so unquestionably superior to all others, tried and untried, as to justify the prescription of its sole and its exclusive use"; and the several street railway companies are therefore left free to deal with patentees and inventors for the selection of such "fenders" as will in practice prove most efficient.

Hawaiian Cable Concession.—Reuter's Agency learns that, according to arrangements recently entered into between an American sugar planter and the Hawaiian Government, a contract has been signed granting an annual subsidy of $40,000, with an exclusive right for 20 years to land a cable from the American Continent. By this arrangement, which has been ratified by the Legislature of the Republic, the Hawaiian Government bind themselves not to permit the landing of any other cable on the Hawaiian group. The contractors, however, make it conditional that the line will not be constructed until an annual subsidy of $175,000 has been arranged with the United States Government. According to the contract the line must be commenced in May, 1897, and completed in November, 1898. The negotiations for the contract were conducted with the Hawaiian Republic with the greatest secrecy, and, on it becoming known that it was signed, a meeting of the Honolulu Chamber of Commerce was immediately called, at which the British and German members protested against the granting of any exclusive right.

Expiry of a Swan Glow Lamp Patent.—On the 29th prox. will expire patent No. 4,202 of 1881, granted to Mr. Joseph Wilson Swan for "Improvements in and Relating to Incandescent Electric Lamps." In carrying out the invention the patentee states that he "welds together by means of a deposit of hard carbon, the ends of the filament and the metallic sockets into which the ends are inserted," after shaping the ends of the leading-in wires to suit the shape of the filament. The patentee describes three methods of carrying out his process: (I.) The filament is electrolytically coated with copper everywhere, except on the parts inserted in the sockets and for a short length of about 1mm. beyond. It is then removed from the plating bath, carefully washed and dried, and next immersed in a bath of any suitable hydro-carbon liquid or vapour "from which carbon deposits with the action of heat." A current is then passed through the filament of such a strength that the uncoppered portions "become so strongly heated that a deposit of carbon takes place," the process being continued "until a considerable deposit of carbon resulting in a bulbous enlargement of the parts on which it has taken place is obtained, and the welding together of the sockets and ends of the filament already referred to is effected." (II.) The filament, in this process, is immersed in a bath of mercury, "or other suitable liquid metal," nearly up to the point of attachment to the sockets, and the containing vessel filled above the bath with a suitable hydro-carbon liquid or vapour. On a current of proper strength being passed through the filament in the same manner as before, the exposed portion of the filament becomes coated with a carbonaceous deposit. (III.) The deposit is obtained in the third method by placing a metal clip across the carbon filament, immersed as described in a hydro-carbon liquid or vapour, close to the point of its attachment to the sockets. On connecting the leading-in wires to a source of current, the current is shunted from the main portion of the filament and heats the portion in and near the sockets. The claims of this patent were two in number: (1) Producing by means of electric heating a coating or deposit of carbon over the junction of the metallic socket and the carbon filament inserted in it. (2) In producing a liquid carbon deposit above mentioned, the application of a metallic deposit by electrical action to the part of the filament required to be kept cool, and on which the carbon deposit is not to take place.

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ELECTROMAGNETIC THEORY.—LXXIV.*

BY OLIVER HEAVISIDE.

(*Continued from page 573.*)

§ 287. Passing to the consideration of the application of the expansion theorem to diffusion problems, take first what is one of the simplest cases, as well as one of the most interesting. Let a cable be earthed at both ends, and a steady impressed force e be inserted at $x=0$. The potential produced is given by (17), § 256, namely

$$V=\frac{\text{shin}\, q(l-x)}{\text{shin}\, ql}e=\frac{\sin s(l-x)}{\sin sl}e, \qquad (40)$$

where $q^2=-s^2=\text{RS}p$. The practical way of getting this operational solution was described on the same page. Being an easy case, we can see that it is right by noting that it makes $V=0$ at $x=l$, and $V=e$ at $x=0$.

Take the form (30) of the expansion theorem. Take Y to be the numerator, and Z the denominator. The roots of Z are those of shin ql. But not the zero root, because to rationalise shin ql, which is an odd function of ql (and therefore of $p^{\frac{1}{2}}$), we must exclude it. This may be formally done by making Z be (shin ql)/ql; but it is unnecessary, for by omitting the zero root from shin $ql=0$ we come to the same result. Noting this, we may use either of the forms given in (40). The first gives the result in terms of the values of p. But these are negative, therefore the second form is the most convenient. So we have

$$p\frac{dZ}{dp}=\tfrac{1}{2}s\frac{dZ}{ds}=\tfrac{1}{2}sl\cos sl. \qquad (41)$$

Also, putting $p=0$, the final steady state is $e(1-x/l)$. So the expansion theorem (30) gives

$$V=e\left(1-\frac{x}{l}\right)+e\Sigma\frac{\sin s(l-x)\epsilon^{pt}}{\frac{1}{2}sl\cos sl}, \qquad (42)$$

where the summation ranges over the finite roots of $\sin sl=0$; that is, $sl=\pi$, 2π, 3π, &c.; and p in the exponential function is given by $\text{RS}p=-s^2$. Owing to the dependence of p on the square of s, we see that only the positive roots of $\sin sl=0$ need be counted. That is, it is really the values of p that control matters. Equation (42) may be at once reduced to

$$V=e\left(1-\frac{x}{l}\right)-2e\Sigma\frac{\sin sx}{sl}\epsilon^{pt}, \qquad (43)$$

which was obtained before.

§ 288. Next take the same case as last with the sole change made of insulating instead of earthing at $x=l$. Then, by (22), § 258, the potential is given by

$$V=\frac{\cosh q(l-x)}{\cosh ql}e=\frac{\cos s(l-x)}{\cos sl}e, \qquad (44)$$

which, as before, we see to be correct by the formula making $V=e$ at $x=0$, and $C=0$ at $x=l$. Now in this case, the denominator is rational, as a function of p, that is to say, so no reservation is needed, and the expansion theorem (40) makes

$$V=e+e\Sigma\frac{\cos s(l-x)}{\frac{s}{2}\frac{d}{ds}\cos sl}\epsilon^{pt}; \qquad (45)$$

ranging over the positive roots of $\cos sl=0$; or, $sl=\frac{1}{2}\pi$, $1\frac{1}{2}\pi$, &c. Effecting the differentiation in the denominator, and simplifying the numerator by the vanishing of $\cos sl$, we reduce (45) to

$$V=e-2e\Sigma\frac{\sin sx}{sl}\epsilon^{pt}, \qquad (46)$$

which is the expansion required. The summational part is of the same form as in (43). But of course there is a different series of values of sl, and also of the p's. There is no confusion between p the differentiator, and its specialised algebraical values denoted by the same symbol. The latter only occur in algebraical summations; the former in operational solutions.

§ 289. The above two cases being sufficiently illustrative when the impressed force is situated terminally, and the terminal conditions are of the simplest type, making either the potential or the current vanish, take next the case of an intermediate impressed force, though still with the simple terminal conditions. Say that there is earth on at $x=0$, insulation at $x=l$, and an impressed force e at $x=y$. Then, by (41), (42), § 260, the resulting potentials, putting $q^2=-s^2$ for convenience in the expansions to be found, are given by

$$V_1=\frac{\cos sy}{\cos sl}\cos s(l-x)\,.\,e, \qquad (47)$$

$$V_2=\frac{\sin sx}{\cos sl}\sin s(l-y)\,.\,e, \qquad (48)$$

V_1 being the potential when x is on the right side of y, and V_2 when on the left side. Here, of course, s^2 is the differentiator $-\text{RS}p$.

First, putting $s=0$, we see that the final steady state is $V_1=e$, $V_2=0$. So applying (30), we obtain

$$V_1=e-e\Sigma\frac{\cos sy}{\frac{1}{2}sl\sin sl}\cos s(l-x)\,.\,\epsilon^{pt}, \qquad (49)$$

$$V_2=0-e\Sigma\frac{\sin sx}{\frac{1}{2}sl\sin sl}\sin s(l-y)\,.\,\epsilon^{pt}, \qquad (50)$$

subject to $\cos sl=0$, as in the last case, or $sl=(n-\frac{1}{2})\pi$, where n is a positive integer. We may now simplify by means of $\cos sl=0$, leaving

$$V_1=e-2e\Sigma\frac{\cos sy}{sl}\sin sx\,.\,\epsilon^{pt}, \qquad (51)$$

$$V_2=\ -2e\Sigma\frac{\cos sy}{sl}\sin sx.\,\epsilon^{pt}, \qquad (52)$$

the simplest form of the expansions.

The transition from the operational solutions (47), (48) to the expansions (49), (50) involves two formal processes, viz., the change in the denominator, done by the differentiation which occurs when the summational sign and the time factor are introduced, and the addition of the outside term. In going further, we reach (51), (52), by the omission of terms which vanish in the preceding equations. The same occurs in the previous examples. Now this omission may be done in the act of applying the expansion theorem, thereby deriving (51), (52) directly from (47), (48) without the more complicated intermediate equations. And, in fact, so far as arriving at (51), (52) is concerned, through the expansion theorem, we may make the omission in the operational solution. But the steady part of the solution must be extracted first; and in any case, the operational solution is made nonsense of (considered as a general operational solution) by the too early omission. So the omission is properly done in the act of conversion to the expanded series.

§ 290. If both terminals are earthed, whilst the impressed force is intermediate, at the point y, we have, by (37), (38), § 260, the results

$$V_1=+\frac{\cos sy}{\sin sl}\sin s(l-x)\,.\,e, \qquad (53)$$

$$V_2=-\frac{\sin sx}{\sin sl}\cos s(l-y)\,.\,e, \qquad (54)$$

on the right and left sides of the impressed force respectively. So the expansion theorem makes

$$V_1=e\left(1-\frac{x}{l}\right)-2e\Sigma\frac{\cos sy\sin sx}{sl}\epsilon^{pt}, \qquad (55)$$

$$V_2=-\frac{ex}{l}-2e\Sigma\frac{\cos sy\sin sx}{sl}\epsilon^{pt}, \qquad (56)$$

where we first write down the outside terms got by putting $s=0$ in the previous equations, and then write the summational general term, changing the denominator by the operator $\frac{1}{2}s(d/ds)$, which is equivalent to $p(d/dp)$, and omitting terms

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which, in virtue of $\sin sl = 0$, vanish from the result with changed denominator.

The determinantal equation depends only upon the nature of the terminal conditions apart from impressed force. There may be any distribution of impressed force, intermediate or at the terminals as well, but unless we change the terminal arrangements, there will always be the same set of normal systems. In (55), (56), for example, e is entirely at the point y. But make it be a function of y, representing a distributed impressed force. Then the integration of (55), (56) with respect to y, so as to include all the impressed forces, will give the resulting potential. The outside terms are altered, and likewise the size of the normal systems in the summation, but the type of the normal systems, say $\sin sx\, \epsilon^{pt}$, is not changed, and the same series of s's and p's remains in force.

§ 291. Owing to the equidistant spacing of the roots of the determinantal equation in the above cases, which arises from the fact that the terminal reflection coefficients are of size $+1$ or -1, as the case may be, the expanded solutions are readily calculable numerically at once. It is somewhat different when we depart from the simplicity of terminal earth or insulation, as the roots become unequally spaced, and require preliminary determination from trigonometrical tables before the formulæ can be subjected to calculation. The process of expansion is, however, the same. Let, for a first case, the impressed force be at the beginning, $x = 0$. Then we only want the formula on the right side of the force. This is (35), § 259, in which put $a = 0$, making

$$V = \frac{1 - \alpha}{\epsilon^{ql} - \alpha\beta\epsilon^{-ql}}\{\epsilon^{q(l-x)} + \beta\epsilon^{-q(l-x)}\}\tfrac{1}{2}e, \qquad (57)$$

which shows the potential at x due to e at $x = 0$, when the terminal reflection coefficients are α and β, at $x = 0$ and l respectively. In terms of the terminal resistance operators Z_0 and Z_1, we have

$$\alpha = \frac{Z_0 - R/q}{Z_0 + R/q}, \qquad \beta = \frac{Z_1 - R/q}{Z_1 + R/q}, \qquad (58)$$

by § 261, equations (49) and (52). Here Z_1 is such that $V = Z_1C$ is the equation of voltage for the terminal arrangement at $x = l$, and $V = -Z_0C$ for that at $x = 0$.

When the terminal arrangement is a mere resistance, we have $Z_0 = R_0$ say, and $Z_1 = R_1$, these being constants. Notice, in passing, the singular case $\alpha = 1$. By (57) it makes $V = 0$; that is, the cable cannot be charged at all. This happens when Z_0 is infinite, which needs an infinite terminal resistance at every moment, and no permittance.

Going further, let us expand (57). The best way is, by means of the given expressions for α and β, to convert it to circular form first, before applying the expansion theorem, although it will come to the same thing in the end if we expand (57) as it stands, and then change to circular functions. Adopting the former course, put $q = si$ in (57) and (58), and reduce by ordinary algebra. The result is

$$V = \frac{\{\sin + (Z_1 s/R)\cos\} s(l - x)}{(1 - Z_0 Z_1 s^2/R^2)\sin sl + (Z_0 + Z_1)(s/R)\cos sl}\,e. \qquad (59)$$

This is, by its construction, only another form of the operational solution itself, the meaning of s^2 being $-RSp$. Observe, also, that although Z_0 and Z_1 are unspecified, no further reductions of the kind just made are required for them in any case allowing of the application of the expansion theorem, because they are then rational functions of p, and therefore of s^2. So (59) is the operational solution in a form which is convenient for the immediate application of the expansion theorem.

Put $s = 0$ to find the steady state. Practically, put 1 for $\cos sl$ and $\cos sx$, and sl or sx for $\sin sl$ and $\sin sx$. The result is

$$V_0 = \frac{R(l - x) + Z_1}{Rl(1 - Z_0 Z_1 s^2/R^2) + Z_0 + Z_1}\,e. \qquad (60)$$

Now if the terminal arrangements are mere resistances, say R_0 and R_1, this becomes

$$V_0 = \frac{R(l - x) + R_1}{Rl + R_0 + R_1}\,e, \qquad (61)$$

which is obviously right, because the denominator is the total resistance of the circuit, and the numerator is that part of it which lies to the right of the point x. Similarly, if the terminal arrangements, though not simple resistances themselves, have finite steady resistances, then $s = 0$ in Z_0 and Z_1 produces them, and (61) is still the result, where R_0 and R_1 denote the effective steady resistances. But it may happen that the term containing s^2 in (60) does not vanish. It may be infinite, so caution is needed when the effective terminal resistance is infinite. Thus, (60) may be written

$$V_0 = \frac{R(l - x) + Z_1}{Rl(1 + Z_0 Z_1 Sp/R) + Z_0 + Z_1}\,e, \qquad (62)$$

in terms of p. Now suppose the terminal arrangement at A is a condenser, making $Z_0 = (S_0 p)^{-1}$. The p is cancelled. But at the same time the denominator is made infinite, R_0 being infinite. So if R_1 is finite, the result is $V_0 = 0$. That is, the cable settles down to a neutral state ultimately when charged through a condenser, provided there is not infinite resistance at the further end. On the other hand, when the condenser is at B, making $Z = (S_1 p)^{-1}$, say, the result is $V = e$, the full value, provided the resistance at A is finite. Lastly, if both R_1 and R_0 are infinite, by having condensers at both ends, say $Z_1 = (S_1 p)^{-1}$, $Z_0 = (S_0 p)^{-1}$, the result of putting $p = 0$ in (62) is

$$V_0 = \frac{S_0 e}{S_0 + S_1 + Sl}. \qquad (63)$$

This result may be verified by the law of displacement in condensers. On one side of the impressed force is the elastance S_0^{-1}, and on the other side $(S_1 + Sl)^{-1}$. So the total displacement is

$$\frac{e}{S_0^{-1} + (Sl + S_1)^{-1}} = \frac{eS_0(Sl + S_1)}{S_0 + Sl + S_1}, \qquad (64)$$

Divide by $Sl + S_1$ the permittance on the right side of e, and the result is V_0, as in (63), the final steady potential of the cable and further condenser. On the other side of the impressed force—that is, on the side of the condenser at A which is next the cable—the potential is negative, being lower than the above V_0 by the amount e. It is the side of the condenser at A next the earth that is charged positively. The reverse is the case in the dielectric of the cable and the B condenser. The simplest mental realisation is obtained by the use of Maxwell's displacement current.

If we compare these cases with the formula (61), understanding that R_0 and R_1 are the steady terminal resistances, we see that they are in agreement, except that when R_0 and R_1 are *both* infinite, the result (61) is ambiguous. In such a case we must go back to the more complete formula (60), or (62), and interpret it instead.

Having thus settled V_0, the outside term to express the steady state when there is one, we may apply the expansion theorem to (59) or to any form of the same that may be more convenient. Another form is

$$V = \frac{\cos sx(\tan sl + Z_1 s/R) + \sin sx(\tan sl \,.\, Z_1 s/R - 1)}{(1 - Z_0 Z_1 s^2/R^2)\left(\tan sl + \dfrac{(Z_0 + Z_1)s/R}{1 - Z_0 Z_1 s^2/R^2}\right)}\,e, \qquad (65)$$

obtained from (59) by expanding the numerator, and then dividing the numerator and denominator in that equation by $\cos sl$.

The determinantal equation is

$$\tan sl + \frac{(Z_0 + Z_1)s/R}{1 - Z_0 Z_1 s^2/R^2} = 0, \qquad (66)$$

or, which is the same,

$$\tan sl = -\frac{Rl(Z_0 + Z_1)sl}{(Rl)^2 - Z_0 Z_1 (sl)^2}. \qquad (67)$$

This simplifies to

$$\tan sl = -\frac{Z_0}{Rl}sl, \qquad (68)$$

when $Z_1 = 0$, and to

$$\tan sl = -\frac{Z_1}{Rl}sl, \qquad (69)$$

when $Z_0 = 0$. In these equations the Z's are functions of $(sl)^2$ in virtue of being functions of p in general.

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In the case of the terminal arrangements being mere resistances, producing a constant ratio of the potential and current at the terminals, we have the simple terminal conditions considered by Fourier. Z_0 or Z_1, or both, as the case may be, are constants. The values of sl are then very easily determined by means of a table of tangents. This kind of terminal condition, which includes the extreme cases of terminal earth and insulation, is the only one that admits of the expansion of an arbitrary function after the manner of Fourier—that is to say, by the use of the property of the vanishing of the integral of the product of any two different normal systems. The reason is because there is no energy in the terminal arrangements that can by itself affect the state of the cable. It is true that there is waste of energy in the terminal resistances, but that does not count at all. It is wasted and done for. So the specification of the initial state merely requires a statement of the potential in the cable itself; that implies electric energy, upon which the later state of the cable when left to itself depends, in the absence of an impressed force to introduce fresh energy. But whenever the terminal arrangement departs from the above simple type, involving merely a waste of energy from the cable, Fourier's method fails. The integral of the product of two normal systems along the cable is no longer zero. The initial state may or may not include any energy in the terminal arrangements. If it does, this terminal energy must be allowed for by widening the conjugate property, or in other ways. But even if it does not, the energy in the cable itself will set up energy in the terminal arrangements in a reversible manner, not by mere waste, so the complete normal systems must include the terminal arrangements as well as the cable. Now if the terminal arrangements consist only of condensers and resistances (or equivalently), however complicated in detail, we only introduce electric energy. This is like that in the cable (its self-induction being ignored here), viz., the energy of electric displacement. The conjugate property which has to take the place of Fourier's is then substantially the same, with a wider range, however. It is the property of the vanishing of the total mutual energy of a pair of complete normal systems. But should we introduce magnetic energy into either or both of the terminal arrangements, the last property breaks down. We have to go to a still wider one, viz., that the mutual potential energy (or electric, here), of a pair of normal systems equals the mutual magnetic energy of the same, the terminal arrangements being included. This may work out in a complicated manner.

But the expansion theorem goes straight to the final simplified result, irrespective of the absence or presence of energy or of the power of receiving and storing energy in the terminal arrangements, and of the kind of conjugate property required to effect the expansion after the manner of Fourier extended. Thus, applying it to (65), following the formula (30), and using $\frac{1}{2}s\,(d/ds)$ instead of $p(d/dp)$, we obtain

$$V = V_0 + 2e\Sigma \frac{\cos sx\,(\tan sl + Z_1 s/R) + \sin sx\,(\tan sl\,.\,Z_1 s/R - 1)}{sl\,(1 - Z_0 Z_1 s^2/R^2)\left(\dfrac{1}{\cos^2 sl} + \dfrac{d}{d(sl)}\,\dfrac{(Z_0 + Z_1)s/R}{1 - Z_0 Z_1 s^2/R^2}\right)}\epsilon^{pt}, \tag{70}$$

by performing one differentiation upon the denominator in (65). We cannot carry it further profitably without specifying what the natures of Z_0 and Z_1 really are. Since, however, the values of sl in the summation are fixed by the equation (66), that is by the vanishing of the denominator in (65), we may substitute the right member of (67) for tan sl in (70), and similarly put $\sec^2 sl$ in terms of the Z's. But there is no particular advantage in doing so, unless the Z's are given, and we desire to make possible simplifications of expression.

In obtaining (70) by the expansion theorem, no notice was taken of the factor $(1 - Z_0 Z_1 s^2/R^2)$ in the denominator in (65). It has its roots truly, but they are inoperative. They lead to nothing. The factor may therefore be regarded as belonging to the numerator of (65), if we please. Or, keeping it in the denominator, we see that its vanishing does not make the denominator vanish, and therefore its roots are out of the question.

(To be continued.)

MOLECULAR ELECTRICITY.

BY J. H. POYNTING, SC.D., F.R.S.

(Continued from page 647.)

When a line or tube of induction moves sideways into an electrolyte composed of such condenser molecules it finds the molecules with their axes distributed equally in all directions. It will pick out those already facing in the direction suitable for it—those requiring the least energy for its purpose, and those alone need be drawn.

In Fig. 4 (*a*) two lines of induction, X X, Y Y, are represented as ready to move into an electrolyte, in which A B, A B represent the suitable molecules.

The successive stages are represented by *b*, *c*, *d*, *e*, and the final result is that the highest B atom is delivered up to the

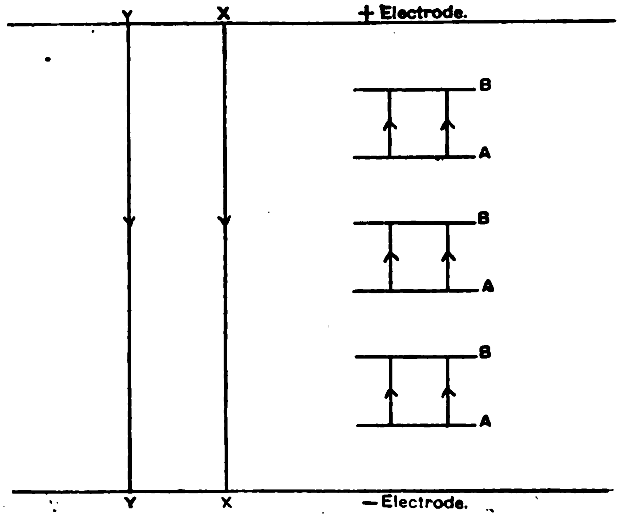

FIG. 4*a*.

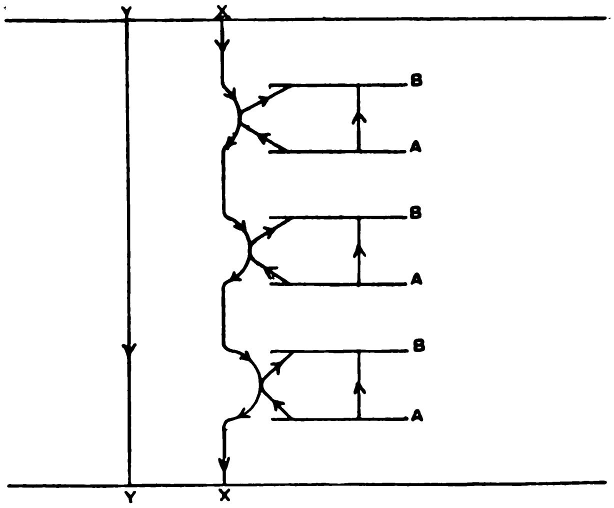

FIG. 4*b*.

+ electrode, and the lowest A atom to the − electrode, while all the intermediate atoms in the chain change partners, merely forming molecules like the original ones, but with their axes reversed.

If more lines come in they will find new molecules directed as they require, and soon also the collisions occurring in the liquid will distribute the axes of the molecules of the first chain into various directions, so that some of these, too, will be ready for later lines of induction.

The coalescence and destruction of the parts of two tubes which run alongside each other in opposite directions, upon which the whole process depends, will naturally tend to take place, as less potential energy will be needed for the coalesced tubes than for the two side by side. The energy of the final configuration is the same as that of the initial configuration,

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except at the two ends, so that if X X and Y Y bring in enough energy to provide for the new configurations at the electrodes the process will continue. If X X and Y Y bring in an excess of energy we may regard the change of partners as occurring with more or less of a rush, and the excess is converted into internal molecular energy, partly kinetic, partly potential; in

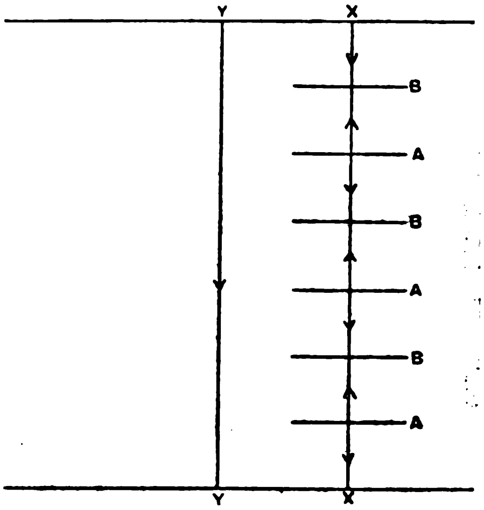

Fig. 4*c*.

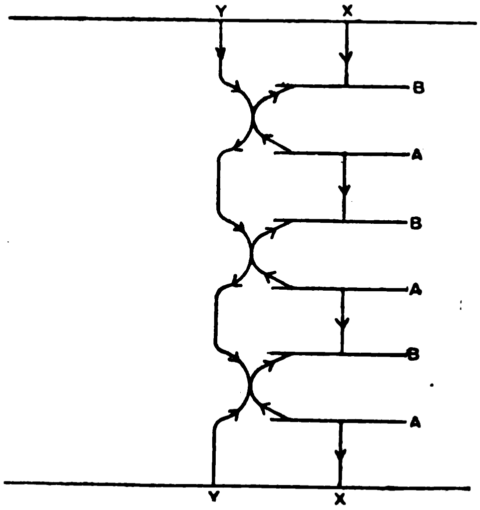

Fig. 4*d*.

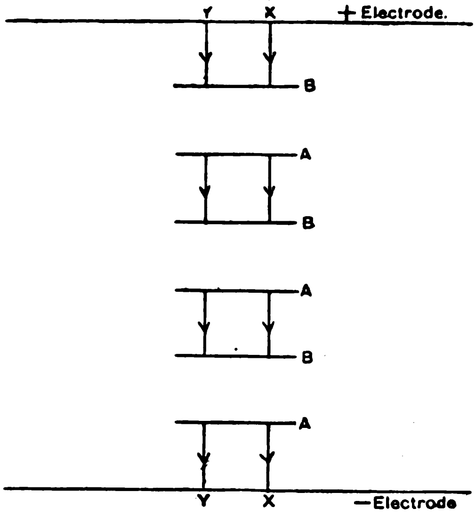

Fig. 4*e*.

fact, the chain of recombined molecules is warmer than it was, and we have the Joule C^2R effect.

For simplicity we have considered the tubes X X, Y Y as stretched through free space till they come to the chain of molecules which they are to rearrange. But it is easy to see how a tube may be handed on from chain to chain without any free existence. In Fig. 5 (*a*) a tube X X already threads a chain of A B molecules and in *b*, *c*, *d*, are shown the successive stages of its transfer to a neighbouring chain. The process is rendered more capable of representation by supposing each member of the second set of molecules lifted its own depth upwards. The derivation of each stage from the preceding is evident. This is doubtless the process which we must suppose to occur in all cases, and the tubes must be regarded as threading such chains in the dielectric, even before they enter the electrolytic cell.

Let us now consider what must happen at the electrodes. If the ions unite chemically with the electrodes, the positive and negative atoms find respectively negative and positive atoms ready to combine with them, and no difficulty is introduced at this point. But if the ions are set free, as are hydrogen and oxygen at platinum electrodes in dilute acid, we are brought face to face with the great, and, it is to be confessed,

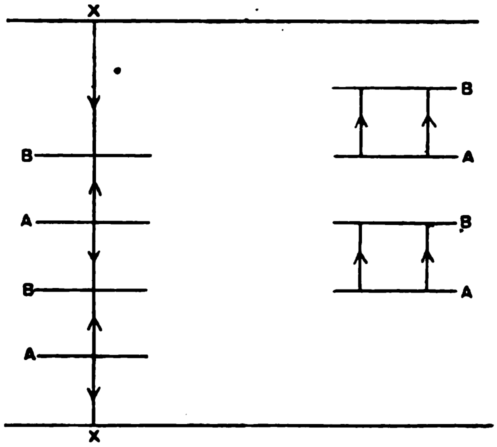

Fig. 5*a*.

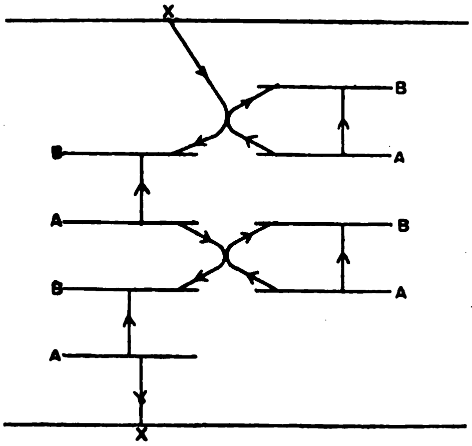

Fig. 5*b*.

the yet unsolved difficulty in the hypothesis. Take the case of the hydrogen atoms released at the cathode, the atoms such as the lowest A in Fig. 4 (*e*). We may think of them as connected at first by tubes of induction going from them to platinum atoms on the surface of the cathode. But soon the gas bubbles up, and there is no manifestation of the charge all of one kind which we have ascribed to the separate hydrogen atoms. We may attempt several explanations. The common notion appears to be that the hydrogen gives up its charge to the platinum, and then rises up quite deprived of electricity. This might occur by the breaking away of the tubes from the hydrogen atoms and the withdrawal of the positive ends into the platinum, the positive charge moving across the separating space, like a disembodied soul, from its hydrogen habitation into the platinum. The platinum having two neutralising souls, becomes as merely material as the deserted hydrogen. But this is strongly against

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our experimental knowledge of charge, which is always, so far as we know, on matter, whereas here charge crosses over a separating space. We might suppose this got over by thinking of the hydrogen and platinum atoms as coming absolutely in contact, shortening the connecting tubes to nothing, and putting them out of existence. If the tubes are not re-created when the hydrogen rebounds the gas rises up without electricity.

But, according to the current ideas of chemistry, the hydrogen issuing from the cell is not atomic, but molecular, and consists of paired atoms at least; that is to say, it is a chemical compound, differing from ordinary compounds it is true, in that the two members of each molecule are the same in kind, but the atoms are held together by chemical attraction, and satisfy each other's chemical affinity just as much as if they were different elements. If our hypothesis has any truth in it, this means that electric induction exists between the atoms and holds them together, a view supported, I think, by the phenomena of electric discharge

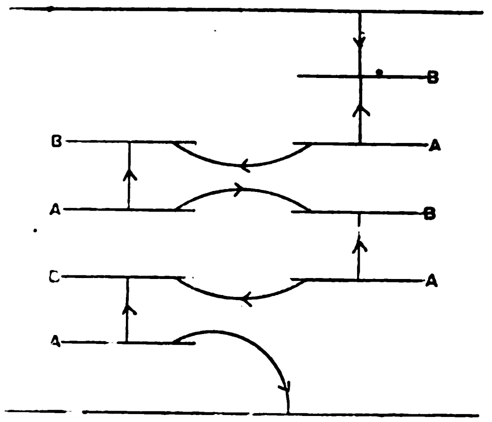

Fig. 5*c*.

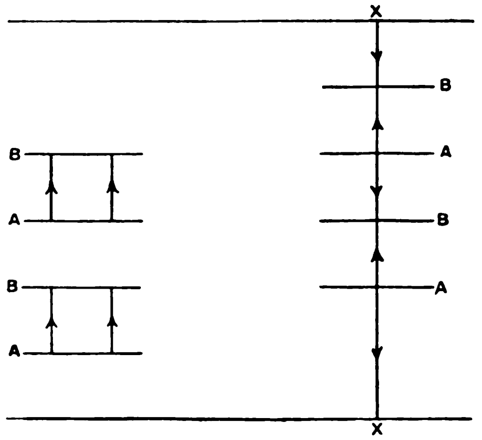

Fig. 5*d*.

in gases and the electrolysis which appears to take place in that discharge. To be consistent, then, we must suppose that the hydrogen, when it rises up, consists of pairs of + and − atoms, and for us the difficulty is to explain, not what has become of the hydrogen charge, but how half the atoms have succeeded in exactly reversing their charges, so that they are able to combine with the other half to form neutralising pairs. And, of course, we must extend our supposition of the constitution of an element as being made up of + and − atoms to the platinum also. When the lines of induction move into the platinum, the − atoms of the surface pairs are freed from their + partners, and are free to form pairs with the + hydrogen atoms. But when half the hydrogen reverses its charge half the platinum must do the same in order that it too may effect the neutral combination which we find when the electrolysis has ceased. Perhaps the best course is to say that if our main hypothesis of identity of chemical attraction and electric induction is real, then the reversal of charge, such as occurs on our supposition at the electrodes, is up to the present an unexplained, an ultimate fact. Without attempting explanation, but rather as a crude mode of picturing a process which would lead to the result, we might think of a + H and a − Pt as coming absolutely in contact, so that the tube ends can slide round on the surface of the atoms and across the bridge of contact until + is on the Pt and − on the H. Possibly Fig. 6 will make this clearer.

In (*b*) two atoms have come in contact, in (*c*) the tubes are beginning to slide round, in (*d*) the ends have changed places, and in (*e*) the atoms have drawn apart with reversed charges.

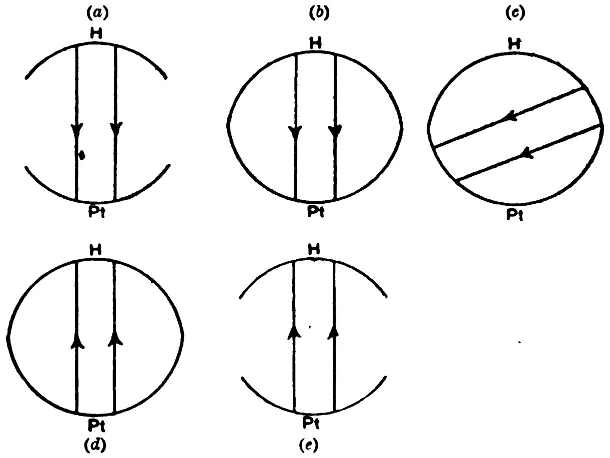

Fig. 6.

Having thus or otherwise reversed half the pairs, combination with the other half may ensue as in Fig. 7, the result being hydrogen molecules and platinum molecules each consisting of + and − pairs.

At first sight it seems as though the reversal occurring in the spark discharge of a Leyden jar or a Hertz vibrator would give us the key to the reversal pictured in Fig. 6. But further examination takes away this hope. The jar reversal is never complete and exact such as we have to suppose the atomic reversal. Indeed, the induction may have any value, + or −, less numerically than the initial value, as it gradually dies

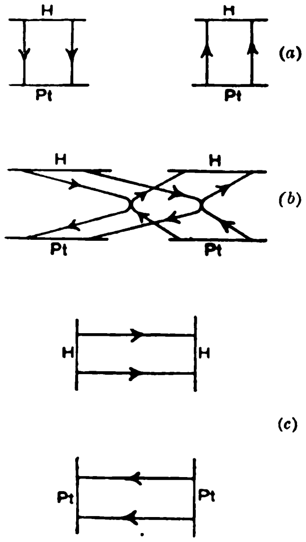

Fig. 7.

down to zero through the successive vibrations. We shall see later how some account may be given of the reversal in vibrators, an account which quite destroys any analogy with atomic reversal.

Perhaps a better analogy is afforded by two vortex rings A and B when they are playing at leap frog. The first widens out and lets the second go through it. Before the passage the liquid is streaming through A towards B. After the passage it is streaming from B towards A, so that if we think of induction as corresponding to direction of flow we have here a

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reversal. But I suspect that this liquid analogy is much more appropriate to a magnetic than to an electric hypothesis.

Were it not for the magnetic difficulties involved there would be some temptation to attempt a theory in which the sign of charge is merely a statement of the kind of atom concerned, and that the tubes, like gravitation tubes, have nothing but alignment and neither + nor − direction. But this would, I fear, be getting over one difficulty only by introducing much greater difficulties hereafter.

We shall assume, then, that in some way or other reversal can take place in certain cases, and we may apply it at once to explain the apparently neutral condition of the ions in the electrolytic cell. We suppose that half the ionic atoms in Fig. 4 reverse or change charges with the electrode atoms, as in Fig. 6, and that then they go through the process of Fig. 7 with the other half, and so form + and − pairs, exhibiting no external electrification.

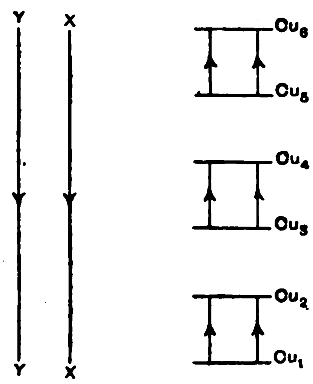

Fig. 8*a*.

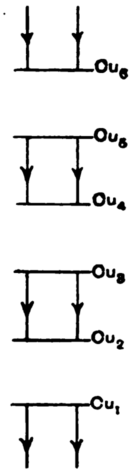

Fig. 8*b*.

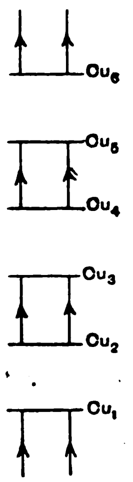

Fig. 8*c*.

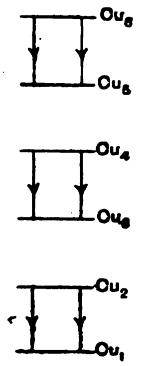

Fig. 8*d*.

A similar reversal will enable us to give an electrolytic account of metallic conduction. The great distinction between electrolytes and metals is that in the former there are opposite atomic processions, while in the latter there is apparently no motion in either direction. Electrolysis without procession means, as we have just seen with the electrodes, where the procession stops, reversal of charge. Suppose, then, that such reversal is possible with every metallic molecule. Imagine a copper wire carrying a current to be made up of molecules, as represented in Fig. 8 (*a*), and let tubes of induction X X, Y Y be just moving into the wire. Before the current is established the molecular axes are evenly distributed in all directions, but the tubes entering in select those most suitable, as shown in (*a*), turning the configuration to that shown in (*b*); if now reversal takes place we get (*c*). Let two more tubes come in, and we get (*d*), a reversal of which gives the same arrangement as (*a*) as far as the copper is concerned, but the four entering tubes of induction have entirely disappeared.

(*To be continued*)

AN IMPROVED PORTABLE PHOTOMETER.*

BY W. H. PREECE, C.B., F.R.S., AND A. P. TROTTER, B.A., A.M.I.C.E.

When light falls upon a surface, that surface is said to be illuminated. The illumination depends simply upon the light falling upon the surface, and has nothing to do with the reflecting power of the surface, just as rainfall is independent of the nature of the soil. As a rain gauge receives the full amount of rain when it is placed horizontally (disregarding wind), and receives less when it is tilted, so the surface is fully illuminated when it faces the source of light, and is less fully illuminated when the light falls upon it at an angle. The proportion between the full rainfall or illumination and the measured rainfall or illumination varies as the cosine of the angle of incidence of the rain or of the light. This angle is 0deg., and the cosine is 1, when the rain gauge is placed horizontally, or when the light falls perpendicularly on the surface. It would, perhaps, be unnecessary to call attention to these very elementary matters were it not that the difference between the photometry of illumination and the ordinary photometry of candle-power is often confused.

The lighting of streets and of buildings may be specified by the maximum and minimum illumination. The primary purpose of an illumination photometer is to measure the resulting illumination produced by any arrangement of lamps, irrespective of their number, their height, or of their candle-power. Illumination photometers containing sub-standards of light have been designed by Prof. Weber,† Prof. Mascart‡ and others. One of us described an illumination photometer before the Royal Society in 1883.§ This consisted of a box blackened within. Over the end was stretched a Bunsen screen of paper, on the middle of which was a grease spot. At a distance of 12in. was another screen of drawing paper. The grease spot was so screened that no light fell upon it except that which was reflected from the drawing-paper screen. At the end of the box opposite the Bunsen screen was an eyepiece consisting of a plain tube. Within the box a small glow lamp was fixed, and in order to make a measurement of the illumination of the drawing-paper screen, the current through the lamp was varied by a rheostat until the grease spot was invisible. The readings were recorded in *luces*, a *lux* being suggested by one of us at the Paris Electrical Congress, 1889,‖ as the name for the illumination due to a carcel lamp at one metre, and equivalent to a British standard candle at 1·058ft. The only defect of this photometer was the yellowish and reddish colour of the lamp when dimmed for low readings. In 1884 we designed a portable photometer¶ in which the lamp could be moved towards or withdrawn from the Bunsen screen, and a mechanism was provided by which, when a pointer moved a certain distance over a uniformly divided scale, the displacement of the lamp was as the square of that distance. The Bunsen spot was viewed by Rudorff mirrors in the usual way. This instrument worked well, but the range was small, and could not be easily increased. The lamp would have to be moved to a very considerable distance from the screen for measuring the feeble illuminations met with in street lighting. Eight years later one of us experimented with modifications of this instrument, and found that in ordinary street lighting the illumination is often only equal to that due to one candle at 14ft. distance. A large number of different methods of reducing the light were tried. Many combinations of lenses, the eclipsing device used in dissolving views, photographically shaded glass screens, and other devices were used, and finally a white reflecting screen was inclined at different angles to a small electric lamp, and on this principle a photometer was constructed in February, 1892. It was found that the Bunsen screen could be replaced with advantage by a simple white cardboard diaphragm pierced

* Paper read before Section G, British Association, Ipswich meeting.

† *Electrotechnische Zeitschrift*, 1884, p. 166. *La Lumière Electrique*, Vol. XII., p. 468.

‡ *Bulletin de la Société Internationale des Electriciens*, 1883, p. 103.

§ *Proc.* Roy. Soc., XXXV., p. 39 (1883), and *Proc.* Inst. C. E., Vol. CX., p. 98.

‖ *The Electrician*, Vol. XXIII., p. 478.

¶ *Proc.* Inst. C. E., Vol. CX., p. 101.

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with one or more holes.* The illumination of this diaphragm, generally in a horizontal position, was the illumination to be measured. Below this was the reflecting screen, enclosed in a box about 2ft. by 6in. by 5in. with a pair of small glow lamps and a secondary battery. The screen could be inclined towards the glow lamps by means of a chain wound up on a cam mounted on a spindle, the cam being formed so as to give an open scale. A hand or pointer on the spindle indicated readings on a dial. Many measurements and a number of photometrical surveys of different streets and public buildings in London were made in 1892, and were recorded by means of plans with isophotal contour lines and otherwise.†

During the present year an improved form of this photometer has been constructed. The chain and cam, which allowed the instrument to be used only in a horizontal position, have been

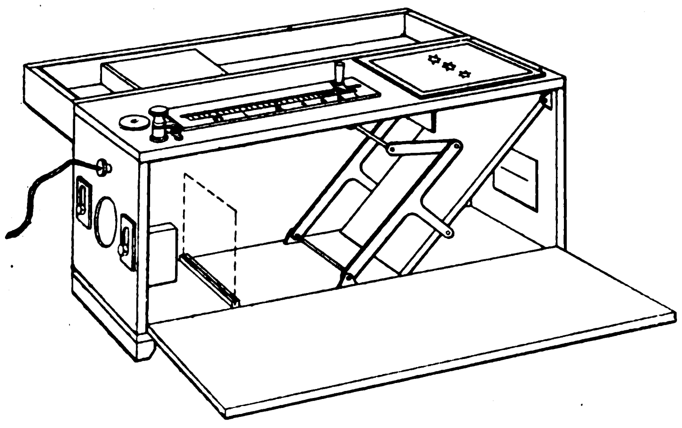

FIG. 1.

replaced by a system of levers. The object of these levers is to give an open scale. If the motion of the pointer were proportional to the angular movement of the screen, the scale would be approximately a scale of cosines. The instrument is shown in Fig. 1 with the lid open and the front let down. It measures 1ft. $3\frac{3}{4}$in. by $5\frac{1}{2}$in. by $9\frac{1}{2}$in. high (400mm. by 140mm. by 242mm.). On the end to the left there is a red glass window, and immediately within are two 12-volt lamps (one of which is shown in Fig. 2), one of about 1 c.p., and the other of 2 c.p. It can be seen through the window if either or both of the lamps are alight. The lamps are held in special lampholders, capable of adjustment as to height by clamping screws. These clamping screws and the base of one of the lampholders are shown in Fig. 1. A switch on the top of the

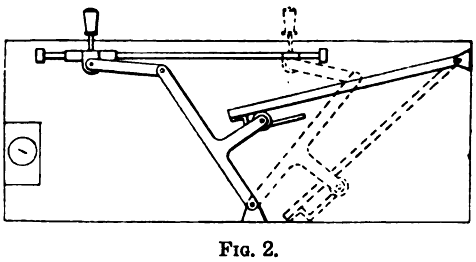

FIG. 2.

instrument enables either or both lamps to be turned on and off. At the other end of the box the reflecting screen is hung. The middle of the screen is about 11in. (28cm.) from the lamps. It is shown in Fig. 1 in the lowest position. In Fig. 2 the screen and one of the levers, together with one of the rollers on which the screen rests, and the handle by which it is moved, are shown with the screen in its highest position by full lines, and in its lowest position by dotted lines. In its highest position the filaments of the lamps are a little below the plane of the screen, no direct light from the lamps then reaches the screen, and it is only faintly illuminated to about $\frac{1}{200}$th of one candle at a foot, by stray light, which is excluded as much as possible. The diaphragm is placed horizontally immediately above the hinged screen. Three small star-shaped holes are cut in it, and through them the illuminated reflecting screen can be seen. A handle carrying a pointer moving over a graduated scale controls the inclination of the screen by means of the levers and links. A guide, attached to the back of the screen (shown in Fig. 2), allows the instrument to be turned on its side without interfering with the working. In order to take a measurement, one or both of the lamps are turned on, and the handle is moved until the screen seen through the holes in the diaphragm matches the diaphragm in brightness. If the colour of the light outside is about the same as that of the lamps, the middle hole may be made to disappear. The observer should stand approximately in the vertical plane passing through the three holes, so that he may see that part of the screen through them which lies immediately beneath them.

Various substances have been tried for the diaphragm and screen. Thin metal painted with a whitewash made of magnesia and isinglass is perhaps the best; the diffused reflection practically follows Lambert's cosine law, but the material is easily soiled and cannot be cleaned. Bristol board from which the glaze has been removed by a damp cloth closely follows the cosine law within the angular range required in this case. It is important that there should be no glaze on the surface of the hinged screen, since the inclination of the lamp to the screen and of the screen to the eye for maximum illumination is about 45deg. But as the scale is graduated by experiment, a slight departure from the cosine law does not matter. On the other hand, it is of greater importance that the screen should be very smooth and flat. Under very feeble illuminations, the light from the small lamp making an angle of incidence very nearly 90deg., minute irregularities are easily seen, and make accurate readings difficult. For ordinary street lighting and for general industrial photometry a slight departure from the cosine law on the part of the diaphragm is of no practical consequence, so long as there is no perceptible glaze, for it is always observed nearly vertically and never at a large angle of incidence.

The colour difficulty is reduced, in the first instance, by the freedom of motion of the levers. The handle may be quickly moved to and fro on each side of the true reading, and the middle position may be estimated. In measuring the illumination due to arc lamps, the colour difficulty becomes troublesome. The colour of the glow lamp in the photometer should be approximately a mean between the colour of the standard of light wherewith the instrument is calibrated, and that of an arc lamp. This halves the difficulty, which can never be entirely removed, since differently-coloured lights are not physically comparable; it may, however, be relegated entirely to the laboratory by the use of a coloured screen and diaphragm.

If the hinged screen be tinted pale blue, some of the yellow rays of the lamp in the photometer are absorbed, and the reflected rays approximate to grey—that is, to feebly illuminated white. On the other hand, if the diaphragm is tinted yellow, the white light from electric arcs, or of daylight, may be reduced to approximately the same colour as that of the lamp in the photometer. In the first case the brilliance of the hinged screen is reduced, and a brighter lamp would have to be used to restore the true value of the scale readings; and in the second case the brilliance of the diaphragm would be reduced, and the scale readings would be too high. But by tinting both screens the calibration of the instrument need not be disturbed.

The screen being coloured pale blue and the diaphragm pale yellow, there is no difficulty in obtaining disappearance of the hole in the diaphragm when illuminated by arc light or even by daylight. The selection of the colours suitable for obtaining a true measurement is based upon the mean of a number of measurements. White screens are used, and the comparison should be made in a building illuminated by a number of arc lamps. A number of measurements are made with quick oscillations of the handle, and the mean is taken. Several screens and diaphragms of different tints being in readiness, pairs are tried and a selection is made of a pair which give a good

* *Proc.* Phys. Soc., XII., p. 355 (1893). *The Electrician*, Vol. XXXI., p. 173.

† *Proc.* Inst. C. E., Vol. CX., pp. 42-51.

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colour match,* and, if possible, the mean reading given by the white screens. A slight departure from the mean could be corrected by the use of a coefficient. It is not suggested that strongly coloured lights can be scientifically compared in this manner, but only that the yellowish light of a glow lamp may be compared with the whitish light of an arc or of subdued daylight. We employed this device in 1884, and Messrs. G. W. and M. R. Patterson, the translators of Palaz's "Industrial Photometry," who have used it in connection with a Lummer-Brodhun photometer, remark† that it "can, of course, give no additional absolute accuracy to the photometric measurements; it, however, adds greatly to the comparative accuracy of the results, as it makes it possible to measure relative intensities under various conditions with great precision." But it should be observed that the selection of the tints may be made at leisure, and under favourable laboratory conditions, and by thus avoiding all colour trouble during ordinary use of the photometer, a very considerable gain in precision is secured.

The scale is 5½in. (137mm.) long, and is shown in Fig. 3. With the smaller of the two lamps the highest reading is equivalent to one candle at a foot; with the larger lamp it is twice this illumination. The oscillations of the handle generally extend at first over two scale divisions, and after three or four oscillations their amplitude may be reduced to about one scale division. The half of a scale division may be estimated, except at the highest part of the scale, which is slightly contracted. The precision is about 2 to 3 per cent. The contraction of the scale at the upper end is intentional, and is caused by the arrangement of the levers.

In case of renewal of the lamps it is very important that other lamps should be placed in exactly the same optical position in the photometer, otherwise the scale would have to be recalibrated. In order to fix the height of the lamps, which is the only adjustment necessary, a sheet metal screen, shown by dotted lines in Fig. 1, is placed in a holder attached to the floor of the photometer. Two small holes are drilled in this screen, and a white paper screen, having a black horizontal line, is fastened to the end of the box (*see* Fig. 1) opposite to

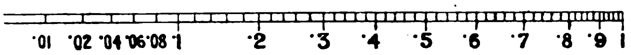

Fig. 3.

the lamps. The hinged screen being lifted by the levers out of the way, "pin-hole images" of the filaments are thus thrown on to this screen, and the lamps being set so that the single horse-shoe filament appears nearly closed up (*see* Fig. 2), the dark line between its two limbs is made to fall on the black horizontal line. The images being magnified, considerable accuracy is possible.

Although the principal object of this photometer, as of those which preceded it, is the measurement of illumination, it is sometimes desirable to measure the candle-power of a lamp in a street without removing it from its position. By the use of a graduated arc such measurements can be made with the present photometer. A quadrant is fastened to the side of the photometer, and a pin at the centre from which the quadrant is struck acts as a gnomon. A spirit level on the top of the instrument being adjusted, the angle of incidence may be read in degrees on the quadrant, and at the same time the cosine of this angle may be read on an adjacent scale. It is necessary to find the slant height or direct distance from the source of light to the photometer.

To measure the vertical height of the light, set the photometer so that the shadow falls on 45deg. Measure the distance from the pin to the lamp horizontally, and from the pin to the ground vertically. The sum of these distances is the height of the actual source of light. This can be measured to about 2 per cent., say 3in. in 12ft. 6in.

To find the slant height at any distance, the height of the light being known: divide the height of the lamp above the photometer by the cosine of the angle of incidence; the quotient is the slant height required. Or the horizontal distance may be measured and the square of this distance added to the square of the height of the light. This gives the square of the slant height.

To find the candle-power, the illumination in units of a candle at a foot being observed, the light from other lamps being carefully screened, the slant height being known: multiply the illumination by the square of the slant height, and divide by the cosine of the angle of incidence.

On hilly ground it is necessary to know the height of the lamp above the photometer at each point of measurement. It is best, in that case, merely to record the angles, and afterwards to find the tangents. The horizontal distance between the photometer and the lamp-post, divided by the tangent, gives the required height. It may be observed that when the square of the slant height in feet is equal to the cosine of the angle of incidence, the scale graduated in units of a candle at a foot becomes a scale of candle-power, and when the square of the distance in feet is 10, or 100, or 1,000 times the cosine, the multipliers 10, 100, or 1,000 may be used to convert it into a scale of candle-power. The square of the slant height being known, the photometer may be tilted until the required cosine is indicated by the shadow of the pin. If the slant height is measured by the sum of the squares of the horizontal distance and the height, the square is at once obtained.

We have calibrated our photometers either by standard candles, or by sub-standard glow lamps supplied from secondary batteries, or by the amyl-acetate standard lamp or Hefner unit. This standard, which is well recognised in physical work, is 0·877 of a standard candle, or a standard

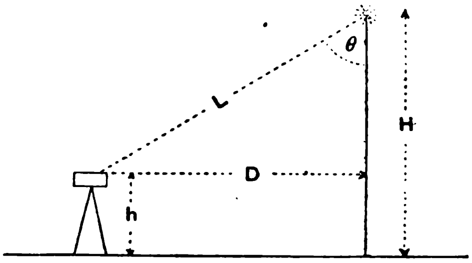

Fig. 4.

candle is 14 per cent. more than an amyl-acetate lamp. Placed at 1ft. distance from, and perpendicular to, the diaphragm, the photometer being placed on its side, the illumination is 0·877 of a candle at a foot. If it is brought to a distance of 11¼in. ($\sqrt{0{\cdot}877}$ft.), it is equivalent to 1 candle at a foot. But this distance and position is inconvenient. If it is placed at a distance of 1ft., and at an angle of 55° 10′, the illumination on the diaphragm is one-half of a candle at a foot, since cosine 55° 10′ = 0·57, and 0·57 × 0·877 = 0·5. A mark is therefore made at this angle on the quadrant, and is inscribed, H.U. = ½ c.p.

Considerable experience with the use of small glow lamps supplied from portable secondary batteries has given us great confidence in this kind of secondary standard of candle-power. The battery is always freshly charged before each evening's work, and is discharged for half an hour before use. The lamps are only turned on while an observation is being taken.

The 1893 photometer was arranged to be held in the hand; our 1884 photometer stood on a tripod about 2ft. 6in. from the ground. The street measurements made in 1892 were all made with a photometer placed on the ground, the diaphragm being about 6in. from the pavement. The proper height for an illumination photometer is a matter of opinion. When the photometer is placed on the ground, the large number of measurements required for a thorough photometric survey of a street or empty building can be quickly made. For some purposes—for example, in an exhibition or a church—a stand is necessary; the calculations of candle-power then become rather more tedious.

The various observed and computed quantities may be expressed as follows:—D = horizontal distance from photometer to lamp-post (*see* Fig. 4); L = slant height from photometer to

* Owing to the Purkinje effect, an exact colour match cannot be maintained throughout the whole range. The holes in the diaphragm look yellowish under strong illumination and bluish under feeble illumination.

† "A Treatise on Photometry." Palaz. American translation. Appendix, p. 312.

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light; H = height of light above the ground; h = height of the photometer diaphragm from the ground; θ = angle of incidence; c/f^2 = illumination of units of a candle at a foot; c.p. = candle-power, then

$$H - h = D/\tan\theta;$$
$$L = [H - h]/\cos\theta = \sqrt{D^2 + [H - h]^2};$$
$$c.p. = (c/f^2 \times L^2)/\cos\theta.$$

The following is an example of the measurement of the illumination and candle-power in the case of a street lamp:—

D	θ	c/f^2	$\tan\theta$	$\cos\theta$	$H-h$	H	L	L^2	$c/f^2 \times \cos\theta$	c.p.
20	66°	0·025	2·25	0·407	8·9	11·9	21·8	475	0·0614	29

A PORTABLE MAGNETIC-FIELD TESTER.*

BY PROF. W. E. AYRTON, F.R.S., AND T. MATHER.

In June, 1892, the authors described a portable ballistic galvanometer of the moving-coil type before the Physical Society of London,† but owing to delay in the manufacture the instrument was not ready in time to be shown at the meeting. Since that time many experiments have been carried out with the instrument then described, and the galvanometer has been used to map out the stray fields of various dynamos, and to explore the magnetic fields in the neighbourhood of switchboards of electric light stations.

This first instrument possessed several structural defects, but the most serious faults experienced were, first, inconstancy of zero, and, second, a considerable want of proportionality between quantity and swing—or strength of field and swing of the needle—a proportionality which theoretically should hold for all angles of whatever magnitude. Eventually both these

FIG. 1.

difficulties were traced to magnetism in the suspended coil, a property which, although every care may be taken to prevent contamination of the material with iron, is very difficult to eliminate. After much experimenting, with a view to avoiding traces of magnetism in the suspended parts of swing-coil galvanometers, a satisfactory method was devised early in 1894, and a description of a reflecting galvanometer fitted with an improved coil appeared in the technical papers in the autumn of that year.‡ Meanwhile an improved form of the portable ballistic galvanometer had been prepared, in which the details of construction were considerably modified, so as to make the working parts more accessible, and an improved shape of coil was employed. For ballistic galvanometers the best shape of the cross-section of the moving coil is not the same as that for a current galvanometer, for whilst a current instrument should have a coil whose section approximates to two circles touching one another, a ballistic instrument is improved by using a sector-shaped coil of narrow angle, as shown in Fig. 1.

The instrument as now made is shown in Fig. 2, whilst Fig. 3 gives a sectional plan. A circular base provided with levelling screws carries a C-shaped magnet M (Fig. 3), between the poles of which the coil C is suspended. The discharges are led into and out of the coil by the suspensions, one being a straight phosphor-bronze strip, and the other a spiral surrounding the straight strip. Both suspensions are attached to an ebonite head near the top of the central tubes, this head serving the purpose of zero adjustment, and the arrangement is such that the whole of the suspended parts can be readily withdrawn.

The arm carrying the suspension head overhangs the scale, so as to permit of the pointer making one or more complete revolutions, and in this way an instrument having a very long range is obtained. For example, the body of the instrument shown in Fig. 2 has a diameter of 4in., and the length of the scale, reckoning only one revolution of the pointer, is about 11in. As it is quite possible to use $1\frac{1}{2}$ or 2 revolutions without straining the suspensions unduly, we have here an instrument with a scale as long as that of an ordinary reflecting galvanometer (18in.) in a very compact form.

To increase the range of the instrument still further, and to make the instrument suitable for measuring the stray magnetic

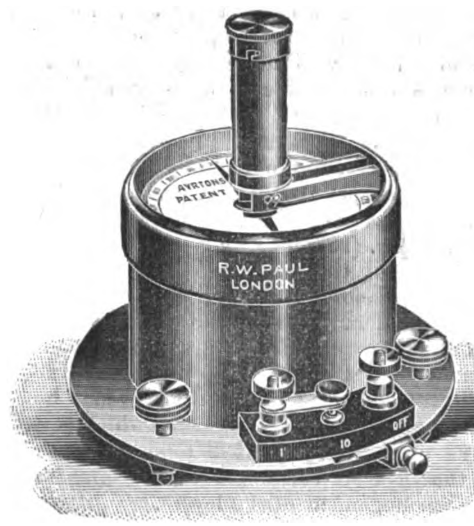

FIG. 2.

field in close proximity to dynamos, pole-pieces, &c., a switch, S (Fig. 3), is arranged to put a resistance coil R in series with the suspended coil, thus multiplying its range by 10. The same switch, when moved to the position OFF (Fig. 2) breaks the circuit of the instrument and lifts a spring, L (Fig. 3), which clamps the coil. A short-circuit key, K, on the front of the galvanometer is used to bring the pointer to rest, for when this is pressed the motion of the coil becomes aperiodic.

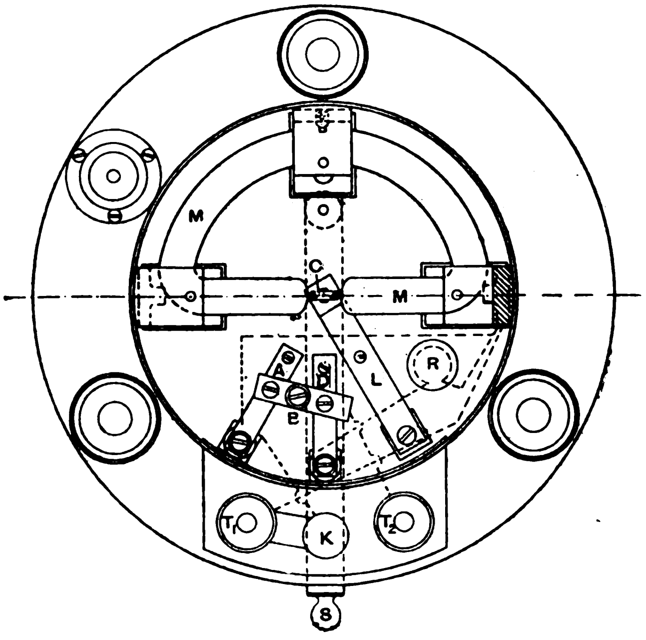

FIG. 3.—Sectional Plan.

The scale of the instrument is divided into 200 parts, and as a field tester the sensibility is such that with an appropriate test coil the scale reads off directly the strength of field in C.G.S. units.

For some purposes it is convenient to have the scale graduated in microcoulombs, in which case, besides reading the quantity directly, the swing of the instrument multiplied by the total resistance of the galvanometer circuit measures the

* Paper read before the British Association at Ipswich. Section A.
† See *The Electrician*, June 17, 1892, Vol. XXIX., p. 174.
‡ See *The Electrician*, October 5, 1894, Vol. XXXIII., p. 661.

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total change of induction through that circuit. Such a scale is useful in testing iron for permeability, &c., for by suitably arranging the resistance of the circuit the scale reading can be made to read off B, the induction density, directly.

Theory of Portable Field Tester.

Let H = strength of magnetic field in C.G.S. units;
n = number of turns in coil;
r = mean radius in centimetres of coils projected on medial plane;
l = mean length of each coil, supposed rectangular;
I = moment of inertia of moving parts;
ω = angular velocity imparted to coil by discharge;
α = torque exerted by suspension when twisted through unit angle;
N = total change of flux through circuit;
R = resistance of the circuit.

Then, assuming that the plane of the coil is parallel to the field of magnet when the discharge passes, we have—

Moment exerted by the coil at any instant

$$= r\,l\,n\,\mathrm{H}\frac{d\mathrm{N}}{dt}\,\frac{1}{\mathrm{R}} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$= y\frac{d\mathrm{N}}{dt}\ \text{(say)} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

therefore angular impulse $= \int y\frac{d\mathrm{N}}{dt}\,dt \quad . \quad . \quad . \quad . \quad . \quad (3)$

$$= y\,\mathrm{N} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

This must be equal to the angular momentum imparted to the coil, hence

$$\mathrm{I}\,\omega = y\,\mathrm{N} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Now, the energy stored in the coil at the completion of the discharge is

$$\frac{\mathrm{I}\,\omega^2}{2},\ \text{and is therefore} = \frac{\mathrm{I}}{2}\left(\frac{y\,\mathrm{N}}{\mathrm{I}}\right)^2 \ \text{from (5)}$$

$$= \frac{y^2\,\mathrm{N}^2}{2\,\mathrm{I}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Now, all this energy is expended in twisting the suspensions through an angle, ϕ, where ϕ is the swing of the pointer. But the work done in the process is

$$\int_0^{\phi} \alpha\,\theta\,d\theta$$

$$= \frac{\alpha\,\phi^2}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Equating (6) and (7) we have

$$\frac{\alpha\,\phi^2}{2} = \frac{y^2\,\mathrm{N}^2}{2\,\mathrm{I}},$$

from which

$$\phi = \pm\frac{y}{\sqrt{\alpha\,\mathrm{I}}}\,.\,\mathrm{N};$$

i.e., ϕ is proportional to N.

Table *showing Calculated Swings produced by discharging a Constant Quantity of Electricity through a single turn of Wire bent to four coils of Various Shapes.*

Assuming: 1st, constant magnetic field; 2nd, constant control; 3rd, constant length of wire in coil; 4th, constant diameter of wire in coil; 5th, no added mass.

Shape.	Proportions.	Swing.	Relative moment of inertia.
Rectangular.........	length = breadth × ∞	100·0	0·0
„	l = 10 b	91·0	2·32
„	l = 2 b	75·6	23·1
Square	l = b	61·0	50·0
Circular	—	71·0	60·7
Rectangular.........	2 l = b	45·0	68·1
„	10 l = b	11·5	97·6
„	∞ l = b	0·0	100·0

Herewith we give a table showing the relative swings produced by discharging a given quantity of electricity through a given length of wire wound into coils of various shapes. From this it will be seen that the long narrow coil has considerable advantage over common shapes as regards sensibility. At the same time it permits of much greater range than the forms which necessitate the use of a central core in order to obtain the requisite strength of field to give good shielding from external disturbing fields. The use of a narrow coil also enables swings to be taken in either direction without reducing the range, whereas instruments with cores necessarily have their maximum range of 180deg. reduced to something less than 90deg. if arranged to read either right or left of zero.

PROF. L. F. VERNON-HARCOURT'S PRESIDENTIAL ADDRESS TO SECTION G.

[ABSTRACT.]

THE RELATION OF ENGINEERING TO SCIENCE.

It has appeared to me that the exceptional occasion of addressing a gathering of scientific persons, and of engineers who testify their interest in science by attending these meetings, would be best utilised by considering the relation that engineering in general, and maritime and hydraulic engineering in particular, bear to pure science, and the means by which progress in engineering science might be best promoted, and its scope and utility increased.

In addition to the oft-quoted definition of civil engineering as "the art of directing the great sources of power in Nature for the use and convenience of man," Thomas Tredgold also defined it, in 1828, as "that practical application of the most important principles of natural philosophy which has, in a considerable degree, realised the anticipations of Bacon and changed the aspect and state of affairs in the whole world." If the influence of engineering could be thus described in 1828, when railways and steamships were in their infancy, and the electric telegraph and the various modern applications of electricity and magnetism had not come into existence, how far more true is it at the present day, when the various branches of engineering have attained such a marvellous development! Moreover, Tredgold foresaw the great capabilities of development possessed by engineering, and its dependence on science; for he stated that "the real extent to which civil engineering may be applied, is limited only by the progress of science; its scope and utility will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical art, since its bounds are unlimited, and equally so must be the researches of its professors." If the full significance of these statements may be accepted as correct, engineers might fairly claim to have a right to say, "As engineers we are necessarily men of science, and no branch of science is outside our province." It might, however, be said that no engineer, with his absorbing professional avocations, would have the time to acquire even the rudiments of the principal branches of science, with their ever-increasing developments, to the study of each of which the life-work of many earnest searchers into the secrets of Nature is wholly devoted. Among the branches of science necessary for the engineer, two may be regarded as of the highest importance, namely, mathematics and physics, upon which the science of engineering mainly depends; and without an adequate knowledge of these no person should be able at the present day to enter the profession of a civil engineer. Other sciences of considerable, though of comparatively minor importance to engineers in general, are chemistry, geology, and meteorology; but each of these assumes an enhanced value in special branches of engineering.

Mathematics in Relation to Engineering.—The pre-eminent importance of mathematics in relation to engineering may be accepted as fully established; and a President of the Institution of Civil Engineers would not now tell a pupil, at their first interview, that he had done very well without mathematics, a remark made to me by a justly celebrated engineer over 30 years ago. All branches of applied mathematics have been utilised by engineers, or, as in the case of several general principles and tidal calculations, by mathematicians to their benefit; but graphic statics will probably gradually supersede analytical methods for the calculation of stresses, as more rapid in operation and less subject to errors, which are also more easily detected in graphic diagrams. Pure mathematics, in its higher branches, appears to have a less direct connection with engineering; but applied mathematics is so largely dependent upon pure mathematics that the latter, including the calculus and differential equations, cannot be safely neglected by the engineer, though certain branches, as, for instance, probabilities, the theory of numbers, the tracing of curves, and some of the more abstruse portions of the subject, may be dispensed with.

Physics in Relation to Engineering.—Physics has been placed after mathematics, as many physical problems are determined by mathematics; but in several respects physics, with its very wide scope in its relation to the various properties of matter, is of equal importance to engineers, for there are few problems in engineering

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in which no part is borne by physical considerations. Electrical engineering is very intimately connected with physics, for it really is the application of electricity to industrial purposes. The very close relation between electricity and magnetism, discovered by Oersted in 1820, and further established by the remarkable researches of Faraday, has led to the present system of generating electricity by the relative movement of coiled conductors and electro-magnets, in dynamo-electric machines worked by a steam engine or other motive power. The electrical current thus generated can be transmitted to a distance with little loss of energy, and it can either be used directly for lighting by arc or incandescent lamps, or be reconverted into mechanical power by the intervention of another dynamo. Electricity is also employed for the simultaneous firing of a series of mines at a safe distance from the site of the explosion.

The manufacture of iron, steel, and other metals, and the formation of alloys, are essentially chemical operations; and the Bessemer and Gilchrist processes, by which steel is produced in large quantities directly from cast iron, by eliminating a portion of the carbon contained in it, and also the injurious impurities, silicon and phosphorous, in place of the former costly and circuitous method of removing the carbon from cast-iron to form wrought-iron, and then combining a smaller proportion of carbon with the wrought-iron to form steel, are based on definite chemical changes, and necessitated chemical knowledge for their development.

Cements and mortars depend for their strength and tenacity, when mixed with water, upon their chemical composition and the chemical changes which occur. The value of Portland cement requires to be tested quite as much by a chemical analysis of its component parts, as by the direct tensile strength of its briquettes; for an apparently strong cement may contain the elements of its own disruption, in a moderate proportion of magnesia or in an excess of lime. The chemical change which has been found to occur in the Portland cement of very porous concrete exposed to the percolation of sea water under considerable pressure, by the substitution of the magnesia in sea water for the lime in the cement, if proved to take place even slowly under ordinary circumstances, would render the duration of the numerous sea works constructed with Portland cement very precarious, and necessitate the abandonment of this very convenient material by the maritime engineer.

Benefits conferred by Engineering upon Pure Science.—Engineering is generally concerned in the application of the researches of science for the benefit of mankind, and not in the extension of the domain of pure science, which necessitates greater concentration of attention and study than the engineer in practice in able to devote to it. Engineers, however, though never able to repay the ever-increasing debt of gratitude which they owe to past and present investigators of science, except in rendering these abstract researches of practical utility, have, nevertheless, been able incidentally to promote the progress of science. Thus mechanical science, by the construction of calculating machines, the planimeter, integrating machines, the tide predictor and tidal harmonic analyser of Lord Kelvin, the self-registering tide-gauge, and various other instruments, has lightened the labours of mathematicians; whilst excavations for works and borings have assisted the investigations of geologists. The mechanical genius of Lord Rosse led mainly to the success of his gigantic telescope, which has revealed so many secrets of the heavens; and the rapidity of locomotion, due to the labours of engineers, has greatly facilitated astronomical observations and physical discoveries, besides promoting the concourse of scientific men and the diffusion of knowledge. Electrical engineering, moreover, is so closely allied to electrical physics that the development of the one necessarily promotes the progress of the other. The observations, also conducted by hydraulic and maritime engineers in the course of their practice, aid in extending the statistics upon which the science of meteorology is based.

Engineering as an Experimental Science.—Engineering, so far as it is based on mathematics, is an exact science, and the strains due to given loads on a structure can be accurately determined; but the strength of the materials employed has to be ascertained before any structure can be properly designed. Accordingly, the resistance of materials to tension, compression, and flexure, has to be tested, and their limit of elasticity and breaking weight determined. Thus, previously to the construction, by Robert Stephenson, of the Britannia Tubular Bridge, the first wrought-iron girder bridge of large span erected, numerous experiments on various forms of wrought iron were carried out by that eminent mathematician and mechanician Eaton Hodgkinson, who had previously indicated the proper theoretical form for cast-iron girders, and to whom the success of the bridge across the Menai Straits was in great measure due. Besides the numerous tests always now made of the materials employed during the progress of any large engineering work, railway bridges are also subjected to severe test loads before being opened for public traffic, by which the safety of the structures and their rigidity, as measured by the amount of deflection, are ascertained, serving as a guide for subsequent designs. Numberless experiments have been made on the flow of water in open channels, over weirs, through orifices, and along pipes; and the influences of the nature of the bed, the slope, depth, and size of channel, have been investigated by various hydraulicians. Mr. Thomas Stevenson measured the force of waves at some places on the Scotch coast; Professor Osborne Reynolds has examined the laws of tidal flow in a model of the inner estuary of the Mersey, and in specially shaped experimental models; and I have found it possible in small working models of the Mersey and Seine, not merely to reproduce the configuration of the bed of the estuary out at sea, but also to observe the effects of different forms of training works in modifying sandy estuaries. Mr. William Froude, after his retirement from active practice, devoted his abilities to experiments on the motion and resistance of ships in water, which have proved of inestimable value to the naval architect, and which formed the subject of his Presidential Address to this Section in 1875. Electrical engineering is specially adapted for experimental investigation, and in this branch theory and practice are so closely allied that some of the most eminent exponents of the theory of the subject, such as Lord Kelvin and Dr. Hopkinson, have developed their theories into practical results. In most other branches the investigator is generally distinct from the engineer in large practice; but it may be safely said that an able investigator and generaliser in engineering science, as, for instance, the late Prof. Rankine, accomplishes work of more value to the profession at large than the practical engineer, who, in the world's estimation, appears the more successful man.

Every branch of engineering science is more or less capable of being advanced by experimental investigations; and when it is borne in mind that the force of waves, the ebb and flow of tides in rivers, the influences of training works in estuaries, and the motion of ships at sea have been subjected to experimental research, it appears impossible to assign a limit to the range of experiments as a means of extending engineering knowledge. Problems of considerable interest, which can only be solved by experiments or by comprehensive generalisations from a number of examples, must frequently present themselves to engineers in the course of their practice, as they have to myself; and engineers would render a great service to the profession if they would follow up the lines of investigation thus suggested to them, in the true spirit of scientific inquiry.

Scientific Training of Engineers.—In most professions, preliminary training in those branches of knowledge calculated to fit a student for the exercise of his profession is considered indispensably necessary; and examinations to test the proficiency of candidates have to be passed as a necessary qualification for admission into the Army, Navy, Church, Civil Service, and both branches of the law. Special care is taken in securing an adequate preliminary training in the case of persons to whom the health of individuals is to be entrusted, not merely by experience in hospitals, but also by examinations in those branches of science and practice relating to medicine and surgery, before the medical student can become a qualified practitioner. If so much caution is exercised in protecting individuals from being attended by doctors possessing insufficient knowledge of the rudiments of their profession, how much more necessary should it be to ensure that engineers are similarly qualified, to whom the safety and well-being of the community, as well as large responsibilities in regard to expenditure, are liable to be entrusted! The duty of the engineer is to apply the resources of nature and science to the material benefit and progress of mankind; and it, therefore, seems irrational that no guarantee should be provided that persons, before becoming engineers, should acquire some knowledge of natural laws, and of the principles of those sciences which form the basis of engineering. The Institution of Civil Engineers has, indeed, of recent years required some evidence of young men having received a good education before their admission into the student class; but some of the examinations accepted as sufficient for studentship, such as a degree in any British university, afford no certainty in themselves that the persons who have passed them possess any of the qualifications requisite for an engineer; and it is quite unnecessary to become a student of the Institution in order to become an engineer. The Council of the Institution has no doubt been hitherto deterred from proposing the establishment of an examination in mathematics and natural science, as a necessary preliminary to becoming an engineer, by the remembrance that some of the most distinguished engineers of early days in this country were self-taught men; but since those days engineering and the sciences upon which it is based have made marvellous advances; and in view of these developments, and the excellent theoretical training given to foreign engineers, it is essential that British engineers, if they desire to retain their present position in the world, should arrange that the recruits to their profession may be amply qualified at their entrance in theoretical knowledge, in order to preserve the standard attained, and to be in a position to achieve further progress. No amount of preliminary training will, indeed, necessarily secure the success of an engineer, any more than the greatest proficiency would be certain to lead the medical student to renown as a physician or surgeon; but other conditions being equal, it will greatly promote his prospects of

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advancement in his profession, and his utility to his colleagues and the public. The engineers of the past achieved great results in the then early dawn of engineering knowledge by sound common sense, a ready grasp of first principles and of the essential points of a question, capacity for acquiring knowledge, power of managing men and impressing them with confidence, and shrewdness in selecting competent assistants. These same qualities are still needed for success in the present day, coupled with an opportunity of exhibiting them; but far more knowledge of mathematics and other sciences is required now, owing to the enormous advances effected, if the progress of engineering science is to be maintained. Even though in some branches engineers in large practice may not have the time, or retain the requisite facility, for solving intricate mathematical problems, they should be able readily to comprehend the full bearing of the principles presented, and to understand the nature of the solutions put before them, which nothing but the scientific faculty implanted by early training in mathematics and physics can adequately secure. A qualifying examination for engineers would usefully stop persons at the outset from entering the profession who failed to evince the possession of the requisite preliminary knowledge; it would indicate, by the subjects selected, the kind of training best calculated to fit a person to become a useful engineer; and it would protect the public, as far as practicable, from the injuries or waste of money that might result from the mistakes of ill-qualified engineers.

Specialising in Engineering.—Some branches of engineering have for a long time been kept distinct from others, such as the construction of steam engines, locomotives, and marine engines, shipbuilding, heavy ordnance, hydraulic machinery, and other purely mechanical works, one or more of which have been treated as specialities by certain firms, and also gas lighting, and, more recently, electric lighting. In the department, however, of civil engineering in its narrower signification, as distinguished from mechanical engineering, engineers of former times were regarded as equally qualified to undertake any of the branches of public works; and the same engineer might be entrusted with the execution of roads, railways, canals, harbours, docks, sewerage works and waterworks; while even steamships were not excluded from the category in Brunel's practice. The engineer of to-day, indeed, would be lacking that important factor for success, common sense, if he declined to execute any class of work which he might be asked to undertake; and a variety of work is very useful to the engineer in enlarging his views and experience, as well as in extending the range of his practice. The tendency, however, now in engineering, as in medicine, is for the engineer's practice to be confined to the special branch in which he has had most experience, a result which cannot fail to be beneficial to the public, and calculated to promote the progress of each branch. The powers of the human mind are too limited, and life is too short, for engineers to be able to acquire, in the present day, equal proficiency in the theory and practice of the several branches of engineering science, with their ever-widening scope and development; and, as in the domain of abstract science, general progress will be best achieved in engineering science by the concentration of the energies of engineers in the advancement of their special line of practice.

Value of Congresses on Special Branches of Engineering.—The scope of engineering science is extending so fast that it is impossible for the Institution of Civil Engineers, which, as the parent society, embraces every branch within its range of subjects, to give more than a very limited time for the consideration and discussion and of Papers relating to the non-mechanical branches of the profession comprised in public works. Mechanical, electrical, and gas engineers have special societies of their own for advancing their knowledge and publishing their views and experience, while sharing equally with the other branches in the benefits of the older Institution. Congresses accordingly afford a valuable opportunity for railway, hydraulic, and sanitary engineers of expressing their views, and enlarging their experience by consultation and discussion with engineers of various countries. My experience of the six maritime, inland navigation, and waterworks international congresses I have attended in England and abroad, has convinced me of the very great value of such meetings in collecting information, comparing views, and obtaining some knowledge of foreign works and methods; whilst the acquaintances formed with some of the most celebrated foreign engineers afford opportunities of gaining further information about works abroad, and deriving experience from their progress and results.

Engineering Literature.—Lawyers have been defined as persons who do not possess a knowledge of law, but who know where to find the law which they may require. It may be hoped that a similar definition is not applicable to engineers; but with the rapid increase of engineering literature it is most desirable that engineers should be able readily to refer to the information on any special subject, or descriptions of any executed works, which may have been published. Much valuable matter, however, is buried in the *Proceedings* of engineering and scientific societies, and in various publications, and often a considerable amount of time is expended in fruitless search. This great waste of time and energy, and the loss of available information involved, led me a few years ago to suggest that a catalogue of engineering literature ought to be made, arranging the lists of publications relating to the several branches under separate headings. There is a possibility that this arduous and costly task may be partially accomplished in separate volumes, and, at any rate, the first step has been effected by the publication, under the auspices of the Paris Inland Navigation Congress of 1892, of a catalogue of the publications on inland navigation. A start has also been made in France, Italy and England towards the preparation of a similar catalogue on maritime works, which it may be hoped means will one day be found to publish on the meeting of some future congress. Engineers who have searched, even in the best libraries, for the published information on any special subject will appreciate what a great boon an engineering subject catalogue would be to the profession, and indirectly to the public at large.

Concluding Remarks.—In this address, I have endeavoured, though very imperfectly, to indicate how engineering consists in the application of natural laws and the researches of science for the benefit and advancement of mankind, and to point out that increased knowledge will be constantly needed to keep pace with, and to carry on, the progress that has been made. The great advantages provided by engineering works in facilitating communications and intercourse, and consequently the diffusion of knowledge, in increasing trade, in extending civilisation to remote regions, in multiplying the comforts of life, and affording enlarged possibilities of enjoyment and change of scene, may be regarded as amply acknowledged; but the more gradual and less obvious, though not less important, benefits effected by engineering works are not so fully realised.

A comparison of engineering with the other chief branch of applied science, medicine, exhibits some similarities and differences. In both professions, the discoveries of science are utilised on behalf of mankind; but whilst physicians devote themselves mainly to individuals, engineers are concerned in promoting the well-being of the community at large. Persons reluctantly consult doctors when they are attacked by disease, or incapacited by an accident; but they eagerly resort for enjoyment to railways, steamships, mountain tramways, piers, great wheels, and Eiffel towers; and they frequently avail themselves of the means of cheap and easy locomotion to complete their restoration to health by change of air and climate. Physicians try to cure people when they are ill; whereas engineers endeavour, by good water-supply and efficient drainage, to maintain them in health; and in this respect, the evident results of medical skill are far more readily realised than the invisible, though more widespread, preventive benefits of engineering works. Statistics alone can reveal the silent operations of sanitary works; and probably no better evidence could be given of the inestimable value of good water and proper drainage on the health of the population of large towns, when aided by the progress of medical science, than the case of London, where, towards the close of the last century, the death-rate exceeded the birth-rate, and the numbers were only kept up by constant immigrations; whereas now, in spite of the vast increase of the population and the progressive absorption of the adjacent country into the ever-widening circle of houses, the number of births exceed the deaths by nearly 900 a week.

The remarkable triumphs of engineering have been due to the patient and long-continued researches of successive generations of mathematicians, physicists, and other scientific investigators, and it is by the utilisation of these stores of knowledge and experience that engineers have acquired renown. A higher tribute of gratitude should perhaps be paid to the noble band of scientific investigators who, in pursuit of knowledge for its own sake, have rendered possible the achievements of engineering, than to those who have made use of their discoveries for the attainment of practical benefits; but they must both be regarded as co-workers in the promotion of the welfare of mankind. The advancement of science develops the intellectual faculties of nations, and enlarges their range; whilst the resulting progress in engineering increases their material comforts and prosperity. If men of science, by closer intercourse with engineers, could realise more fully the practical capabilities of their researches, and engineers, by a more complete scientific training, could gain a clearer insight into the scientific aspect of their profession, both might be able to co-operate more thoroughly in developing the resources of nature, and in furthering the intellectual and material progress of the human race.

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Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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EXHIBITIONS.

As secretary of the Society of Arts, which originated the very idea of industrial exhibitions, and as one having an unique experience of modern raree-shows, something more definite and conclusive might reasonably have been expected from the pen of Sir HENRY TRUEMAN WOOD than is discoverable in his recent letter to *The Times*. As an historical retrospect the letter is not without interest, but it contains nothing whatever in the shape of ripe counsel, and ends in a piece of empty flattery of our good friends the French. The individual manufacturer, as distinguished from the pseudo-manufacturer, who mainly sells goods of other people's make, has probably long ago made up his mind that, so far as he is immediately concerned, exhibitions are a costly mistake. When, however, one comes upon two or more manufacturers gathered together for the purpose of considering the advisability of recommending their particular trade to hold aloof from this or that proposed exhibition, considerable hesitancy is displayed by them, notwithstanding their almost invariable individual experience of the futility of exhibiting. Nor is it very difficult to see whence this state of indecision arises. There is a vague feeling abroad that the splash made by an exhibition does good on the whole, although those who actually help to make the splash may never see any tangible return for their outlay. Hence the disinclination to take part oneself in any given exhibition is beautifully balanced by a desire to see someone else do so; and this again is dashed with misgiving, lest after all this someone else may be the exception that proves the rule, and instead of altruistically benefiting the trade at large may reap a fine harvest for himself. The natural resultant of all these component

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perplexities is a general grumble followed by a general rush to get places. Now it is right here, as our American relations express it, that the industrial community would be glad to have the truth, the whole truth and nothing but the truth about exhibitions from a veteran Royal Commissioner like Sir Henry Trueman Wood. Instead of this, the best part of a column of our leading daily paper is devoted to a mere historical *résumé*, with just a hint of a personal preference for "smaller exhibitions." The genuine idea of exhibition has, we are told, and indeed are well aware, "developed in a wrong and unfortunate direction." Originally these shows were intended to be "collections illustrative of material and industrial progress," to bring to the notice of the public the latest thing in each department of industry, to afford "opportunity for comparison." But the novelty of these huge aggregations of industrial products soon wore off, and—though Sir Henry Wood does not take this factor into account—the belief that production was the whole duty of man soon faded, and in consequence the £200,000 surplus of the Exhibition of 1851 has been the only thing of the kind. It was at this juncture that Sir Philip Cunliffe Owen came forward with that happy thought—that insidious idea—of adding "a judicious flavouring of amusement" to the exhibitional ingredient. We know the result. To-day, as Sir Henry Wood truly puts it, the chief use of industrial exhibits is "to lend an air of respectability" to a mere raree-show. Having arrived by due process of evolution at this stage of development, one would have thought that the logical outcome would be to apply the surgeon's knife and lop off the now useless industrial member. The Secretary of the Royal Commission for the Chicago Exhibition is not, however, quite sure "what special conclusion is to be drawn from these considerations."

The purpose of an ordinary industrial exhibition is twofold—to educate the public and enlighten the members of the industrial section of the community as to what each member of it is doing and how he does it. Well, it is tolerably clearly realised in these days: firstly, that the public does not want to be educated, at any rate in this particular way; secondly, that the last thing an exhibitor cares to do is to enlighten a competitor. The whole *raison d'être* of the "serious" exhibition has therefore, so to speak, become converted into a very good reason for its non-existence. But "shall there be no more cakes and ale"? Far from it. We would suggest that the electrical industry, at any rate, would do well to supply the public demand for these commodities. The iron trade or the textile trade indeed might find it somewhat difficult to attract public attention through the medium of the public's amusements. But an electrical Kiralfy would esteem it an easy task to convert an entire exhibition, so called, into one long display of the capabilities of electricity—and why not? A lavish use of search lights, arc lamps, glow lamps, and illuminated fountains would serve to exhibit one aspect of the subject. Then trips in electric trams, gondolas, and launches, swings in electric cranes, and hoists in electric lifts might bring home to the mind exactly what the electric motor can do when put to it. All cooking would, of course, be done electrically, and concert halls and theatres would be connected up telephonically. Miniature waterfalls would illustrate the possibilities of the electric transmission of power, and realistic, well-lighted coal mines would set forth the many virtues of electric pumping, hauling and coal-cutting. There need be no pretence to solemnity, no awe-inspiring stands filled with unintelligible exhibits, no business-like advertisement placards, but merely "sixteen hours' continuous amusement." Education, though not the ostensible object of Electrical Utopia, would be a result. When the public has no long-felt wants it is the business of the manufacturer to supply it with a few. All the electrical paraphernalia of A.D. 1895 are as naught, unless the public can be pleasantly persuaded into purchasing.

THE BRITISH ASSOCIATION AT IPSWICH.

Thursday, September 12th.

The Sectional Meetings commenced with a grand total of about 1,150 visitors, which, while much smaller than the corresponding total at the opening of the Oxford meeting last year, was a marked improvement upon the number of visitors at the last Ipswich meeting.

In Section A, the address by Prof. W. M. Hicks on ether structure called forth appreciative remarks from Lord Kelvin, Prof. FitzGerald and others. Lord Kelvin remarked on the high degree of satisfaction with which we may view the fact of the structure and dynamical functions of one and the same ether providing explanations of so diversified a range of physical and chemical actions; and he looked forward to the time when electrical, chemical, gravitational and every physical action could be explained by some hypothesis of a universal medium or ether, and to the far-distant time when every one of the questions proposed by Prof. Hicks would be answered. Prof. FitzGerald called attention to the curious dilemma that the hypothesis of a vortex-ether explanation of Nature involved. There should, he said, be both positive and negative *matter*, a set of positive hydrogen atoms, and a set of negative hydrogen atoms; and he remarked that it has been sought to dispose of this dilemma by conceiving that only *one* kind of each elementary atom is known to us in this material universe, the opposite kinds of all the elements having been repelled—by negative gravity—to some unknown and infinitely distant universe of worlds!

The first Paper read in Section A was by the President, Capt. Sir Douglas Galton, who happily had quite recoved from his indisposition of the previous evening. This Paper, or "Memorandum on the Reichsanstalt, Charlottenburg," had for its main object the appointing of a Committee, who should be charged with the duty of approaching the British Government with a view to the creation of a similar institution in this country. The Reichsanstalt is, in its chief department, an institution for the pursuit of pure scientific research. A subsidiary department engages in the work of testing and commercial research. Sir Douglas suggested, as one solution of the problem, that Kew Observatory should be extended and amplified, so as to cover the range of pure research in addition to its present normal functions. A most interesting debate, in which many competent speakers took part, followed the reading of this Paper. The general consensus of opinion was that in the matter of pure research Britain is far behind Germany; and a cry was raised for more complete organisation of research in this country. To this opinion Lords Kelvin and Rayleigh, and Profs. Ayrton, FitzGerald, Thompson and others, gave unanimous voice. There were, however, differences of opinion as to the *modus operandi*. Some thought that the support of pure research should come directly from the State, which should be asked to provide lands, buildings and funds; some few, headed by Prof. FitzGerald were disposed to throw the duties upon the existing Universities; while Prof. Ayrton spoke a timely note of warning when he pointed out the utter hopelessness of State aid, until it shall have been shown to the Government and the nation that pure research is of as great national importance as the building of warships. It was also pointed out that the attitude of the British Government towards scientific research, as well as music, literature and the drama, was essentially different from that of Continental Governments; and that, unless scientific research could show a better cause that the others, it stood only an equal chance with them of State patronage.

Meanwhile, in Section G, the Presidential Address by Prof. L. F. Vernon Harcourt, on "The Relation of Engineering to Science," was read, and was succeeded by a highly debatable

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Paper on "Light Railways as an Assistance to Agriculture," which was read by Major-Gen. Webber. The author advocated the introduction of light railway lines along the side of country roads, connecting farm with farm and market; and he pronounced this course to be one likely to ameliorate the state of agriculture. His lines would not in any sense be feeders to main railway lines; nor was it proposed that they should be built so as to have any prospect of being used as main lines. They were essentially road lines. A long and brilliant discussion ensued, during part of which a mimic "battle of the gauges" was fought. Perhaps the best thing was said by Mr. W. Worby Beaumont, who pointed out that it was futile to discuss questions of gauge and the relative merits of steam, cable, electricity, &c., until radical improvements had been made in the financial machinery for bringing such railways into existence.

Friday, September 13th.

Electrical Papers were conspicuous by their absence on Friday, and the nearest approach made to a topic of electrical interest was when the combined Sections A and B debated "On the Evidence to be gathered as to the Simple or Compound Character of a Gas, from the constitution of its Spectrum." Prof. Schuster opened the discussion, and during his remarks made the interesting statement that he considered all evidence based on vacuum tube and spark discharge to be excluded; his reason being that under either of these conditions the behaviour of the gas, and therefore the character of its spectrum, might be abnormal. There was no saying what influence and electrical discharge might have on the behaviour of the gas. Prof. Runge followed with an interesting hypothesis of the compound nature of helium, based upon the duality of its spectrum. An attempt was made by Dr. Johnstone Stoney to give greater weight to the importance of the German methods of research, by insisting that there is not anywhere in the United Kingdom facilities for carrying on such researches as those of Prof. Runge. But the point of these remarks was turned by Prof. Armstrong, who briefly announced that Prof. Runge's researches had not been conducted under State aid, but had been carried on at the investigator's personal expense; and that it was open to anyone in the United Kingdom to "go and do likewise."

In the evening the Association met in the Public Hall, to listen to an able and interesting lecture by Prof. Silvanus P. Thompson, on "Magnetism in Rotation." The lecturer sketched, in his inimitable style, the development of the rotatory magnetic field and its uses, from the starting point of Arago's discoveries of the influence of metallic masses on moving magnets. The subject was pursued down to its latest and most commercial developments, as well as in the direction of a plausible hypothesis of terrestrial magnetism and earth currents. The practical side of the subject was illustrated by means of a three-phase generator and polyphase motor, the latter being coupled to various useful implements, including a coffee mill and a mangle.

Saturday, September 14th.

An inspection of the *Journal* for Saturday made it apparent that this day had been selected to bear the chief burden of the scarcity of Papers. Many of the Sections did not assemble, and in Section G there was only one Paper of electrical interest. This was read by Mr. J. Napier, the Public Analyst for the County of Suffolk, and dealt with the Hermite sewage deodorising process, now being tried at Ipswich. The particulars of this process are known to our readers, and it will be sufficient if we notice the modifications of the complete process which have been adopted at Ipswich. Instead of supplying the deodorising liquid—the Hermite liquid—to every house, and passing it through every branch drain and sewer, the liquid is merely caused to flow, from an up-town inlet, through the main sewer and discharge itself with the sewage at the sea outfall. Thus it is used only as a main flush. In the discussion which followed, the impression seemed to prevail that the Hermite process is one intended only for application to ancient and defective sewage systems as a less expensive remedy than the complete reconstruction of the sewers. This misapprehension we hasten to correct, as the Hermite process, if it is useful at all, is equally of use in modern and perfect sewage systems as in old and defective ones. Its value lies in the treatment of sewage at the earliest possible stage.

Monday, September 16th.

Monday was "electrical day" in Section G, and a lengthy programme was arranged for that day. The proceedings were opened by Mr. P. Dawson, who read a lengthy and interesting Paper on "The Modern Application of Electricity to Traction Purposes." The author briefly sketched the various systems which are now well established, but he devoted his chief time and attention to the advocacy of the overhead trolley system. Instructive comparisons were made between the abundant development of electric traction on the Continent and in America, and the paucity of development at home. Mr. Blackwell followed with some remarks, during which he insisted that the chief reason for the tardiness of electric tramways in England was due to the feeble patronage that tramways as a class received in this country. The social status of the tram-car required to be elevated. Mr. J. Head gave some account of what he had seen in America; and another speaker described the principal features of the system in use in the Isle of Man.

The next Paper, which was read by Mr. Trotter, and was contributed by Mr. W. H. Preece and Mr. Trotter, was on the subject of "An Improved Portable Photometer." A reprint of this Paper, with a report of the discussion which followed its reading, will be found elsewhere in our columns. The speakers in the discussion insisted on the importance of seeking to obtain, not only the right kind and amount of light, but the right distribution of it; and municipal bodies were advised that the distribution of illumination in an efficient manner, in streets and public places, was a too much neglected matter, to which more attention should be paid by them if they desire to get the most for their money.

A Paper by Mr. H. A. Earle, on "Storage Batteries," came next, and its main object was to point out the merits of the latest forms of secondary practice, as illustrated by the chloride cell. Speakers in the discussion were unanimous in the opinion that this form of cell is admirably adapted to the severe conditions of electric traction, whether in battery cars or in battery stations connected to conductor systems. A description of the use of these cells was given by Major-Gen. Webber, and others spoke on the same subject.

In a Paper on "The Development of the Telephone Service in Agricultural Districts," read by Major-Gen. Webber, it was sought to show that a great deal of the present condition of agricultural depression is due to the fact that your yokel cannot telephone to market or from village to village; and it was advocated that if he could get three minutes' talk for twopence, as it was attempted to show he might, he would soon become a happy and a prosperous yeoman. The speakers who took part in the debate were of a less sanguine condition of mind in regard to this matter; and they failed to see that what the telegraph had failed to do, the telephone was sure to accomplish, or to believe that the state of depression partially due to the former would be eradicated on the advent of the latter.

The last Paper read was by Mr. A. R. Bennett, on "Some Lessons in Telephony"; and in tone and substance it was a jeremiad on the awful state of this country as compared with foreign countries, as regards telephonic communication.

(To be continued.)

Electric Headlights.—Electric lights, says the *Electrical Engineer* of New York, will soon succeed oil lamps as headlights on all of the passenger train locomotives of the Southern Pacific Company. The Company has been experimenting with electric headlights for some time, and at last has perfected a light that can be operated by a dynamo on the engine which will illuminate the track for a distance of 2,000ft. Oil lamps light the track for only 200ft. ahead of the locomotive, and when running at a high speed engineers are frequently unable to stop, after observing an obstruction on the track, in time to prevent an accident. The Southern Pacific will be the first railroad company in the United States to equip all of its passenger train locomotives with electric headlights.

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LIST OF THE ELECTRICAL PAPERS READ AT THE BRITISH ASSOCIATION.

The following is a complete list of the electrical Papers read and reports presented at the Ipswich Meeting of the British Association:—

SECTION A.

Sir Douglas Galton, F.R.S.—"Memorandum on the Reichsanstalt, Charlottenburg."
W. H. Everett.—"On the Field of a Solenoid."
E. S. Bruce.—"On Probable Projective Lightning Flashes."
Prof. Schuster, F.R.S.—"Some Observations with Lord Kelvin's Portable Electrometer."
Prof. Michie Smith.—"On Indian Thunderstorms."
W. H. Wood.—"On the Local Origin of the Aurora Borealis."
Prof. S. P. Thompson, F.R.S.—"On the Choice of Magnetic Units."
J. M. Barr, W. B. Burnie and Charles Rodgers.—"On Some New Methods and Apparatus for the Delineation of Alternate-Current Wave Forms."
Prof. W. E. Ayrton, F.R.S., and T. Mather.—"On Alternating Wave Tracers."
Lord Kelvin, P.R.S., Messrs. Maclean and Galt.—"Electrification and Diselectrification of Gases."
Prof. Rucker, F.R.S.—"As to whether Vertical (earth-air) Electrical Currents exist in the United Kingdom.'
Mrs. Ayrton.—"On the Equation connecting the P.D., Current, and Length of the Electric Arc."
Prof. W. E. Ayrton, F.R.S., and T. Mather.—"On the Back E.M.F. and True Resistance of the Arc."
Prof. W. E. Ayrton, F.R.S., and T. Mather.—"On a Magnetic Field Tester."
Prof. W. M. Hicks, F.R.S., and Mr. L. T. O'Shea.—"Note on the Electrolysis of Iron."
B. E. Edser and S. G. Starling.—"On the Velocity of Light in a Rarefied Gas through which a Current is passing."
F. G. Baily.—"On the Hysteresis of Iron in an Alternating Field."
E. H. Griffiths, F.R.S.—"On Some Recent Improvements in Measurements of High Temperatures." (Illustrated by apparatus recently acquired by Kew Observatory.)
Report on the Sizes of the Pages of Periodicals.
Report on the Reduction of Magnetic Observations.
Report on the Comparison of Magnetic Instruments.
Reports on Electrical Standards.

SECTION B.

Report of the Committee on Quantitative Analysis by Means of Electrolysis.

SECTION G.

J. Napier.—"Deodorising of Sewage by the Hermite Process.'
P. Dawson.—"The Modern Application of Electricity to Traction Purposes."
W. H. Preece, C.B., and A. P. Trotter.—"An Improved Portable Photometer."
H. A. Earle.—"Storage Batteries."
Major-Gen. Webber, C.B.—"The Development of the Telephone Service in Agricultural Districts."
A. R. Bennett.—"Some Lessons in Telephony."
P. V. Luke, C.B. (Dep. Director of Telegraphs in India).—"The Field Telegraph in the Chitral Campaign."

SIR DOUGLAS GALTON'S PRESIDENTIAL ADDRESS TO THE BRITISH ASSOCIATION AT IPSWICH.

[ABSTRACT.]

In 1831, in the absence of railways, communication between different parts of the country was slow and difficult. Science was therefore localised. Under these social conditions the British Association was founded in September, 1831. The objects of the founders of the British Association were enunciated in their earliest rules to be: "To give a stronger impulse and a more systematic direction to scientific inquiry; to promote the intercourse of those who cultivate science in different parts of the British Empire with one another, and with foreign philosophers; to obtain a more general attention to the objects of science, and a removal of any disadvantages of a public kind which impede its progress." At its third meeting [Cambridge, 1833], the Association, through the influence it had already acquired, induced the Government to grant a sum of £500 for the reduction of the astronomical observations of Baily. And at the same meeting the General Committee commenced to appropriate to scientific research the surplus from the subscriptions of its members. I have always wondered at the foresight of the framers of the constitution of the British Association, the most remarkable feature of which is the lightness of the tie which holds it together. It is not bound by any complex central organisation. It consists of a federation of sections, whose youth and energy are yearly renewed by a succession of presidents and vice-presidents, whilst in each section some continuity of action is secured by the less movable secretaries. The governing body is the General Committee, the members of which are selected for their scientific work; but their controlling power is tempered by the law that all changes of rules or of constitution should be submitted to, and receive the approval of, the Committee of Recommendations. This Committee may be described as an ideal Second Chamber. It consists of the most experienced members of the Association.

The administration of the Association in the interval between annual meetings is carried on by the Council, an executive body whose duty it is to complete the work of the annual meeting. I believe that one of the secrets of the long-continued success and vitality of the British Association lies in this purely democratic constitution, combined with the compulsory careful consideration which must be given to suggested organic changes.

[After a glance at the condition of science in 1831, when the British Association was formed, and a reference to the good done by the Association in the matter of scientific standards, the President gave a sketch of the progress made since 1831 in geology, geography, and astronomy. Coming to physics, he said:] If we turn to the sciences which are included under physics, the progress has been equally marked. In optical science, in 1831 the theory of emission as contrasted with the undulatory theory of light was still under discussion. Young, who was the first to explain the phenomena due to the interference of the rays of light as a consequence of the theory of waves, and Fresnel, who showed the intensity of light for any relative position of the interference waves, both had only recently passed away. The investigations into the laws which regulate the conduction and radiation of heat, together with the doctrine of latent and of specific heat, and the relations of vapour to air, had all tended to the conception of a material heat, or caloric, communicated by an actual flow and emission. It was not till 1834 that improved thermometrical appliances had enabled Forbes and Melloni to establish the polarisation of heat, and thus to lay the foundation of an undulatory theory for heat similar to that which was in progress of acceptation for light. Whewell's report, in 1832, on magnetism and electricity shows that these branches of science were looked upon as cognate, and that the theory of two opposite electric fluids was generally accepted. In magnetism, the investigations of Hansteen, Gauss and Weber in Europe, and the observations made under the Imperial Academy of Russia over the vast extent of that empire, had established the existence of magnetic poles, and had shown that magnetic disturbances were simultaneous at all the stations of observation. At their third meeting the Association urged the Government to establish magnetic and meteorological observatories in Great Britain and her colonies and dependencies in different parts of the earth, furnished with proper instruments, constructed on uniform principles, and with provisions for continued observations at those places. In 1839 the British Association had a large share in inducing the Government to initiate the valuable series of experiments for determining the intensity, the declination, the dip, and the periodical variations of the magnetic needle which were carried on for several years, at numerous selected stations over the surface of the globe, under the directions of Sabine and Lefroy. In England systematic and regular observations are still made at Greenwich, Kew, and Stonyhurst. For some years past similar observations by both absolute and self-recording instruments have also been made at Falmouth—close to the home of Robert Were Fox, whose name is inseparably connected with the early history of terrestrial magnetism in this country—but under such great financial difficulties that the continuance of the work is seriously jeopardised. It is to be hoped that means may be forthcoming to carry it on. Cornishmen, indeed, could found no more fitting memorial of their distinguished countryman, John Couch Adams, than by suitably endowing the magnetic observatory in which he took so lively an interest. Far more extended observation will be needed before we can hope to have an established theory as to the magnetism of the earth.

In electricity, in 1831, just at the time when the British Association was founded, Faraday's splendid researches in electricity and magnetism at the Royal Institution had begun with his discovery of magneto-electric induction, his investigation of the laws of electro-chemical decomposition, and of the mode of electrolytical action. But the practical application of our electrical knowledge was then limited to the use of lightning conductors for buildings and ships. Indeed, it may be said that the applications of electricity to the use of man have grown up side by side with the British

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Association. One of the first practical applications of Faraday's discoveries was in the deposition of metals and electro-plating, which has developed into a large branch of national industry; and the dissociating effect of the electric arc, for the reduction of ores, and in other processes, is daily obtaining a wider extension.

But probably the application of electricity which is tending to produce the greatest change in our mental, and every material condition, is the electric telegraph and its sister, the telephone. By their agency not only do we learn, almost at the time of their occurrence, the events which are happening in distant parts of the world, but they are establishing a community of thought and feeling between all the nations of the world which is influencing their attitude towards each other, and, we may hope, may tend to weld them more and more into one family.

The electric telegraph was introduced experimentally in Germany in 1833, two years after the formation of the Association. It was made a commercial success by Cooke and Wheatstone in England, whose first attempts at telegraphy were made on the line from Euston to Camden Town in 1837, and on the line from Paddington to West Drayton in 1838. The submarine telegraph to America, conceived in 1856, became a practical reality in 1861 through the commercial energy of Cyrus Field and Pender, aided by the mechanical skill of Latimer Clark, Gooch and others, and the scientific genius of Lord Kelvin. The knowledge of electricity gained by means of its application to the telegraph largely assisted the extension of its utility in other directions.

In 1843 Joule described his experiments for determining the mechanical equivalent of heat. But it was not until the meeting at Oxford, in 1847, that he fully developed the law of the conservation of energy, which, in conjunction with Newton's law of the conservation of momentum, and Dalton's law of the conservation of chemical elements, constitutes a complete mechanical foundation for physical science.

Who at the foundation of the Association, would have believed some far-seeing philosopher if he had foretold that the spectroscope would analyse the constituents of the sun and measure the motions of the stars; that we should liquefy air and utilise temperatures approaching to the absolute zero for experimental research; that, like the magician in the "Arabian Nights," we should annihilate distance by means of the electric telegraph and the telephone; that we should illuminate our largest buildings instantaneously, with the clearness of day, by means of the electric current; that by the electric transmission of power we should be able to utilise the Falls of Niagara to work factories at distant places; that we should extract metals from the crust of the earth by the same electrical agency to which, in some cases, their deposition has been attributed?

After dealing with engineering progress, the President concluded with a reference to the influence of the intercommunication afforded by the British Association on science progress.

The advances in engineering, he said, which have produced the steam-engine, the railway, the telegraph, as well as our engines of war, may be said to be the result of commercial enterprise rendered possible only by the advances which have taken place in the several branches of science since 1831. Having regard to the intimate relations which the several sciences bear to each other, it is abundantly clear that much of this progress could not have taken place in the past, nor could further progress take place in the future without intercommunication between the students of different branches of science. I claim for the British Association that it has fulfilled the objects of its founders, that it has had a large share in promoting intercommunication and combination. Our meetings have been successful because they have maintained the true principles of scientific investigation. We have been able to secure the continued presence and concurrence of the master-spirits of science. They have been willing to sacrifice their leisure, and to promote the welfare of the Association, because the meetings have afforded them the means of advancing the sciences to which they are attached. The Association has, moreover, justified the views of its founders in promoting intercourse between the pursuers of science, both at home and abroad, in a manner which is afforded by no other agency. The weekly and sessional reunions of the Royal Society, and the annual *soirées* of other scientific societies, promote this intercourse to some extent, but the British Association presents to the young student during its week of meetings easy and continuous social opportunities for making the acquaintance of leaders in science, and thereby obtaining their directing influence. It thus encourages, in the first place, opportunities of combination; but, what is equally important, it gives at the same time material assistance to the investigators whom it thus brings together. The reports on the state of science at the present time, as they appear in the last volume of our *Proceedings*, occupy the same important position, as records of science progress, as that occupied by those reports in our earlier years. We exhibit no symptom of decay.

Great Britain maintained for a long time a leading position among the nations of the world by virtue of the excellence and accuracy of its workmanship, the result of individual energy; but the progress of mechanical science has made accuracy of workmanship the common property of all nations of the world. Our records show that hitherto, in its efforts to maintain its position by the application of science and the prosecution of research, England has made marvellous advances by means of voluntary effort, illustrated by the splendid munificence of such men as Gassiot, Joseph Whitworth, James Mason, and Ludwig Mond; and, whilst the increasing field of scientific research compels us occasionally to seek for Government assistance, it would be unfortunate if by any change voluntary effort were fettered by State control. The following are the principal voluntary agencies which help forward scientific research in this country: The Donation Fund of the Royal Society, derived from its surplus income. The British Association has contributed £60,000 to aid research since its formation. The Royal Institution, founded in the last century, by Count Romford, for the promotion of research, has assisted the investigations of Davy, of Young, of Faraday, of Franklin, of Tyndall, of Dewar, and of Rayleigh. The City Companies assist scientific research and foster scientific education, both by direct contributions and through the City and Guilds Institute. The Commissioners of the Exhibition of 1851 devote £6,000 annually to science research scholarships, to enable students who have passed through a college curriculum, and have given evidence of capacity for original research to continue the prosecution of science, with a view to its advance, or to its application to the industries of the country. Several scientific societies, as, for instance, the Geographical Society and the Mechanical Engineers, have promoted direct research, each in their own branch of science, out of their surplus income; and every scientific society largely assists research by the publication, not only of its own proceedings, but often of the work going on abroad in the branch of science which it represents. The growing abundance of matter year by year increases the burden thus thrown on their finances, and the Treasury has recently granted to the Royal Society £1,000 a year to be spent in aid of the publication of scientific Papers not necessarily limited to those of that Society. The Universities and colleges distributed over the country, besides their function of teaching, are large promoters of research, and their voluntary exertions are aided in some cases by contributions from Parliament in alleviation of their expenses. Certain executive departments of the Government carry on research for their own purposes, which in that respect may be classed as voluntary. The Admiralty maintains the Greenwich Observatory, the Hydrographical Department, and various experimental services, and the War Office maintains its numerous scientific departments. The Treasury maintains a valuable chemical laboratory for Inland Revenue, Customs, and agricultural purposes. The Science and Art Department maintains the Royal College of Science, for the education of teachers and students from elementary schools. It allows the scientific apparatus in the national museum to be used for research purposes by the professors. The Solar Physics Committee, which has carried on numerous researches in solar physics, was appointed by and is responsible to this Department. The Department also administers the Sir Joseph Whitworth engineering research scholarships. Other scientific departments of the Government are aids to research, as, for instance, the Ordnance and the Geological Surveys, the Royal Mint, the Natural History Museum, Kew Gardens, and other lesser establishments in Scotland and Ireland; to which may be added, to some extent, the Standards Department of the Board of Trade, as well as municipal museums, which are gradually spreading over the country. For direct assistance to voluntary effort the Treasury contributes £4,000 a year to the Royal Society for the promotion of research, which is administered under a Board whose members represent all branches of science. The Treasury, moreover, contributes to marine biological observatories, and in recent years has defrayed the cost of various expeditions for biological and astronomical research, which in the case of the "Challenger" expedition involved very large sums of money. In addition to these direct aids to science, Parliament, under the Local Taxation Act, handed over to the County Councils a sum, which amounted in the year 1893 to £615,000, to be expended on technical education. In many country districts, so far as the advancement of real scientific technical progress in the nation is concerned, much of this money has been wasted for want of knowledge. And whilst it cannot be said that the Government or Parliament have been indifferent to the promotion of scientific education and research, it is a source of regret that the Government did not devote some small portion of this magnificent gift to affording an object lesson to County Councils in the application of science to technical instruction, which would have suggested the principles which would most usefully guide them in the expenditure of this public money. There could scarcely be a more advantageous addition to the assistance which Government now gives to science than for it to allot a substantial annual sum to the extension of the Kew Observatory, in order to develop it on the model of the Reichsanstalt.

The various agencies for scientific education have produced numerous students admirably qualified to pursue research, and at

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the same time almost every field of industry presents openings for improvement through the development of scientific methods. If students do not easily find employment, it is chiefly attributable to a want of appreciation for science in the nation at large. This want of appreciation appears to arise from the fact that those who nearly half a century ago directed the movement of national education were trained in early life in the universities, in which the value of scientific methods was not at that time fully recognised. Hence our elementary, and even our secondary and great public schools, neglected for a long time to encourage the spirit of investigation which develops originality. This defect is diminishing daily. There is, however, a more intangible cause which may have had influence on the want of appreciation of science by the nation. The Government, which largely profits by science, aids it with money, but it has done very little to develop the national appreciation for science by recognising that its leaders are worthy of honours conferred by the State. Science is not fashionable, and science students—upon whose efforts our progress as a nation so largely depends—have not received the same measure of recognition which the State awards to services rendered by its own officials, by politicians, and by the Army and by the Navy, whose success in future wars will largely depend on the effective applications of science.

The Reports of the British Association afford a complete chronicle of the gradual growth of scientific knowledge since 1831. They show that the Association has fulfilled the objects of its founders in promoting and disseminating a knowledge of science throughout the nation. The growing connection between the sciences places our annual meeting in the position of an arena where representatives of the different sciences have the opportunity of criticising new discoveries and testing the value of fresh proposals, and the Presidential and Sectional addresses operate as an annual stock-taking of progress in the several branches of science represented in the sections. Every year the field of usefulness of the Association is widening.

PROF. W. M. HICKS' PRESIDENTIAL ADDRESS TO SECTION A.

[ABSTRACT.]

In making a choice of subject for my address the difficulty is not one of finding material, but of making selection. The field covered by this Section is a wide one. Investigation is active in every part of it, and is being rewarded with a continuous stream of new discoveries and with the growth of that co-ordination and correlation of facts which is the surest sign of real advancement in science. The ultimate aim of pure science is to be able to explain the most complicated phenomena of Nature as flowing by the fewest possible laws from the simplest fundamental data. A statement of a law is either a confession of ignorance or a mnemonic convenience. It is the latter, if it is deducible by logical reasoning from other laws. It is the former when it is only discovered as a fact to be a law. While, on the one hand, the end of scientific investigation is the discovery of laws, on the other, science will have reached its highest goal when it shall have reduced ultimate laws to one or two, the necessity of which lies outside the sphere of our cognition. These ultimate laws—in the domain of physical science at least—will be the dynamical laws of the relations of matter to number, space, and time. The ultimate data will be number, matter, space, and time themselves. When these relations shall be known, all physical phenomena will be a branch of pure mathematics. We shall have done away with the necessity of the conception of potential energy, even if it may still be convenient to retain it; and—if it should be found that all phenomena are manifestations of motion of one single continuous medium—the idea of force will be banished also, and the study of dynamics replaced by the study of the equation of continuity.

Before, however, this can be attained, we must have the working drawings of the details of the mechanism we have to deal with. These details lie outside the scope of our bodily senses; we cannot see, or feel, or hear them, and this, not because they are unseeable, but because our senses are too coarse-grained to transmit impressions of them to our mind. The ordinary methods of investigation here fail us; we must proceed by a special method, and make a bridge of communication between the mechanism and our senses by means of hypotheses. By our imagination, experience, intuition, we form theories; we deduce the consequences of these theories on phenomena which come within the range of our senses, and reject or modify and try again. It is a slow and laborious process. The wreckage of rejected theories is appalling; but a knowledge of what actually goes on behind what we can see or feel is surely if slowly being attained. It is the rejected theories which have been the necessary steps towards formulating others nearer the truth. It would be an extremely interesting study to consider the history of these discarded theories, to show the part they have taken in the evolution of truer conceptions, and to trace the persistence and modification of typical ideas from one stratum of theories to a later. I propose, however, to ask your attention for a short time to one of these special theories—or rather to two related theories—on the constitution of matter and of the ether. They are known as the vortex atom theory of matter and the vortex sponge theory of the ether. The former has been before the scientific world for a quarter of a century, since its first suggestion by Lord Kelvin in 1867, the second for about half that time. In what I have to say I wish to take the position, not of an advocate for or against, but simply as a prospector attempting to estimate what return is likely to be obtained by laying down plant to develop an unknown district. This is in fact the state of these two theories at present. Extremely little progress has been made in their mathematical development, and until this has been done more completely we cannot test them as to their powers of adequately explaining physical phenomena.

The theory of the rigid atom has been a very fruitful one, especially in explaining the properties of matter in the gaseous state; but it gives no explanation of the apparent forces which hold atoms together, and in many other respects it requires supplementing. The elastic solid ether explained much, but there are difficulties connected with it which decide against it. The mathematical rotational ether of MacCullagh is admirably adapted to meet these difficulties, but he could give no physical conception of its mechanism. Maxwell and Faraday proposed a special ether for electrical and magnetic actions. This ether requires the same mathematical treatment as that of MacCullagh. Lord Kelvin's gyrostatic model of an ether is also of the MacCullagh type. Lastly, we have Lord Kelvin's Labile ether, which again avoids the objections to the elastic solid ether. In MacCullagh's type of ether the energy of the medium when disturbed depends only on the twists produced in it. This ether has recently been mathematically discussed by Dr. Larmor, who has shown that it is adequate to explain all the various phenomena of light, electricity, and magnetism. Meanwhile, it may be borne in mind that the vortex sponge ether belongs to MacCullagh's type.

Already before a formal theory of a fluid ether had been attempted, Lord Kelvin * had proposed his theory of vortex atoms. The permanence of a vortex filament with its infinite flexibility, its fundamental simplicity with its potential capacity for complexity, struck the scientific imagination as the thing which was wanted. Unfortunately the mathematical difficulties connected with the discussion of these motions, especially the reactions of one on another, have retarded the full development of the theory.

Maxwell was, I believe, the first to point out the difficulty of explaining the masses of the elements on the vortex atom hypothesis. To me it has always appeared one of the greatest stumbling-blocks to the acceptance of the theory. We have always been accustomed to regard the ether as of extreme tenuity, as of a density extremely though not infinitely smaller than that of gross matter, and we carry in our minds that Lord Kelvin has given an inferior limit of about 10^{-19}. There are two directions in which to seek a solution. The first is to cut the knot by supposing that the atoms of gross matter are composed of filaments whose rotating cores are of much greater density than the ether itself. The second is to remember that Lord Kelvin's number was obtained on the supposition of elastic solid ether, and does not necessarily apply to the vortex sponge.

Ever since Prof. J. J. Thomson proved that a vortex atom theory of matter is competent to serve as a basis of a kinetic theory of gases, it has been urged by various persons as a fatal objection that the translation velocity of the atoms falls off as the temperature rises. I must confess this objection has never appealed to me. Why should not the velocity fall off? The velocity of gaseous molecules has never been directly observed, nor has it been experimentally proved that it increases with rise of temperature. We have no right to import ideas based on the kinetic theory of hard discrete atoms into the totally distinct theory of mobile atoms in continuity with the medium surrounding them. Doubtless the molecules of a gas effuse through a small orifice more quickly as the temperature rises, but it is natural to suppose that a vortex ring would do the same as its energy increases. To make the objection valid, it is necessary to show that a vortex ring passing through a small tube, comparable with its own diameter, would pass through more slowly the greater its energy. It is not, however, necessarily the case that in every vortex aggregate the velocity decreases as the energy increases. The mathematical treatment of thin vortex filaments is comparatively easy, and little attention has been paid to other cases. Let us attempt to trace the life history as to translation velocity and energy of a vortex ring. We start with the energy large; the ring now has a very large aperture, and has a very thin filament. As the energy decreases, the aperture becomes smaller, the filament thicker, and the velocity of translation

* "Vortex Atoms," *Proc.* Roy. Soc Edin., VI., 94; *Phil. Mag.* (4), 34.

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greater. We can trace quantitatively the whole of this part of its history until the thickness of the ring has increased to about four times the diameter of the aperture, or perhaps a little further. Then the mathematical treatment employed fails us, or becomes very laborious to apply. Till 18 months ago this was the only portion of its history we could trace. Then Prof. M. J. M. Hill* published his beautiful discovery of the existence of a spherical vortex. This consists of a spherical mass of fluid in vortical motion and moving bodily through the surrounding fluid, precisely as if it were a rigid sphere.

If we pass on to consider how a vortex atom theory lends itself to the explanation of physical and chemical properties of matter independently of what may be called ether relations, we find that we owe almost all our knowledge on this point to the work of Prof. J. J. Thomson,† which obtained the Adams' Prize in 1882. This, however, is confined to the treatment of *thin* vortex rings, still leaving a wide field for future investigation in connection with thick rings and with vortex aggregates which produce no cyclosis in the surrounding medium. His work is an extremely suggestive one. He shows that such a theory is capable, not only of explaining the gaseous laws of a so-called perfect gas, but possibly also the slight deviations therefrom. Quite as striking is his explanation of chemical combination—an explanation which flows quite naturally from the theory. A vortex filament can be linked on itself: two or more can be linked together, like helices drawn on an anchor ring; or, lastly, several can be arranged together like parallel rings successively threading one another. In the latter case, for such an arrangement to be permanent, the strengths of each ring must be the same, and further, not more than six can thus be combined together. The linked vortices will be in permanent combination on account of their linkedness; the other arrangement may be permanent if subject to no external actions. If, however, they are disturbed by the presence of other vortices they may break up. When atoms are thus combined to form a compound, a certain number of molecules will always be dissociated; the compound will be permanent when the ratio of the average paired time to the unpaired time of any atom is large. Thomson considers every filament to be of the same strength. Then an atom consisting of two links will behave like a ring of twice the strength, one of three links, of three times the strength, and so on. On this theory chemical compounds are to be regarded as systems of rings, not linked into one another but close together, and all engaged in the operation of threading each other.

The energy of rings thus combined is less than when free; consequently they are stable, and the act of combination sets free energy. Further, Thomson points out that for two rings to combine their sizes must be about the same when they come into proximity; consequently combination can only occur between two limits of temperature corresponding to the energies within which the radii of both kinds of rings are near an equality.

Thomson's theory of chemical combination applies only to thin rings. Something analogous may hold also for thick rings, but it is clearly inapplicable to vortex aggregates similar to that of Hill's. We are not confined, however, to this particular kind of association of vortex atoms in a molecule. For instance, I have recently found‡ that one of Hill's vortices can swallow up another and retain it inside in relative equilibrium. The matter requires fuller discussion, but it seems to open up another mode of chemical combination.

A vortex atom theory of matter carries with it the necessity of a fluid ether. If such a fluid is to transmit transversal radiations, some kind of quasi-elasticity must be produced in it. This can be done by supposing it to possess energetic rotational motions whose mean velocity is zero, within a volume whose linear dimension is small compared with the wave length of light, but whose velocity of mean square is considerable. We can make little further progress until we know something of the arrangement of the small motions which confer the quasi-rigidity. This may be completely irregular and unsteady, or arranged in some definite order of steady motions. I am inclined to the view that the latter is nearer the truth. In this case we should expect a regular structure of small cells in which the motions are similar. By the word cell I do not mean a small vessel bounded by walls, but a portion of the fluid in which the motion is a complete system in itself. Such a theory might be called a cell theory of the ether. The simplest type perhaps is to suppose the medium spaced into rectangular boxes, in each of which the motion may be specified as follows. Holding the box with one set of faces horizontal the fluid streams up in the centre of the box, then turns round, flows down the sides and up the centre again. In fact, it behaves like a Hill's vortex squeezed from a spherical into a box form. Each box has thus rotational circulation complete in itself. The six adjoining compartments have their motion the same in kind but in the reverse direction, and so on. In this way we get continuous and energetic small motions throughout the medium, and the state is a stable one. If there is a shear, so that each cell becomes slightly rhomboidal, the rotational motions inside tend to prevent it, and thus propagate the disturbance, but the cells produce no effect on the general irrotational motion of the fluid, at least when the irrotational velocities are small compared with those of the propagation of light. In this case the rate at which the cells adjust themselves to an equilibrium position is far quicker than the rate at which this equilibrium distribution is disturbed by the gross motions. The linear dimensions of the cells must be small compared with the wave lengths of light. They must probably be small also compared with the atoms of gross matter, which are themselves small compared with the same standard. We may regard each cell as a dynamical system by itself, into which we pour or take away energy. This added energy will depend only on the shape into which the box is deformed.

At the Bath meeting of this Association, I sketched out a theory of the electrical action of a fluid ether in which electrical lines of force were vortex filaments combined with an equivalent number of hollow vortices of the same vortical strength.* An electric charge on a body depended on the number of ends of filaments abutting on it, the sign being determined by the direction of rotation of the filament looked at from the body. This theory gave a complete account of electrostatic actions, both quantitatively and qualitatively, and a more speculative one as to currents and magnetism. I could only succeed in proving at that time that if the filaments were distributed according to the same laws as electric lines of force, the distribution would be one of equilibrium. Larmor† has recently proved that this is also the necessary distribution for any type of a rotationally elastic ether, and consequently also for this particular case. Currents along a wire were supposed to consist of the ends of filaments running along it, with disappearance of the hollow companions, the filaments producing at the same time a circulation round the wire. A magnetic field was thus to be produced by a flow of the ether, but probably with the necessary accompaniment of rotational elements in it.

This latter, however, was clearly wrong, because each kind of filament would produce a circulation in opposite directions. The correct deduction would have been to lay stress on the fact that the field is due to the motion through the stationary ether of the vortex filaments, the field being perpendicular to the filament and to its direction of motion.

The fundamental postulate underlying this explanation of electric action is that when two different kinds of matter are brought into contact a distribution of vortex filaments in the neighbourhood takes place, so that a larger number stretch from one to the other than in the opposite direction—the distinction between positive and negative ends being that already indicated. To see how such a distribution may be caused, let us consider each vortex atom to be composed of a vortical mass of our secondary medium or cell-structure ether. The atom is much larger than a cell, and contains practically an infinite number of them. It is a dynamical system of these cells with equilibrium of energy throughout its volume. The second atom is a dynamical system with a different equilibrium of energy. Where they come into contact there will be a certain surface rearrangement, which will show itself as a surface distribution of energy in a similar manner to that which exists between a molar collection of one kind of molecules in contact with one of another, and which shows itself in the phenomenon which we call surface tension. In the present case the effect may take place at the interface of two atomic systems in actual contact, or be a difference effect between the two interfaces of the ether and each atom when the latter are sufficiently close. The surface effect we are now considering shows itself as contact electricity.

Such a distribution of small vortex filaments, stretching from one atom to another, will tend to hold them together. We therefore get an additional cause for aggregation of atoms. This does not exclude the others already referred to. They may all act concurrently, some producing one effect, some another—one combining, perhaps, unknown primitive atoms into elements, one elements into chemical compounds, and another producing the cohesion of matter into masses.

On this theory the difference between a conductor and a dielectric is that in a dielectric the ends of the filaments cannot pass from atom to atom, possibly because the latter never come into actual contact. In a conductor, however, we are to suppose that the atomic elements can do so. When a current is flowing, a filament and its equivalent hollow stretch between two neighbouring atoms, they are pulled into contact, or their motions bring them into contact, the hollow disappears, and the rotational filament joins its two ends and sails away as a small neutral vortex ring into the surrounding medium, or returns to its function as an ether cell. The atoms being free are now pulled back to perform a similar operation

* "On a Spherical Vortex," *Phil. Trans.*, 1894.

† "A Treatise on the Motion of Vortex Rings." Macmillan, 1883.

‡ Not yet published.

* "A Vortex Analogue of Static Electricity," *Brit. Assoc. Rep.*, 1888, p. 577.

† "A Dynamical Theory of the Electric and Luminiferous Medium," *Phil. Trans.*, 1894, p. 748.

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for other filaments. The result is that the atoms are set into violent vibrations, causing the heating of the conductor. When, however, the metal is at absolute zero of temperature, there is no motion, the atoms are already in contact, and there is no resistance, as the observation of Dewar and Fleming tends to show. Further, as the resistance depends on the communication of motion from molecule to molecule, we should expect the electrical conductivity of a substance to march with its thermal conductivity. Again, on this theory the resistance clearly increases with increase of distance between atoms—*i.e.*, with increase of temperature. On the contrary, in electrolytic conduction the same junction of filament ends is brought about, not by oscillations of molecule to molecule, but by disruption of the molecule and passage of atom to atom. In this case conduction is easier the more easily a molecule is split up, and thus resistance decreases with increase of temperature. To explain the laws of electrolysis it is only necessary to assume that the strengths of all filaments are the same. A similar hypothesis, as we have seen, lies at the basis of J. J. Thomson's explanation of chemical combination, although it is not necessarily the case that we are dealing with the same kind of filaments. It is evident that the theory easily lends itself to his views as to the mechanism of the electric discharge through gases. The *modus operandi* of the production of the mechanical forcive on a conductor carrying a current in a magnetic field and of electrodynamic induction is not clear. Probably the full explanation is to be found in the stresses produced in the ether owing to the deformation of the cells by the passage of the filaments through them. The fluid moves according to the equation of continuity without slip, and subject to the surface conditions at the conductors. This motion, however, distorts the cells, and stresses are called into play. Any theory which can explain the mechanical forcives and also Ohm's law, must, on the principles of the conservation of energy, also explain the induction of currents.

The magnetic rotation of the plane of polarisation of light does not depend on the structure of the ether, or on the magnetic field itself, but is a result of the atomic configuration of the matter in the field modified by the magnetism. It is generally recognised as caused by something in the field rotating round the direction of the magnetic lines of force. Now the vortex atom, as usually pictured, is incapable of exhibiting this property. It is, however, an interesting fact, and one which I hope to demonstrate to this Section during the meeting, that a vortex ring can have two simultaneous and independent cyclic motions—one the ordinary one, and another which is capable of producing just the action on light which shows itself as a rotation of the plane of polarisation.

Instead of attempting to invent ethers, to deduce their properties from their specifications, and then seeing whether they fit in with experience, we may begin half way. We may assume different forms for the function, giving the energy of the medium when disturbed, apply general dynamical methods, and distinguish between those which are capable of explaining the phenomena we are investigating and those which are not. Invention is then called upon to devise a medium for which the desired energy-function is appropriate. This was the method applied by MacCullagh to the luminiferous ether. He obtained an algebraical form of the energy-function which completely satisfied the conditions for a luminiferous ether; its essential property being that the energy depended only on the rotational displacements of its small parts. He was unable, however, to picture a stable material medium which would possess this property. We recognise now that such a medium is possible if the rotational rigidity is produced by intrinsic motions in the small parts of the medium of a gyrostatic nature. In a most masterly manner Larmor * has recently investigated by general dynamical methods the possibility of explaining electric and magnetic phenomena by means of the same energy-function. Electric lines of force are rotational filaments in the ether,† similar in fact to those I suggested at Bath, whilst a magnetic field consists of a flow of the ether. The same difficulty in accounting for electro-dynamic induction arises, but the general form of the equations for the electrodynamic and magnetic fields are the same as those generally received.

Towards the end of this Paper he is led to postulate a theory of electrons whose convection through the ether constitutes an electric current. Two electrons rotating round each other are supposed to produce the same effect as a vortex ring. The mass of ordinary matter is attributed to the electric inertia of these electrons. The electron itself is a centre or nucleus of rotational strain. If I express a doubt as to the possibility of the existence of these nuclei as specified, I do so with great diffidence.* Whether they can or cannot exist, however, the general results of the investigation are not affected.

Since this Paper was published Larmor has read a second one on the same subject before the Royal Society, developing further his theory of the electron. The publication of this will be awaited with interest. It is impossible in an address such as this to go *seriatim* into the numerous points which he takes up and illuminates, because the mathematical treatment of the general question does not lend itself easily to oral exposition, even to an audience composed of professed mathematicians. There is no doubt but that this Paper has put the theory of a rotationally elastic ether—and with it that of a fluid vortex ether—on a sounder basis, and will lead to its discussion and elucidation by a wider circle of investigators.

* "A Dynamical Theory of the Electric and Luminiferous Medium," *Phil. Trans.*, 1894.

† The necessity that the filaments shall be in pairs does not seem to be recognised. This is, however, essential. Moreover, if the complementary circulations of the filaments between (say) a plate condenser be placed otherwhere than in the same region, the filaments between the plates must rotate as a whole; that is, an electric field would always be combined with a magnetic one.

* It would appear that the same results would flow if two particles oppositely electrified—*i.e.*, joined by two complementary filaments, as already described—were to rotate round each other.

STORAGE BATTERIES.†

BY H. A. EARLE.

When I undertook to read a Paper before this Association, I hoped that I might have been able to treat the subject in a more exhaustive manner; the time at my disposal has, however, been limited, and the subject is one of such magnitude, and the results under different conditions of test so numerous, that I have found it impossible to do more than give a general outline from a practical point of view. It is interesting to trace the history of storage battery manufacture, and, by so doing, each step in the advance up to the present time can best be considered.

The discovery of secondary currents dates back to 1801, when Gautherot found that silver or platinum wires, which had been used to decompose a saline solution, were capable of giving a reverse current of short duration. Ritter in 1803 was, however, the first to make a secondary battery, in which he employed plates of gold separated by cloth or paper, the same being moistened with a saline solution; he experimented with various metals, including lead, but the secondary currents obtained were of short duration, and the batteries only of scientific interest. It appears at first sight strange that Ritter when using lead obtained no increased effects, this being the metal exclusively employed at this time; he, however, used salt water, and this formed chloride of lead scarcely soluble, and a very bad conductor. On this account the current was very weak in comparison with that which would have been obtained if water acidulated with sulphuric acid had been used. Since that time many scientists have investigated the subject, and De la Rive in 1826 obtained secondary currents from platinum plates in a voltameter filled with water and sulphuric acid, and he closely approached the elements of our present storage battery, when, among his many experiments, he used in a primary battery a platinum plate covered with a film of peroxide of lead, and a zinc plate, immersed in an acid solution. The first powerful storage battery was introduced in 1860, when Planté constructed cells composed of lead plates immersed in an acid solution of 1·068 specific gravity (10 per cent. acid); these were a success, with the exception that the method employed for their formation—namely, frequent charges, discharges, reversals of charge, and periods of rest—was too long and expensive for practical purposes, several months being necessary to obtain a useful capacity. The subsequent rapid development and improvements in electrical machinery and lamps created a real demand for a good storage battery, and turned the thoughts of many to the subject, and the next and one of the most important of subsequent improvements was that introduced by Faure in 1881—namely, of pasting a coating of lead oxide on the surface of the plates, which rendered them, after a comparatively short formation, ready for use. The Faure cell was never, however, as originally designed, a practical success, for though the active material was encased in a covering of flannel or felt, the pasted coatings, being on upright surfaces and having insufficient adherence, came away within a period not sufficiently long to give economical results. Swan realised that the active material required a better mechanical support, and introduced a plate of grid form, the interstices serving to retain the material; this frame, combined with the Faure pasting, was the origin of the plate that has been largely used in this country and elsewhere. Up to the date of the expiration of the Swan and Faure patents, the manufacture of pasted plates in this country was in the hands of one company and its licensees, and competition was thereby to a great extent absent; this is, however, more likely to have been an advantage than otherwise, for much has meanwhile been done to perfect and cheapen the production of the solid lead plates, and these are making such strides forward that it seems probable they will eventually outstrip and replace their pasted rivals. Solid plates have

† Paper read before the British Association at Ipswich, Section G.

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been made of various types, and some have been pasted to avoid the expense of formation, the paste in this case serving to give the required capacity till the action of charging and discharging gradually attacked the solid surface. Improved methods have, however, been discovered for effecting rapid formation at a reasonable cost, and, although pasting is now open to all, in all probability there will be little extension of its use—unless means are devised for the better retention of the material.

Another type which differs greatly from the solid lead plate, but which is not pasted, is the chloride plate. In this case the material to become active is a mixture of chloride of lead and chloride of zinc, which is cast into small tablets. These being framed by casting antimonious lead around them under high pressure the subsequent elimination of the chlorine and zinc leaves a porous structure of pure lead, of a crystalline nature, having good conductivity, and with a large surface exposed to the electrolyte, the result being a large capacity for a given weight and for the space occupied. The mere manufacture of an accumulator, with lead and sulphuric acid, is a simple matter, but when combined with the necessary requirements of low first cost for a given capacity and long life, it presents more difficulties than is perhaps generally supposed. Omitting the question of cost, the chief points to be considered are the *chemical action*, the *mechanical construction*, and the proper *treatment* of the cells when made. In lead batteries the minimum weight is limited by the chemical requirements: the theoretical value of lead peroxide is 4·44 grammes per ampere-hour, or roughly one pound is the equivalent of 100 ampere-hours; presuming that the positive and negative plates were identical, the value would be approximately 50 ampere-hours for one pound of peroxide and spongy lead. As a matter of fact the highest capacity plates yield only about seven ampere-hours per pound of positive and negative plates, or 16 ampere-hours per pound of peroxide and spongy lead, due to the facts that a conducting frame of considerable weight has to be employed, and to the impossibility in practical working of

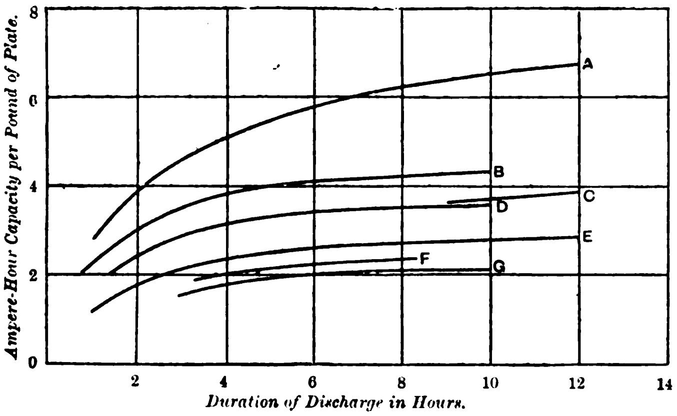

Fig. 1.

reducing the whole of the peroxide. To obtain the best results for a given weight, the frame must be reduced to a minimum consistent with the necessary strength and conductivity, and the distribution of the peroxide must be such as to admit of the perfect circulation of the electrolyte, and its penetration throughout the mass. When the active material is retained in holes or interstices due provision must be made for its expansion on oxidation, for the power exerted is so great that it will bend or burst a frame which holds it too tightly; various methods have been adopted to prevent buckling, but it is still a source of trouble with perforated pasted plates. Solid grooved or ribbed plates, however, the grooves on which are filled with paste, are not subject to the same extent to this fault. Solid plates on which the active material is formed out of the substance of the plate itself are practically free from it. In the chloride plate ample provision is made for this increase in volume by the elimination of the chlorine and zinc, which renders the structure porous and cellular.

Nothing is more interesting than the behaviour of cells under various conditions, and from the innumerable curves that can be plotted we can readily study the effects due to different rates of charge and discharge, to the penetration and strength of the electrolyte, and to the ratio of the positive and negative plates; from these and many other similar tests much useful information can be obtained for guidance both in manufacture and treatment. There is a given rate of charge for every type of cell which is most suitable, not only for its efficiency but also for its durability. With some types a high rate is quite inadmissible, and a period of ten hours is required. Other types, however, are of such a construction that they may be fully charged in four hours without detriment. This variation is mainly due to the disposition of the active material, to its thickness, and to the method of its production, namely, whether it has been mechanically applied, or electrolytically produced. Most of the effects of varying rates of charge can be ascertained from the resultant discharge, but discharge curves have nevertheless characteristics of their own which are to a great extent unconnected with the conditions of charge, and they depend upon the type of plate, strength of acid, the rate of discharge, and other influences.

A series of curves is shown in Fig. 1, and these give at a glance results obtained with plates of various manufacture; in every instance the weight of one positive and one negative has been taken. Knowledge of the ratio of weight of active material to frame is naturally necessary for the complete investigation of these curves, but in this case the weight of the plates themselves has only been taken into consideration, as it is merely intended to show results obtained from various types of plates at present manufactured.

Curve A is taken from plates, the active material on which is of a very porous and cellular nature, of $\frac{5}{16}$ths of an inch thick. It will be noticed that the capacity per pound of plate continues to rise up to the 12-hour rate, and at that point is still slightly on the increase. This increase is no doubt partly due to the gradual penetration of the acid, and partly to the rapid sulphation of the surface at the higher rates. Curve B is that given by a positive plate, the active material on which is distributed in a thin layer over a very large surface, the negatives being the same as employed for curve A. This plate gives less ampere-hours per pound of plate, owing to its possessing a heavy frame, but per pound of peroxide of lead its yield is greater; the active material in this plate is not formed out of the substance of the frame, but is entirely independent of it. A plate of this description, in which the whole face of the active material is directly exposed to the electrolyte, is capable of giving its maximum capacity at a comparatively high rate of discharge. A thin layer of peroxide spread over a large surface reduces the clogging of the surfaces to a minimum, and a free circulation of the electrolyte admits of fresh acid of the proper specific gravity being continually available. Curve C is obtained from a pasted plate suitable for slow rates of discharge, and from its rise in capacity at reduced rates we notice somewhat similar characteristics to that in curve A. There is, however, a remarkable point of difference between curves A and C, for the plates in each instance contain approximately 30 per cent. by weight of active material; curve A therefore gives us about double the ampere-hour yield per pound of active material over curve C, and this is obtained by the cellular and porous structure of the material in the A curve plate. Curve D is taken from plates cast with ribs on their surfaces, the active material being formed out of the substance of the plates themselves; the curve is very similar to B, but falls lower on the scale, this being caused by the weight of the positive plate, its thickness being considerable in order to give a reserve of metal, which in its turn is acted upon as the plate gradually disintegrates. Curve E is given by plates, the surfaces and interior being full of blow holes, which gives a large exposed area; their weight for a given output is, however, large. Curve F is a pasted plate with a solid frame, which gives a poor return for its weight; in this curve we notice the rise in capacity at reduced rates due to pasted plates. Curve G gives the capabilities of very heavy plates, which are pasted on their surfaces, the paste being intended merely to give the required capacity till its disintegration, by which time the frame itself has been sufficiently formed to do the work; the rapid flattening of this curve indicates that the layer of paste is thin.

The curve of voltage of a discharging cell varies greatly, and is dependent upon the rate of discharge, the strength of acid, the distance of plates apart, its curve of internal resistance, and the treatment it has been subjected to beforehand, besides many other interesting conditions. Fig. 2 demonstrates the effect of varying rates; these curves have all been obtained from cells of the same type, the acid having been approximately 1,210 specific gravity when the cell was fully charged. Discharges at varying rates are given—namely, 1 hour, $2\frac{1}{2}$, $3\frac{1}{2}$, $5\frac{1}{2}$ and $7\frac{1}{2}$ hours, and, though slightly different results would be obtained with other types of cells, they may be taken as fair approximation for general reference.

When considering the question of fall in volts on discharges at different rates, it will not be out of place to draw attention to conditions that are frequently given in specifications for storage batteries—in some instances a fall in volts not exceeding 8 per cent., 10 per cent., or 12 per cent. is allowed, and the rate in amperes, and the time in hours, for which the discharge is to be maintained, are stated. This is in most instances unsatisfactory, for what are we to take as our starting point? The E.M.F. on open circuit immediately after complete charge is practically a fixed value, with a given type of cell and a known strength of acid. But the fall in the first few minutes varies greatly according to the rates of discharge, and at high rates it may fall as much as 10 per cent. in a few minutes or even seconds, before a comparatively straight line has been reached, and the cell is working at its normal voltage for the specified rate of discharge. This is quite clear by reference to Fig. 2.

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Charge.						Discharge.							
Charge.	Duration of charge.	Rate in amperes.	Volts at end of charge.	Ampere-hours.	Watt-hours.	Dis-charge.	Duration of discharge.	Rate in amperes.	Volts at end of discharge.	Ampere-hours.	Watt-hours.	Percentage of efficiency.	
												Amp.-hours.	Watt-hours.
No.	Hrs. mins.					No.	Hrs. mins.						
1	3 0	15	2·68	45	..	1	7 30	15	1·68	113	218	...	...
2	9 45	15	2·68	146	...	2	7 45	15	1·70	116	227	79·4	...
3	12 0	15	2·68	180	428	3	9 25	15	1·70	141	278	78·3	64·9
4	12 30	15	2·67	187	443	4	9 50	15	1·70	148	285	79·1	64·3
5	8 45	15	2·50	131	299	5	8 40	15	1·70	130	255	99·2	85·3
6	11 15	15	2·40	169	399	6	9 35	15	1·91	144	274	85·2	68·7
7	11 15	15	2·38	169	398	7	9 32	15	1·915	143	276	85·2	69·3
8	10 35	15	2·136	159	324	8	9 15	15	1·90	139	273	87·4	84·2
9	10 35	15	2·333	159	375	9	9 10	15	1·90	138	264	87·4	70·4
10	10 15	15	2·333	154	361	10	9 0	15	1·90	135	265	87·6	73·4

Another point to which our attention is drawn is the fall of voltage on open circuit after the completion of charge. A series of curves (Fig. 3) are exhibited, showing the fall in voltage for a period of 21 hours, each curve being for a different strength of acid ; it is therefore evident that if a given percentage of fall is allowed, it will be most advantageous for the manufacturer, but not for the purchaser, to allow the battery to stand for a few hours in order that this useless high voltage be reduced. The best way to meet this point is, however, to take the first reading of voltage five or ten minutes after the discharge has commenced.

In other specifications the voltage is fixed to a hundredth of a volt, and the cell must give the specified capacity above this limit in many instances, and especially when high discharge rates are specified the voltage given is much too high on the curve, and in some instances I have found it actually fall on a straight portion of the same, so that the time at which this point is passed raises an unpleasant difference of opinion between the buyer and the seller. This class of specification generally necessitates a very much larger battery than was intended, with corresponding increased cost, and should the manufacturer not have been exceedingly careful in preparing his estimate, he may find that the buyer is not satisfied with a good excess of ampere-hours, but will have his volts as well, even if this means 50 per cent. in ampere-hours in excess of what he thought he was ordering.

There are many ways in which a specification can be framed so that a battery of the exact size required is obtained, and there is no doubt that it is most satisfactory to all concerned if the exact capacity in ampere-hours is specified, and the final voltage of the complete battery at a given rate, the number of cells being omitted. Under these conditions, if the individual cells are discharged down to a low voltage, more cells would be required, but each additional cell on a 100-volt circuit adds 2 per cent. to their number, and correspondingly increases the cost of a battery composed of cells of a given size. On the other hand, a low voltage per cell on discharge enables—up to a given limit—the number of plates per cell to be reduced, and the cost of cell as well. In a competitive tender the manufacturer would, therefore, work out the cheapest arrangement, and I find that this would not admit of the individual cells being discharged to too low a voltage, and that the purchaser would obtain exactly what he required at the lowest price. The actual number of regulator cells is of small moment to the user, and the additional number required when the individual cells are discharged down to a voltage of 1·8 in place of, say, 1·9, is only two in a 100-volt battery.

When tests are made to check the efficiency and capacity of a battery, we can place no reliance on the figures obtained from a single charge or discharge. As a rule no two consecutive discharges from a cell are identical, even when the same is discharged with the same current and down to the same voltage, every discharge being greatly influenced by the previous treatment. The table given above clearly demonstrates this :—

This table is in no way intended to be a guide as to what can be obtained in efficiency tests, but is merely to show the irregular nature of results obtained with slight variations in time, and maximum voltage of charge; the rated capacity of the cell was 15 amperes for 10 hours, or 150 ampere-hours. Charge No. 1 we can omit, as this was given to complete the formation of the cell. Charge No. 2 was for a similar purpose. Charge No. 3 was continued, as were also charges 1 and 2 till the voltage had practically ceased to rise ; a high voltage on charge gives a good return in ampere-hours on the discharge, but if a cell is forced to its maximum capacity we obtain a poor return in efficiency. Charge and discharge No. 4 are very similar to No. 3. Charge No. 5 was stopped when the E.M.F. had risen to 2·5 volts and 30 per cent. less ampere-hours had passed through the cell. Studying the figures up to the end of charge 5, it would have been practically impossible to assume what was going to happen on discharge No. 5 ; on taking this discharge we obtain 20 per cent. increase both in ampere-hour and watt-hour efficiency, and the very high percentage of the former, namely 99·2 per cent., points to the fact that peroxide which had been previously inactive was reduced. The first five discharges you will note were all taken down to 1·70 volts ; this cell had never been used before, so we have its history up to the tenth discharge in the table. The strength of acid at end of charge was practically 1·300 specific in every instance. Charge No. 6 was only continued to 2·40 volts, but it required 2½ hours longer charge to reach this voltage than it previously did on charge 5 to reach 2·5 volts, and this was without doubt due to the good service rendered on the last discharge. The remaining charges and discharges show that the highest efficiencies are obtained when the cell is not charged up to a high voltage, and if worked within reasonable limits 90 per cent. in ampere-hours, and about 80 per cent. in watt-hours, can be obtained with the cell in question when in good order.

Usually, efficiency is not of great importance, for presuming a central-station battery to give one-tenth of the total supply, a variation of even 10 per cent. in efficiency would only represent 1 per cent. variation in the total output; but the time may come when batteries are so cheapened and perfected, that they supply the whole demand of our stations, and their efficiency will then be one of importance, and we may be confronted with specifications as strict as those now framed for dynamos.

The strength of acid solution to be used in a cell is an important point. In the first place, this greatly influences the voltage, as we have seen from Fig. 3; it has also a great effect upon the life ; besides this, in strong acid the plates sulphate more readily, and the sulphate is more difficult to reduce ; it is therefore necessary to carry out most careful tests to ascertain what strength of acid should be used in each type of cell.

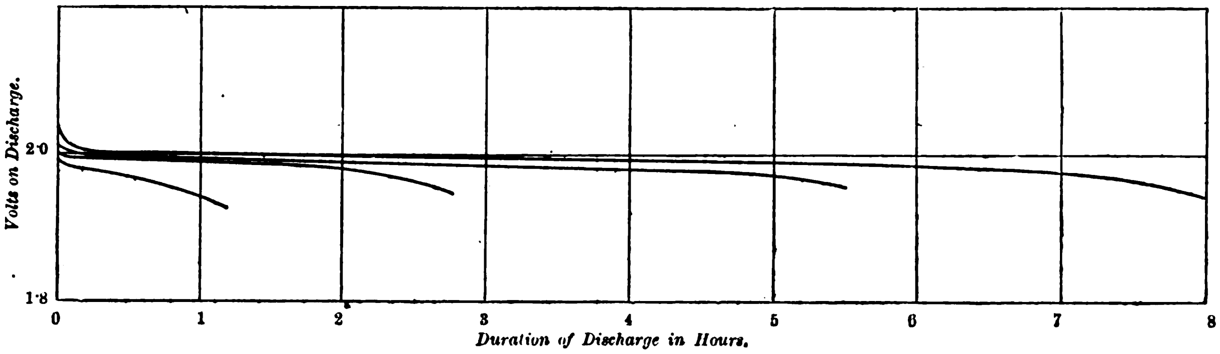

Fig. 2.

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The resistance of acid solutions of different strengths is also a most important consideration, and on Fig. 4 four curves are shown giving its resistance at 0°, 8°, 16° and 24°C. Taking 16°C. as a mean working temperature, it will be noted that acid of about 1·250 specific gravity has the least resistance, and it might be assumed, therefore, that this was the best strength to work at; but we must bear in mind that this strength does not give us the highest voltage, and, moreover, the gravity gradually falls as the cell discharges, and when working with this strength we have falling voltage on discharge, and at the same time increasing resistance of the electrolyte; no fixed law can be laid down, as each type of cell requires a given strength for best results.

Immediately upon commencing our research with a view to ascertain the proper strength of acid, we find that we are confronted with another problem of great interest, which is that different

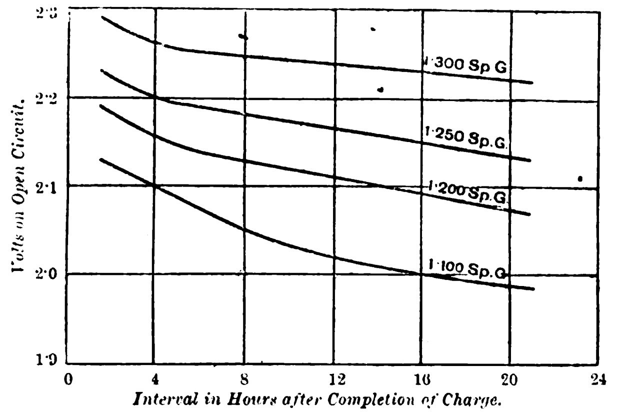

Fig. 3.

strengths give us different capacities from our cell. Fig. 5 gives two most interesting and instructive curves taken from two cells of the chloride type—one with positive and negative plates of 0·24 of an inch thick (curve A), and one with positive and negative plates of 0·4 of an inch thick (curve B). Each cell was discharged at a rate equal to 0·45 of an ampere per lb. of plate. The rate per pound of active material is nearly the same for each cell, though perhaps slightly higher for the thinner plates. The rate of discharge per superficial area was therefore approximately 40 per cent. greater with the thick plates than with the thin. The curves give the yield in ampere-hours per pound of active material with different strengths of acid. Considering the thin plate curve first, we find that with acid of 1·070 we do not obtain more than about 3 per cent. of the maximum capacity; from this point to 1·230, at which point we obtain the maximum capacity, it rises very rapidly;

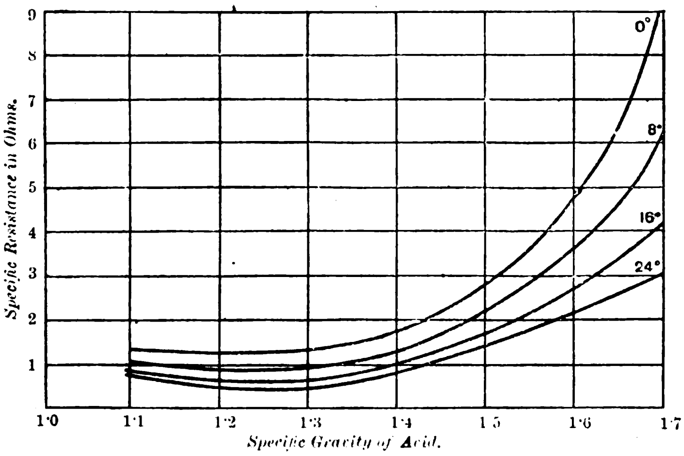

Fig. 4.

each addition of 1 per cent. to the sulphuric acid present in the electrolyte giving an increase of about one ampere-hour capacity per pound of peroxide. From 1·230 to 1·500 it falls as rapidly almost as it rose, and at the latter figure we obtain only 16 per cent. of the maximum. Taking the thick plate curve: at 1·040 specific gravity we obtain about 6 per cent. of the maximum capacity, and it rises till 1·270 is reached; it then falls rapidly, and at 1·500 the output is practically *nil*. Considering these two curves we note that the thin plates give as a maximum 15 ampere-hours per pound of peroxide and spongy lead, or 30 ampere-hours per pound of peroxide alone, or about one-third of the theoretical value. The thick plates, on the other hand, give 10 ampere-hours per pound of peroxide and spongy lead, or 20 ampere-hours per pound of peroxide alone, or about one-fifth of the theoretical value.

The natural question is, Why is this the case; also why are the thick plates the best with very weak acid, and why do they give such a much poorer return with acid of the strength usually employed? I consider that, up to the point at which the curves cross, the better result obtained from the thick plates is due to the fact that on completion of the charge in weak acid the active material is saturated with strong acid, and the quantity contained in the same would be greater with the thick plates than with the thin, and they would therefore give a better output with weak acid than the thin plates. Their increased thickness, however, is of no advantage with acid of the ordinary strength, when the capacity is chiefly dependent upon the penetration of the acid. If we study the portion of the thick-plate curve between 1·150 and 1·400 specific gravity, and compare it with the thin-plate curve, we find that the capacity is practically reduced inversely as the thickness or weight of the plate, and the rate of discharge per superficial area. Quite apart from the question of the proper thickness of the active material, we can see at a glance that very different capacities are obtained with different strengths of acid. On the top of the same figure the mean volts during the discharge are given; these, it will be seen, rise steadily as the strength of the acid is increased. A striking feature is that the curves of voltage cross at the same point that the curves of capacity cross. Upon consideration we come to the conclusion that this is what would be expected, as the rate in amperes on discharge was the same in every case, and an increase in ampere-hours per pound of material means a longer time to complete the discharge, and we see from Fig. 2 that the greater the length of the discharge the higher the mean voltage.

It is the manufacturer's business to make as good a cell as possible, but when it leaves his hands it is judged by the service it renders during its life, and this depends to a very great extent upon

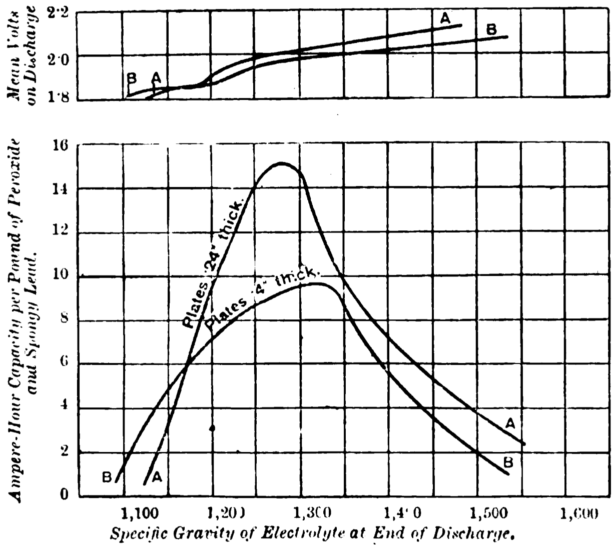

Fig. 5.

the treatment it receives. In the first instance, purity of the electrolyte is essential; brimstone acid should be used, as this is the least likely to contain foreign substances. If this is diluted on the spot the water must be pure, preferably rain, or, if possible, condensed water. With regard to the first charge of the battery, it is generally imperatively stated that this must commence immediately upon the acid being put into the cells; this is, no doubt, necessary with imperfectly-formed pasted plates, or with plates which have been for some time exposed to the air, as they would readily sulphate and require a considerable time to reduce. But positive plates which have been fully formed, and negatives in good condition, are very slightly affected.

Fig. 6 gives five curves, which I have prepared in order to show results obtained from plates in different conditions, some having been left standing in the acid while others were charged. Curve A shows the specific gravity of the acid in the cell in which the plates were allowed to stand for 22½ hours without being charged. During this period it remained absolutely constant—sulphation was therefore absent; the charge was then commenced and continued for eight hours—a rise in specific gravity took place, raising the electrolyte to a gravity above that at which it was put into the cell, which showed that sulphate was previously present in the plates. Curve B shows what happened in another identical cell. Directly the charging current was started the gravity fell rapidly. This I presume is due to the formation of oxide of lead from the pure lead remaining in the active material, and this is sulphated before becoming peroxide of lead. The current throughout the charge was kept constant, and from the curve we see that practically the same number of ampere-hours were expended during the fall as

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during the rise; the specific gravity in this instance also rose slightly above its initial value. The plates in Curve C, which had been standing, sulphated slightly, and reproduced on being charged to a small extent a similar curve to B, and the plates (Curve D) which were charged at once give a very small fall but a considerable rise, showing that sulphate was present in the plates. Curve E is for plates which stood before being charged, and in this instance we notice that no sulphation took place, and that they gave a small fall and rise. My chief object in giving these curves is to demonstrate how very slight differences can give considerable variations.

To return again to the treatment of cells, the chief causes of destruction are too prolonged or excessive rates of discharge, insufficient charging, overcharging, long periods of rest on open circuit without charging, and allowing cells to remain after complete discharge for many hours before recharging. There is also another point which is worth mentioning. Frequently, through under charge or over discharge, the plates become heavily sulphated, the cells no longer give their proper output, and the specific gravity of the electrolyte falls considerably. Of course, a prolonged charge will put this right, but frequently it is assumed that, as the specific gravity is low, the acid merely requires strengthening, and this is done with the best intentions; the fault is, however, aggravated and the plates sulphate more heavily than before. I found on one occasion that acid had been periodically added, and the specific gravity rigidly maintained at 1·200, the charge being always stopped when this strength was reached. The cells were naturally working badly; a prolonged charge was accordingly given, and this raised the strength of the electrolyte as high as 1·450 in some cells, which was a clear indication of what had been done. We find, therefore, that a multitude of causes influence the working and life of storage batteries, and that many of these can be varied at will; the problem, therefore, is to so combine all useful effects that we produce the best possible article with due consideration to low cost. It would be a natural question to ask, What do you consider the best possible article?—and this is easily answered. In a secondary battery we have lead, sulphuric acid solution, and the resultant compounds, and nothing else. The ideal cell is one that is indestructible, and this being given, the first cost and weight, if kept within reasonable limits, are of little moment. At the present moment the life of a cell is its value, and all types are constructed with the knowledge of certain death, and in most types this lingering death is provided for, for we find at the bottom of the boxes a sufficient space to act as a receptacle for the deposit from the disintegrating plates; in other types, where the active material is held permanently in position, disintegration still goes on, with consequent loss of contact. Now this disintegration is what we have to stop; the deposited disintegrated material is as good as ever, for nothing is wasted, and provided it were held in perpetual firm and good electrical contact with the frame, in such a manner that the free circulation and penetration of the acid were not hindered, and the internal resistance were not unduly increased, we should have produced an ideal and indestructible cell.

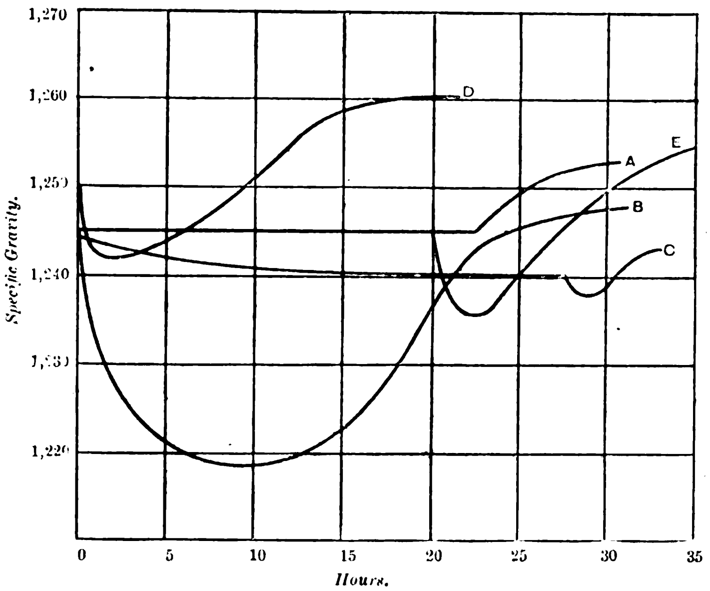

FIG. 6.

I have brought to your notice only a very few of the many interesting features in connection with secondary batteries, and these only in a most superficial manner. I have, however, endeavoured to give a general outline of results obtained in practice, and have not entered into a discussion upon other more serious questions. Many conjectures arise in one's mind when considering the causes of different effects, and each point requires much time and study in order that a fixed law may be deduced from the results obtained, and, again, the results of tests are often so conflicting, and depend so much upon very small differences of condition, that it is by no means an easy matter to arrive at the truth.

SOME LESSONS IN TELEPHONY.*

BY A. R. BENNETT, M.I.E.E.

In 1845 Mr. J. C. Bourne, in his history of the Great Western Railway, wrote: "It is a well-established truth in the history of trade and commerce that the traffic between two cities or countries will increase in proportion to the facilities of communication afforded, or to the speed, security, and cheapness with which such communication can be effected." The truth of this proposition had been demonstrated before Bourne's time in respect to common roads and waterways; since experience has shown that no town can prosper unless it be connected with the railway system of the country. In the beginning, several towns, by spending large sums in opposing railway Bills, succeeded in keeping off the main lines of communication, but the magnitude of the error has long since been manifest, and great efforts have been made, not always successfully, to repair it. Bourne's axiom may nowadays be admitted to embrace telegraphic and telephonic facilities, for places wanting these are at a great disadvantage as compared with more fortunate neighbours. If commerce may be held to constitute the life-blood of a modern nation, roads, railways, and waterways are the arteries through which this blood is conducted, while telegraphs and telephones may be compared to the nerves which feel out and determine the course of that circulation which is a condition of national prosperity. Given two nations, equal or nearly so in natural resources and in the talents and industry of their inhabitants, that one will succeed the better in commerce which possesses the most extended and cheapest facilities for transport the general intercommunication. It has recently been demonstrated that the United Kingdom is deficient in at least two of these essentials—railways in their branch or feeder form, and telephones, which are the natural feeders of the telegraphs. Why this is so may best be discovered by ascertaining by what means, technical or economical, those nations which have most conspicuously outstripped us have attained their superiority. For the purposes of this Paper, in which is considered the telephonic branch of the question, the countries of Europe have been divided into three groups: (1) well telephoned; (2) indifferently telephoned; (3) badly telephoned.

A country may most properly be said to be well telephoned when its smaller towns and villages enjoy facilities, for the existence of a few large exchanges in the capital and chief towns does not entitle it to that distinction. For instance, France, Russia and Portugal all possess good exchanges in their capitals, but are nevertheless badly telephoned as a whole, since their smaller towns and villages are excluded from the circle. On the other hand, we find that the Grand Duchy of Finland, under the same crown as Russia, but enjoying a different system of administration, is distinctly well telephoned. Its area exceeds that of the United Kingdom, although the greater part of its surface consists of lake, forest and waste; its staple industries are fishing and agriculture, yet a telephonic map of Finland discloses a veritable network of lines. All the towns and many of the villages possess exchanges, while the capital, Helsingfors (population 65,000), is one of the best telephoned cities in the world. Last year there were 198 exchanges in Finland, or one to each 12,626 inhabitants. In the United Kingdom there were but 578 exchanges, or one to each 65,537 inhabitants. In proportion to its population, Finland had therefore more than five times as many centres of telephonic activity as the United Kingdom. Even the people of the Aland Islands, in the middle of the Baltic, find a telephone exchange so well worth paying for at the rates which are found remunerative by the exploiting company that in Mariehamn, the capital, there is an exchange telephone to every 13 inhabitants. In fact, Mariehamn is entitled to the distinction of being the best telephoned town in the world. Another Finnish town, Viborg (population 22,344), has an exchange telephone to every 33 inhabitants, and other towns have one to 36, 37, 39 and 40.

Norway is, however, the best telephoned country on the whole. It has a population of 2,000,000, and has little to rely upon in the world's struggle but agriculture, forestry and fishing. Seventy per cent. of its total area is uncultivable, and another 24 per cent. is forest. It has but half-a-dozen towns, the bulk of the population residing in widely-scattered villages. Yet it possesses no fewer than 256 telephone exchanges, or one exchange to each 7,812 inhabitants—more than 8½ times the number in the United Kingdom in proportion to population.

* Paper read before the British Association at Ipswich, Section G.

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Sweden, which takes the second place in the list of well-telephoned countries, possesses greater resources than Norway. It has a population of not quite 5,000,000, one-half of which is dependent on agriculture. Eighty per cent. of the people live outside the towns. A radius of 43½ miles round Stockholm, equal to 5,945 square miles, is unquestionably the best-telephoned bit of country in the world. Almost every village possesses two competing telephone exchanges, while rival systems of trunk lines place the whole of this large area in practically instantaneous communication.

Denmark, with its population of 2,250,000, and its staple industries of agriculture and dairy farming, takes an honourable place, having 152 telephone exchanges within its borders, or one to every 14,639 inhabitants.

The four foregoing countries form a class by themselves. Their telephonic development has been due almost exclusively to companies and co-operative societies. In Sweden the State has of recent years assumed an important position in respect to telephony, but its proceedings and tariffs have been based upon the previously-established procedure and tariffs of the companies whose systems it found in operation. In the two next instances the development attained is due wholly to the fostering care of the respective States.

Switzerland has a population of 3,000,000, which is served by 155 telephone exchanges, or one to every 19,355 inhabitants. All its towns and many of its villages possess telephone stations, and are connected by trunk lines. The Grand Duchy of Luxemburg contains 998 square miles, which is also precisely the area of Dorsetshire. The respective populations are 211,088 and 194,517. Agriculture is the staple industry of Luxemburg, as it is of Dorset.

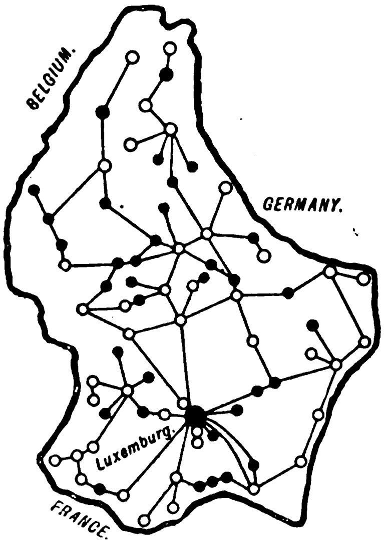

Fig. 1.—Telephonic Map of the Grand Duchy of Luxemburg. Area, 998 sq. miles. Population, 211,088.

We find, however, that while Luxemburg possesses 59 telephone switch rooms within its borders, or one to each 3,577 inhabitants, Dorset has only three—Dorchester, Weymouth, and Poole—or one to each 64,839. Luxemburg had last year 1,315 exchange lines; Dorset, at the present moment, possesses about 70. In Luxemburg there is an exchange telephone to every 160 souls; in Dorset, one to 2,778. Every town and village of Luxemburg is in telephonic communication with the capital and with each other. The accompanying maps (Figs. 1 and 2) exhibit the different stages of development attained in these two equal areas. And yet many counties are worse off than Dorsetshire is.

This completes the list of the European countries which are well telephoned, and constitute Group I. The least favourable result in this group is 328 persons per exchange telephone. A considerable jump must be made in order to reach the best country of Group II. This is the Imperial German Post Office territory, which comprises the whole of the German empire except Bavaria and Wurtemberg. Within its limits there was last year one telephone to every 449 inhabitants. It is noteworthy to remark that the comparatively good position taken by Germany is due to the fact that Berlin, Hamburg, Frankfort-on-Maine, and other chief towns possess very large exchanges, Berlin and Hamburg being amongst the largest in the world, even Hamburg (population 622,530) having a larger number of subscribers than London (population 5,600,000). But the small towns and villages are not developed, and rural intercourse by telephone is practically non-existent. The reason is that the German Post Office has a uniform tariff, applicable equally to the capital and to the smallest village, which, although reasonable for Berlin, is prohibitive for the country folk. The results obtained in Bavaria and Wurtemberg are not dissimilar. Wurtemberg has a lower initial tariff than the Imperial Post Office, but is hampered with restrictions which operate against rural development.

The United Kingdom comes next in order of merit, with one exchange telephone to every 636 persons. These figures, like the Continental ones, refer to last year. The ratio has improved since then both at home and abroad, but the relative positions remain unchanged.

Holland and Belgium complete Group II. A wide gap intervenes between this and Group III., or badly-telephoned class. The best country of this is France, with one exchange telephone to every 1,432 persons; and the worst is Russia, which can only show one to each 13,102 inhabitants.

The foregoing facts are presented in the table, which also gives the leading characteristics of the management in each country.

The questions naturally arise, "To what causes are such vast differences in development to be ascribed?" and "Why is the United Kingdom, with its preponderating commercial importance and unparalleled spirit of enterprise, only tenth on the list, instead of first?" A study of the table supplies the answer. It shows that telephonic development is proportional to the prevalence of the following features: (1) Low rates; (2) local management; (3) facilities for rural intercourse; (4) competition. At least three of these are characteristic of each of the six countries which compose Group I. On the other hand, they are almost completely absent from Groups II. and III., the leading characteristics of which are (1) high rates, (2) centralised management, (3) neglect of small towns and rural districts, (4) absence of competition.

The operation of low rates and competition in the direction of development is easily understood, but that of local management is not so obvious. Its importance, however, is great. No two places are precisely alike in commercial, social or topographical features, and telephonic arrangements which suit one neighbourhood admirably are not appreciated in another where other conditions call for other plans. To meet the wants of a locality fully, it is necessary that its character should be thoroughly understood at the headquarters of management, and this, when exchanges are numerous, is not attainable. On the other hand, a Board or council of local men know the requirements of the community exactly; hence the superiority of the results presented by the Scandinavian local companies and co-operative societies. Wherever management is centralised, uniformity is aimed at as a means to economy and of saving trouble, and what appears good in the capital is apt to be imposed on every other town.

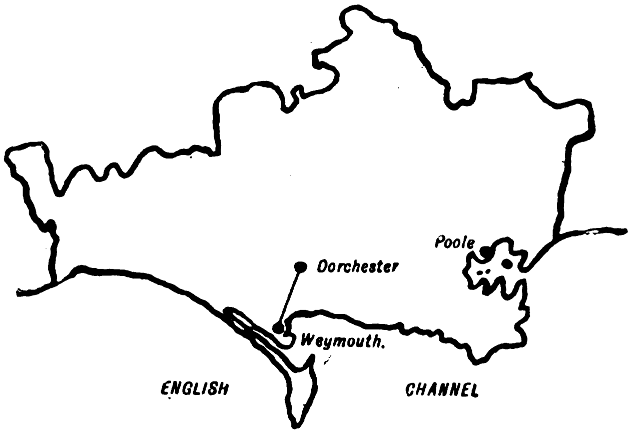

Fig. 2.—Telephonic Map of the County of Dorset. Area, 998 sq. miles. Population, 194,517.

In the countries of Group I. special attention is given to small town and rural development. In Switzerland a village council, commune, or other local authority may establish and manage a telephone station in one of its own buildings, and work it with its own employés, simply paying to the State the ordinary subscription of £4. 16s. for the first, £4 for the second, and £3. 4s. for the third and subsequent years, for the privilege of a junction with the general telephone system of the country. Such stations, of which there are 129 in Switzerland, are available for the despatch and receipt of written telegrams as well as of telephone messages. The local authority is authorised to collect a small surcharge on the ordinary tariff to cover expenses incurred for wages, office, and the annual payment to the State. In Luxemburg a similar system prevails, and is taken advantage of by 34 local authorities. The annual payment to the State for the connection of the municipal station to the general system of the country is uniformly £4 per annum. France has adopted a similar system, but with a much higher scale of charges and with restrictions which appear irksome

Table.

Order of merit.	Country.	Population.	Number of exchange telephones.	Number of persons to each exchange telephone.	Characteristics of Management.
	GROUP I.				
1	Norway	2,000,917	13,943	144	Very low rates. Local management of exchanges. Good rural intercourse. No competition.
2	Sweden	4,784,981	32,602	147	Very low rates. Local management of exchanges in part. Good rural intercourse. Competition.
3	Luxemburg	211,088	1,315	160	Very low rates. Central management, but with delegated control in some cases to local authorities. Good rural intercourse. No competition.
4	Switzerland	3,000,000	17,422	172	Ditto ditto ditto.
5	Denmark	2,185,335	10,325	211	Very low rates. Local management of exchanges. Good rural intercourse. No competition.
6	Finland	2,412,135	7,351	328	Very low rates. Local management of exchanges. Good rural intercourse. Competition.
	GROUP II.				
7	Imperial German Post Office Territory	41,796,966	93,131	449	Fair rates for urban subscribers in large towns; high rates in small towns. Highly centralised management. Bad rural intercourse. No competition.
8	Bavaria	5,594,982	12,400	451	Ditto ditto ditto.
9	Wurtemburg	2,036,522	4,430	459	Low rates for urban subscribers, but with regulations tending to restrict suburban and rural intercourse. Centralised management. No competition.
10	**United Kingdom**	**37,880,764**	**59,569***	**636**	High rates, with regulations unfavourable to development outside towns. Local management in part. Practically no competition.
11	Holland	4,669,576	7,263	643	High rates in three chief towns; low rates elsewhere. Management chiefly centralised. Bad rural intercourse. No competition.
12	Belgium	6,136,444	8,757	700	High rates in large towns; low rates of recent origin in small towns. Centralised management. Indifferent rural intercourse. No competition.
	GROUP III.				
13	France	38,343,192	26,772	1,432	High rates; subscribers also pay capital cost of their installations, except in Paris and Lyons. Centralised management. Bad rural intercourse. No competition.
14	Spain	17,800,000	10,984	1,618	High rates in large towns. Recently introduced reduced tariff for smaller towns. Local management. Bad rural intercourse. No competition.
15	Austria	23,895,413	14,574	1,640	Fair rates, but subscribers pay capital cost of their installations. Centralised management. Bad rural intercourse. No competition.
16	Italy	30,535,848	12,067	2,530	High rates in large towns, except in Rome, where competition exists; low rates in Rome and in small towns, but under strict Government supervision. Bad rural intercourse. No competition except in Rome.
17	Hungary	17,463,473	5,563 *	3,139	High rates in towns; very low rates in villages, but combined with regulations which tend to restrict communication between towns, suburbs, and villages. Partly local management. No competition.
18	Portugal	5,000,000	1,483	3,371	Exchanges only in Lisbon and Oporto. Fair rates. No rural intercourse. No competition.
19	Russia	97,151,789	7,415	13,102	Highest rates in Europe in chief towns; high rates in smaller towns. Partly local management under Government rules. Bad rural intercourse. No competition.

* Company 58,367; Post Office, 1,202.

to the local authorities, since in 1894 only 10 municipal stations existed in the whole of France. In the Scandinavian countries and Finland, local management has had even freer play, with the highly satisfactory result disclosed in the table. The third town of Norway, Trondhjem (population 30,000), is worked by the municipality most successfully at very low rates.

On inquiring in what manner circumstances differ so gravely in the United Kingdom as to preclude the possibility of small towns and rural communities availing themselves of telephonic communication, it appears that, apart from the want of local control and competition, the inelasticity of the present system of tariffs, which was originally invented for towns, is much to blame. In towns distances are short, and subscribers, if the switchrooms are properly distributed, have seldom to pay more than the unit charge; but in country districts distances of several miles must often intervene between the subscriber and switchroom, and as the annual rental exacted increases rapidly with the distance the charges become piled up by the extra mileage beyond the means of the majority of the population. What is wanted is the application of the Austrian (which with some modifications has also been adopted in Luxemburg) system of tariffs, under which all subscribers, whatever their distance may be from the switchroom, are put on an equality as regards annual subscriptions, the only difference being made in the initial payment on joining the exchange, which varies with the length of line required, the object being to reimburse the owners of the exchange system once for all for the additional cost of the extra mileage. In Austria the annual subscription is the same for any distance up to 15 kilometres (9¼ miles). In Luxemburg the annual subscription, provided the distance of the subscriber from an existing route of wires is not greater than 1½ kilometres—which is seldom the case, so numerous are the lines—is always £3. 4s. per annum, which covers all charges for service and maintenance, and confers the right to talk all over the Grand Duchy, which measures 44 by 30 miles. If a subscriber is situated outside the free radius which surrounds every switchroom, he makes, on joining the exchange, an initial payment, designed to cover the cost of the line which intervenes between the free radius and his place. This is charged at the rate of £4 per kilometre only, and the payment may furthermore, if desired, be spread over five years. If located within the free radius, the subscription is simply £3. 4s. per annum without an initial payment. Comparisons are often instructive, and it will be interesting to examine the differences resulting from the application of this system and that which prevails at home.

In Luxemburg a subscriber located five miles (eight kilometres) from the boundary of a telephone area (provided he is not more than 1½ kilometres from an existing line) will pay: A compensation for extra distance, £5 × £4 = £20 in one payment, or, if he chooses, divided in five annual payments of £4, and thereafter an annual subscription of £3. 4s. If 15 kilometres (9¼ miles) away he pays £15 × £4 = £60 down, or £12 for five successive years, at his option, together with an annual subscription of £3. 4s. He may be taken to pay £15. 4s. for the first five years, and £3. 4s. per annum for all time thereafter. The British Post Office charge £14 per annum per mile, so that a subscriber five miles from a switchroom would be charged £70 per annum in perpetuity, while one 9¼ miles away would pay no less than £134 per annum. The National Telephone Company's charges would be more than this in the metropolitan area and less in the provinces, but always, as experience has amply proved, prohibitive.

The different results aimed at in the United Kingdom and in Luxemburg need, therefore, create no surprise. They are simply examples of cause and effect. It cannot be said that such rates as are applied in Luxemburg do not pay. Accounts and balance sheets have recently been published† which prove that even lower charges

† "The Telephone Systems of the Continent of Europe."

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are made remunerative by local companies and municipalities in Holland, Denmark, and Norway.

The telephonic development attained in the Aland Islands, the entire population of which numbers but 18,000, has been mentioned. What have we to show at home of a corresponding nature? The Isle of Man (population 55,608) has one exchange. The Isle of Wight (permanent population 78,672, which is much increased in summer), containing seven or eight flourishing towns, possesses no telephonic facilities whatsoever; and the Channel Islands (population 92,234) are in equally bad case, although both Jersey and Guernsey are places in which a good telephone system would be of the utmost value, owing to the necessity the farmers are under, especially at certain seasons, of maintaining good communication with the ports, St. Helier's and St. Peter's. Exchanges in these towns alone would be next to useless; it is necessary to bring the outlying villages and scattered farmsteads into connection with them, and as this would necessitate many lines of from two to five miles in length, the existing tariff both of the Post Office and National Telephone Company are prohibitive and impracticable in a ludicrous degree. But an intelligent application of one or other of the Norwegian, Finnish, or Luxemburg methods would speedily cover the islands with telephone lines, and that with profit both to the servers and the served. The cases of Jersey and Guernsey have, unfortunately their parallel in most of the country districts in the three divisions of the United Kingdom.

One of the Norwegian companies—the Drammens Uplands—affords a striking example of profitable rural telephony. The area for which it holds a concession from the Government extends over five counties and measures 143 miles from north to south, the most important places served being the villages called Kongsberg and Hönefros. At the end of 1894 the Company possessed 24 switchrooms, 292 subscribers, 478 miles of poles, 1,553 miles of lines, including 671 miles of metallic circuits. Its annual subscription, which covers a line not exceeding 2 kilometres in length, and the right of free conversation over the whole of the five counties, is only £5. 11s. 1d. Its capital account stood at £9,815; its receipts from all sources of the year amounted to £2,332; the net profit was £752 and the dividend 6 per cent. This dividend has been paid regularly during the five years of the Company's existence, and a deterioration and reserve fund built up besides. These are facts which should surely plead against the present era of telephonic stagnation.

The technical features of the Continental systems are, as a rule, best where the tariffs are lowest and the extension of communication greatest. The conditions laid down by the author in his Paper on "The Telephoning of Great Cities," read at the Cardiff meeting of the British Association in 1891, as being necessary to a well-ordered exchange, are fulfilled more nearly in Sweden than elsewhere, especially by the General Telephone Company, which operates in Stockholm and a radius of 43½ mile around. Metallic circuits are universal; special attention is given to prompt switching, and Stockholm is divided into eight nearly equal divisions, each containing a switchroom. The prompt and economical addition of new subscribers is thus rendered easy. The speed achieved in switching is that stated in the Paper to be practicable and proper in a good exchange—viz., 10sec. The countries comprising Groups II. and III. are, with some exceptions, technically behind those of Group I. The reason lies on the surface. The conditions which prevail in Group I. bring about rapid extension; rapid extension involves the solution of problems which do not present themselves while exchanges are in their infancy, and the solution of such problems evolve superior engineers.

THE ONTARIO DRAIN TUNNEL AND ELECTRIC PLANT.*

BY C. R. MC KAY.

The adverse financial conditions which have prevailed during recent years have cut with peculiar keenness into the profits of the silver mining industry, and those mines which can now be profitably worked are exemplifications of the survival of the fittest. Their vast mining and milling plants call for the exercise of almost all branches of science and engineering. Probably no mine system in the world possesses more features of interest and instruction than the Ontario and Daly mines, worked in conjunction under one ownership, and located near Park City, Utah, in the Wahsatch range. The recent completion of the Ontario drain tunnel and the utilisation of its waste water to furnish electric light and power for the numerous works and mills of the Companies present some features which seem to justify description, and which may convey valuable lessons to those engaged in similar projects.

The Ontario has four vertical shafts, only two of which are at present actively used, the several shafts having been sunk in order to reach the ore bodies in the most convenient and economical manner. The shafts now used are No. 2 and 3, the former being at present 1,500ft. in depth and the latter 1,100 feet. The underground workings of these mines have attained such vast dimensions, that if placed end to end, they would form a continuous tunnel nearly 60 miles long.

The chief difficulty and expense encountered during the operation of this mining enterprise has been the disposition of the water which pours into the underground excavations from subterranean reservoirs and streams. Two means only existed by which this could be controlled, these being the continual operation of large and numerous pumping engines, and the cutting of tunnels from the lowest available point of the workings to some surface location which afforded natural drainage for the final disposition of the flow. Either method, of course, involved great expense.

When Ontario shaft No. 3 had reached a depth of 600ft., the quantity of water had become so formidable that considerations of economy impelled the management to run a drain tunnel from the bottom of that shaft to a point nearly a mile distant, through which the drainage was carried off. For several years this tunnel proved equal to the requirements, and resulted in great saving to the Company; but, as the shafts went deeper and the lateral workings extended, the water again became an intolerable burden, and far more serious than ever before, for at this time the Ontario was operating much deeper than any of the surrounding mines, and the ramifications of its underground work had assumed such proportions that not only had the local water greatly increased, but the mines located round about, and, in fact, the entire neighbouring country, had begun to drain into the lower workings of the Ontario. In one case a large adjacent mine which had been unable to contend against the water, and had been closed down on that account, became absolutely dry, and remains so to-day. When the Ontario had reached a depth of 1,200ft. it became necessary to run a new drain tunnel, and to locate it at a depth sufficient to provide for extensive operations in the future.

The decision, as finally made, was to run eastward from the 1,500ft. level of No. 2 shaft, the total length of the tunnel being approximately three miles. It was expected that six years would be required to complete the work, and that the cost would approximate $500,000.

Work was begun on this tunnel July 25, 1888, at the east end. The first 300ft. were driven entirely by hand, during the erection of machinery at the mouth of the tunnel. During November, 1891, a tremendous body of water was encountered, which drove out the men from the face. Bulkheads were useless. Nothing could restrain the flow, and all that could be done was to wait for the water to exhaust itself. The volume was so great that for a distance of 9,000ft. the track had to be raised, because of the insufficient water way, and parts of the track were entirely washed out. Seventy-one days were lost before work at this point could be resumed. As the tunnel neared completion, it became evident that the flow of water therefrom would be permanent and of considerable amount, though no means existed by which the normal flow for the future could be accurately foretold. However, the quantity of water handled by the pumps during past years was known with reasonable accuracy, as was also the decrease in that quantity due to the approach of the face of the new drain. Measurements of the flow at the tunnel mouth had been made from time to time, and comparison of these various sets of figures gave some indication as to the future discharge, and showed that opportunity existed for securing additional conveniences and economy by utilising the water at the tunnel mouth, where a short and steep fall was readily available.

The idea of electrically transmitting this waste energy to those distant points where it could be usefully applied was adopted by Superintendent R. C. Chambers, and the matter of designing and constructing a suitable plant was referred to the writer. Surveys and measurements made at this time, while the tunnel was yet several hundred feet from completion, showed a steady flow of water amounting to about 800 cubic ft. per minute, and an available fall close to the tunnel mouth of 125ft. in 380ft. The general opinion was that a decrease would take place in the near future, but many facts and figures convinced the engineer in charge of the work that a permanent increase would occur in the flow at the mouth. Accordingly a plant was decided upon of sufficient capacity to furnish light to all of the hoisting works, mills, and dwelling houses belonging to the Ontario and Daly mining companies, and sufficient power during the day to drive the machine shops of the mines and mills. No underground lighting was attempted. The choice of a route for the transmission line lay between an overhead line, following a well-travelled road through cañons for a maximum distance of about 6½ miles, and an underground line through the tunnel, to a point well adapted for a centre of distribution, and offering advantages in saving of copper and ease of inspection. The overhead route was considerably the longer, involved a somewhat wider distribution of lead along the main line, and exposed the line to extremely heavy winter weather and to frequent and

* Abstract from the *Engineering Magazine*.

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severe storms during summer. This route was easy of inspection throughout, except in winter weather. The underground route presented the advantages of a shorter line, greater facilities for uniform voltage throughout the system, and absolute protection of the transmission from bad weather and lightning; the entire main line, too, could be inspected and repaired by a workman without dismounting from a tram car. On the other hand, the cost of erection and danger of accidental contact were greater, and the maintenance of proper insulation of the line seemed impossible, owing to the floods of water falling from the roof and timbers of the tunnel, the frequent shifting and breaking of timbers, and the great number of insulating supports required for mechanical strength. Therefore the overland route was chosen for the transmission.

The hydraulic plant is located about 1,600ft. from the mouth of the drain tunnel. The water is conveyed through a wooden flume and ditch to a pressure tank, there being also an overflow ditch with adjustable gate for disposing of surplus water. The pressure tank is provided with a settling compartment and racks for catching drift contained in the water. From the pressure tank is led a wrought-iron pipe of varying diameter. The prime mover is a 3ft. Pelton wheel calculated to deliver on the main belt 90 H.P. when running at 280 revolutions per minute under 120ft. effective head.

The conditions to be fulfilled in the selection of a type of electrical equipment for this plant removed all direct-current systems from consideration. The choice lay between the various alternating single and multiphase systems, generating the maximum line voltage directly, and supplying reducing transformers at various points along the main line. The "monocyclic" system was adopted by reason of great simplicity of the system as a whole, its freedom from lack of balance between the different circuits, the ability to successfully operate self-starting motors of a simple and well-tried type, as well as arc and incandescent lights, and, finally, its first cost, which in this case was less than for any other system excepting the three-phase. The electrical equipment of the power house includes an eight-pole 60-kilowatt "monocyclic" alternator, driven at 900 revolutions by a 12in. belt from the pulley on the wheel shaft. This dynamo at no load generates 2,200 volts at 60 cycles per second, and normal excitation is supplied by an Edison bipolar shunt machine driven from the alternator shaft. The dynamo is over-compounded to furnish 2,500 volts with a full load current of 25 amperes.

From the terminals of the generator three main leads are taken to a skeleton switchboard, on which are located switches, rheostats, indicators, lightning arresters, and a gauge indicating the pressure of the water supplied to the wheel below. All wiring between the dynamo and switchboard is carried beneath the floor of the dynamo room on porcelain insulators in plain sight. The engineer has full control of the entire system without leaving the side of the switchboard.

The transmission line covers a total distance of 6½ miles, and traverses a very rough and broken country, rising at one point to nearly 9,000ft. above sea level. The entire line, however, was located so as to obtain good sun exposure at all times. The poles are of red pine. The loss in the transmission at full load was calculated at about 11 per cent. between the power house and the centre of distribution. The insulation resistance of the system is remarkably high.

The total number of 16 c.p. lamps connected with the system is 700, all supplied at 110 volts. The problem of securing proper distribution of light in the various mills and hoisting works was very successfully solved by a suitable arrangement of the incandescent lamps. The arc lights formerly in use were very unsatisfactory, being difficult to maintain, owing to constant exposure of their mechanism and to clouds of metallic dust and steam, and especially objectionable because of localising the light and casting numerous dense shadows. The wiring and fixtures in the mills are subjected to very unfavourable working conditions. The most objectionable feature is the effect of metallic dust, steam, and sulphuric acid vapours upon exposed metal surfaces, and upon the insulation of the wire. Frequent testing has failed, however, to indicate any grounds or short-circuits. Hard rubber waterproof sockets are used throughout the mills, and the lights are tapped directly on the supply branches without rosettes, the branches being protected by switches and cut-outs in sheltered places.

There are three motors connected to the system, two of 15 H.P. each and one of 25 H.P. The 15 H.P. motors drive the machine shops of the Marsas Mill and the Ontario Mine; the large motor is located in the saw mill at Ontario No. 3 shaft.

On February 24, 1895, the plant was started. A trial run failed to develop any defects throughout the entire installation. On the following day, during a heavy storm of snow and sleet, the entire load of lamps connected with the system was thrown on. The performance, under load, of the installation in the power house was thoroughly satisfactory. The dynamos ran smoothly and quietly, and failed to show any evidence of heating in any part. This lack of heating has characterised their performance at all times since the beginning of operations.

The method of furnishing excitation to the generator in a plant of this character is a factor of vital importance in securing close regulation. It may be stated as a general rule that, where the normal field strength of the generators is a function of their speed, close regulation of voltage for large and rapid fluctuations of load is impossible to attain in a water-power plant. To insure constant excitation the exciting machine should always be driven by a separate water-wheel where the conditions permit of such arrangement.

The plant has run constantly since its completion without interruption or repairs of any sort, barring the breakage of the exciter shaft by a tight belt shortly after the start. The accident caused interruption of service for 12 hours only, and was purely a result of carelessness.

During the month of June some interesting experiences occurred with lightning. On one occasion an electric storm of great intensity prevailed along parts of the line most distant from the power house. During the space of a half hour no less than 13 separate strokes of lightning came into the switchboard from the main line, all of these being successfully discharged by the arresters. The final discharge, however, was of such severity as to start an arc between the discharge points of the arresters on the two main wires. This arc of comparatively low resistance immediately short-circuited the dynamo through a portion of the large copper strip used as a ground connection, and the machine ran in that condition for fully 10sec. before being disconnected. No damage whatever was sustained by the dynamo. The two arresters, however, were rendered absolutely useless, the brass discharge knobs being completely melted down, and several were fused together. After removing the damaged arresters, the dynamo was again started, and no further difficulty was encountered.

Two engineers are employed to operate the Ontario electric system, each of whom runs the plant 12 hours daily. No labour is involved, and, owing to the steadiness of the load both day and night, the attention required in the power house is limited to the inspection of oil in the various bearings and the starting and stopping of the plant at the beginning and end of each run, at which time the machinery is wiped off. The motors require no attention during their operation. The entire system at any instant involves only the attendance of the engineer at the power house, who also makes any slight repairs or alterations required from time to time throughout the distribution. The operating expenses therefore practically include only the engineer's pay, occasional minor supplies and lamp renewals.

The total cost of the Ontario system is a matter of gratification when viewed in comparison with recent figures showing cost of similar installations elsewhere, and in view of the diversity of service and economy of attendance secured. The saving effected by the installation is somewhat difficult to estimate accurately because of the large additional service hitherto unpossessed by the Company. The interest account is somewhat higher than that charged against the old arc-light plant. The labour account for the service now rendered by the present plant is very considerably reduced, some income is already derived from the sale of current for lighting, and the amount saved annually in fuel and illuminating oil exceeds $3,000.

The great drain tunnel is being extended through the Ontario ground to the Daly mines, and a continuation of work has resulted in a notable increase in the flow of water available at the power house, the amount being at present about 1,500 cubic feet per minute. Negotiations are nearly completed for doubling the installation at the power house, with the object of providing a reserve unit in case of breakdown, and of selling current by contract to a local organisation for lighting and incidental power service in Park City. The extension of the plant will involve but comparatively small outlay and labour, and the attendance will not be increased. It is, therefore, confidently expected that the plant will be made to earn dividends, in addition to furnishing its present service free of cost to the owners.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *August 31, 1895.*

Engineering Education.—The Society for the Promotion of Engineering Education will hold its second annual meeting at Springfield, Mass., on Monday, Tuesday and Wednesday of next week. This Society was organised at Chicago during the World's Fair, and is in a very flourishing state. As a rule college jealousies in this country prevent co-operation in educational work, but our professors of engineering seem to be free from this narrow spirit, judging from the very general manner in which they participate in the proceedings of this

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Society. The programme of the coming meeting contains 17 items, including 31 Papers. Prof. D. C. Jackson will read a Paper on "Electrical Engineering" and Prof. George D. Shepardson one on "Teaching Industrial Applications of Electricity," while several of the others will also be partly devoted to electrical engineering. An interesting part of the proceedings will be the reading and discussion of Papers criticising American engineering schools, contributed by Prof. Ritter of Zurich, Prof. Hele-Shaw of Liverpool, Prof. Voit of Munich, Prof. Goodman of Leeds, Prof. Unwin of London, and Prof. Bunt of Carlsruhe.

Electrical Combinations.—A decided tendency has been manifested in large cities towards combining under one management the various electric street railway lines. This has been done to a large extent in Brooklyn and more recently in Philadelphia, and a movement is now on foot in St. Louis to combine under one management all of the street railways and under another all of the electric lighting companies. This latter combination is, however, rather an unusual one, as heretofore the Edison Illuminating Companies have held aloof from alternating and arc lighting companies. While such consolidations may doubtless result in a reduction of expenses, yet it is quite probable that the real motive lies in the opportunity afforded for stock watering. The tendency of all American corporations is to keep down dividends to the minimum by increasing the capitalisation, and frequently the ingenuity of capitalists is taxed to insure the carrying out of such a programme, and gives rise to the numerous re-organisations and consolidations to which large corporations in this country are subjected.

Conduit Railways.—It is reported on good authority that another of the large horse railways of New York City will soon commence to change over to electric traction, using a modified Budapest system. It is also being persistently rumoured that the Metropolitan Cable Company, which controls the Broadway and other lines, will also before long discard the cable and instal a system similar to that now employed on Lenox-avenue, which is practically the same as the one so successfully in use for more than five years at Budapest, Hungary. It seems very probable that during the next few years underground conduit electric-traction systems will be very largely adopted in our principal cities. The result of this, however, promises to be disastrous to electric railway interests in smaller cities on account of the pressure that consequently will be brought to bear by the public to obtain the substitution of electric underground conduit traction for trolley systems.

CORRESPONDENCE.

GENERAL FORMULA FOR THE MAGNETIC FORCE AT ANY POINT IN THE PLANE OF ANY POLYGONAL FIGURE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to the interesting Paper of Prof. G. M. Minchin in *The Electrician* of September 6th, it can be easily seen that the result (5) is only a particular case of a more general formula, applicable to any kind of polygonal figure. Keeping the same notation, but supposing the angles B C D A to be respectively a_1 a_2 a_3 a_4, and applying the same elegant way of calculating, we shall find, as the expression of the magnetic force in any point of the plane,

$$F = \Sigma \frac{\sin a}{p}.$$

This result, of course, reduces itself to the result (5) when the figure is a rectangle, *i.e.*, when the angles a are right angles.

If we consider a plane curve as a polygonal figure of an infinite number of sides, we get, as an expression for the magnetic force,

$$F = \int \frac{ds}{r \rho \cos \theta}.$$

ds = element of arc;
ρ = radius of curvature;
r = distance from the point where the force is being calculated to the element of arc;
θ = angle between r and ρ.

Many interesting consequences could easily be drawn from both these formulæ.—Yours, &c., Osc. Colard.

Brussels, September 10, 1895.

MAGNETIC UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: As a past student under Dr. Sumpner, I certainly agree with what he says in your issue of September 6th. I know how I used to get muddled over B, H, N, L, quadrant, henry and secohm (to say nothing of μ and π). If names of past celebrities, often twisted beyond recognition, are to be given to strange units, where will the poor student of the future be? There are bound to be international differences as to the names to use; and even if such universally popular names as Faraday and Thomson (British or American as you please) are used, can it be supposed that the "diminished editions" of these names are beautiful or have anything (saving sentiment) to recommend them? Do *farad* and *thom* even recall much of the people they are intended to represent? The whole subject of units requires years of discussion and arbitration before any system can confidently be decided upon.—Yours, &c., C. M. Mayson.

September 11, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: It appears from the letters recently published in your columns that many of your correspondents, including Prof. Silvanus Thompson, continue to measure magnetic flux in lines. This is scientifically inaccurate, as the dimensions of magnetic flux are $L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-1}$, and the dimension of a line is L.—Yours, &c., J. A. Kingdon.

29, Marlborough-hill, N.W., Sept. 16, 1895.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s.

The Edition for 1896 is in active preparation, and orders for Advertisements and Subscriptions can now be sent in.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series *can be obtained of the Booksellers or direct from the Publishing Offices :—*

Laboratory Notes and Forms.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett *(now ready)*. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"The Work of Hertz."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. nett, is now ready.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A Large-Sheet Table, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s. —each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

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A Sheet Table showing Total Capital Outlay and Receipts and Expenditure for the year 1894 of the Statutory Electric Supply Undertakings of the Metropolis is now ready, printed on thick paper, price 6d.

A Sheet Table giving similar particulars in relation to Provincial Statutory Electric Supply Undertakings is now ready, printed on thick paper, price 6d.

"Electric Motive Power."—A new work, by Mr. Albion T. Snell, with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d. post free (abroad 11s.).

"Electrical Engineering Formulæ," a pocket-book by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"Drum Armatures and Commutators."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d (abroad 8s.). Prospectus on application.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

Tenders Invited.—The Corporation of Eccles invite tenders for the supply and erection of Lancashire boilers, alternating-current dynamos and engines, cables, street boxes, &c , and transformers. Plans, specifications, &c., may be seen at the offices of the Town Clerk, or of the Consulting Engineer (Mr. S. V. Clirehugh), Temple Chambers, Brazennose-street, Manchester, on and after the 18th inst. Tenders must be sent in to Mr. Geo. Wm. Bailey, Town Hall, Eccles, by 12 o'clock noon on the 30th inst. Additional information is given in our advertisement columns.

———— The Asylums Committee of the London County Council invite tenders for the erection of fire alarm and telephone systems at their asylums at Banstead, Surrey, and Colney Hatch, London, N. Tenders by 12 o'clock, 30th inst.

———— The Electric Lighting Committee of the Harrogate Corporation require tenders for the supply and erection of the following plant:—(*a*) Lancashire boilers, economiser, feed pumps and accessories; (*b*) steam alternators, condensers, fittings, &c., steam exhaust feed and sundry pipes, valves, &c.; (*c*) switchboard and instruments; (*f*) transformers and accessories; (*g*) meters; (*h*) overhead travelling crane. Specifications may be obtained from the Borough Surveyor, Harrogate, and tenders, addressed to the Town Clerk, Municipal Offices, Harrogate, must be delivered on or before the 30th inst. Further particulars are given in our advertisement columns.

———— The Building Committee of the Harrogate Corporation invite tenders for wiring the new Montpellier Baths for the electric light. Specifications, &c., may be obtained from the architects (Messrs. Baggalay and Bristowe), 66, Victoria-street, London, S.W., and tenders, addressed to the Town Clerk, Municipal Offices, Harrogate, must be in by the 30th inst.

———— The Board of Control, Dublin, require tenders for the supply and erection of two direct-coupled steam engines and dynamos, a battery of accumulators, main switchboard, &c., for the lighting of the Purdysburn Asylum, Belfast. Tenders to Secretary, Board of Control, Custom House, Dublin, by 28th inst.

———— The Dundalk Town Commissioners invite tenders for the erection and maintenance of the necessary plant for lighting the town by electricity from July 1, 1896. Tenders by October 7th.

———— The Queenstown Town Commissioners require tenders for the erection of works and the necessary plant for generating electric current for the public and private lighting of the town. Tenders by Thursday next, the 26th instant.

———— The Corporation of Dewsbury invite tenders for wiring the public baths and library for the electric light. Tenders must be in by 12 o'clock noon to-morrow (Saturday).

———— The Baden State Railway authorities invite tenders for the supply of a quantity of telegraph poles. Tenders to the Gr. Hauptverwaltung der Eisenbahnmagazine, Gr. Badische Staatseisenbahnen, Carlsruhe, by the 23rd.

———— The municipal authorities of Tongres, Belgium, invite tenders for the concession for the public and private electric lighting of the town. Tenders to the Administration Communale by October 10th.

———— The Director of the Grand Cercle at Aix-les-Bains requires tenders for supplying electric current for an installation of 1,200 lamps. Tenders to M. le Directeur du Grand Cercle, Aix-le-Bains (Savoie), France.

———— The Leeds Guardians require tenders for providing and fixing some new, and repairing other, lightning conductors at their workhouse premises in Beckett-street. Tenders, by the 24th inst., to the Clerk (Mr. J. King), Union Offices, East Parade, Leeds.

———— Tenders are required for installing the electric light at Wagstaffe's Steam Preserve Works, Hurst Brook, Ashton-under-Lyne.

Tenders Invited.—The Directors of the Great Western Railway Company invite tenders for various stores from November 1st next to October 31, 1896, and amongst these are telegraph instruments, india-rubber goods, copper, iron and steel wire, telegraph ironwork, tools and drysalteries, electric light carbons, copper, zinc, &c., pipes, screws, bolts and rivets, iron and steel tubes, telegraph poles and yellow pine, &c. Tenders, addressed to Mr. G. K. Mills, Secretary, Paddington Station, W., must be in by October 7th.

Tenders Accepted.—The Bedford Town Council have received the following tenders for the supply of vulcanised rubber cables:—

	£	s.	d.
W. T. Henley's Telegraph Works Company (London) (*accepted*)	£1,797	13	3
India Rubber Company (Silvertown)	2,077	16	4
W. T. Glover and Co. (Salford)	2,131	7	1
Siemens Bros. and Co. (London)	2,158	12	11
Telegraph Manufacturing Company (Helsby)	2,582	6	8

———— Four tenders were received by the Huddersfield Industrial Society for installing the electric light in their boot and shoe and confectionery departments. The tender of Mr. T. W. Broadbent, of Huddersfield, has been accepted.

———— The Metropolitan Asylums Board have accepted the tender of Mr. Thomas Beeley, of Hyde, for supplying three boilers at the new Brook Hospital for £1,407. 15s.

Tenders Received.—Some time ago the Leyton District Council decided to light their Public Offices and Technical Institute by electricity, and they commissioned Prof. H. Robinson to obtain tenders from 13 of the best electrical firms. Nine tenders have now been received by the Council, but four of the 13 firms originally selected by Prof. Robinson declined to tender. Separate tenders were sent in for the Public Offices and the Technical Institute:—

	Public Offices.			Technical Institute.		
Drake and Gorham	£573	14	2	£382	7	4
Paterson and Cooper	500	10	3	359	7	8
Sharp and Kent	630	15	4	402	5	2
Crompton and Co.	660	13	5	543	2	1
Strode and Co.	493	3	3	323	13	2
Joel (H. F.) and Co.	510	13	5	324	7	3
Brush Company	472	5	11	306	15	9
Spagnoletti (J. E.) and Crookes	475	8	0	315	12	0

All of London.

The tenders have been referred to the General Purposes Committee for consideration and report.

———— The Wakefield Corporation have received 40 tenders for the supply and erection of plant for their electricity supply station, and these have been referred by the Electric Lighting Committee to Mr. R. Hammond, consulting engineer, for analysis and report.

Appointment.—Mr. Laurence M. Waterhouse, A.I.E.E., of Aberdeen, has been appointed lecturer in electrical engineering, telegraphy and telephony at the Croydon County Polytechnic. He previously held a similar position at the Municipal Technical School at Brighton. Mr. Waterhouse was also for some time with the "P. and O." Company as electrician on some of their steamships. He holds the full technological certificate of the City and Guilds of London Institute in electric lighting with first-class honours. In 1890 he was medallist in the Electrical Department at the Heriot Watt College, Edinburgh, under Dr. R. Mullineux Walmsley.

———— Mr. E. F. J. Hewlett, M.I.E.E., has been appointed electrical engineer to the Rockhampton Gas and Coke Company (Limited), Rockhampton, Queensland. Mr. Hewlett was previously employed by the Hove Improvement Commissioners, and was for some time engaged by Messrs. Siemens Bros. and Co.

Appointment Vacant.—The City and Guilds of London Technical College require an assistant demonstrator in the electrical engineering department. Salary £80 per annum. Apply to the Principal, Leonard-street, Finsbury, E.C.

Dissolution of Partnership.—By mutual friendly agreement Mr. S. P. Tatham has retired from the partnership of "Girdlestone, Tatham and Co." of Davies-street, Berkeley-square, W., as from the 31st August last. The remaining partners will carry on the business under the style and title of "Girdlestone and Co.," who have made an arrangement for retaining Mr. Tatham's services.

———— Messrs. W. Jeffery and F. Taylor, who have hitherto carried on business as electrical engineers under the style of Jeffery, Taylor and Co., at 11, Queen Victoria-street, London, E.C., have dissolved partnership.

New Firms.—Messrs. R. F. Venner and A. M. Sillar have entered into partnership and will carry on an agency business at 10, Delahay-street, Westminster, S.W. The new firm will act as sole agents for the "Hookham" electricity meters (Birmingham and District excepted) and for the Nalder and Harrison Construction Syndicate (Limited).

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BANKRUPTCIES.—We give below a list of the principal creditors in the bankruptcy of Thomas Watts Scott, trading as an electrical engineer, under the style of T. W. Scott and Co., at Broad-street, Birmingham :—

General Electric Company, London	£108	0	0
Glover (W. T.) and Co., Manchester	41	0	0
Electric Construction Company, Wolverhampton	40	0	0
India-Rubber Company, London	34	0	0
Blackman Ventilating Company, London	16	0	0
Verity (B.) and Sons, London	12	0	0
Bourne and Grove, Worcester	11	0	0

——— A receiving order has been made in the estate of Dr. Joseph Whatmough, trading as an electrical engineer under the styles of D. J. Whatmough and T. and P. Dyer at 39 and 40, High-street, Oldham.

LIQUIDATION.—The order for the winding-up of Dalziel's News Agency of America (Limited) was made in December last, and the summary and observations now issued by the liquidator state that the Company was incorporated in 1891, with a capital of £100,000, to acquire from Dalziel's Cable News Agency (Limited) (in the prospectus styled the parent company) its interest in an American company known as Dunlap's Cable News Company, together with the business and goodwill of the parent Company in the United States. Accompanying the prospectus was a report from Mr. Dalziel which estimated the profits at £30,000 per annum. It would appear from the deficiency account now published that instead of earning this handsome profit the Company's trading resulted in an average loss of about £20,000, calculating from the date of incorporation to the date when the Company ceased business. The unsecured liabilities amount to £33,908. 19s. 5d., and of this sum £18,758. 2s. 1d. is due to the petitioning creditors (Messrs. Hallett and Co.) and £12,319. 2s. 3d. to Dalziel's Cable News Agency (Limited). There are no available assets, and as to the contributories, the total deficiency is stated to be £76,058.

B.A. STANDARD SCREW THREADS.—Messrs. Lehmann Brothers, of 38, Hampshire-street, Torriano-avenue, London, N.W., send us their latest price list of British Association Standard Screw Threads. Copies of the price list can be obtained on application.

CHLORIDE STORAGE BATTERIES.—The Chloride Electrical Storage Company (Limited) have just issued a new edition in pocket form of their battery catalogue. This edition has been considerably revised and enlarged. It is neatly printed, and contains full information as to capacity, weights, dimensions, &c., and gives illustrations of several types of plates. Those firms interested can obtain complete copies of the catalogue on application to the Company.

GENERAL ELECTRIC COMPANY.—This Company inform us that, as owners of Patent No. 3,664 (dated February 28, 1891), entitled "Improvements in Electrical Switches," they have granted licences for the manufacture and sale of their well-know "Tumber or Link" switches (with either a link movement or a heel piece) to the following firms: The Edison and Swan United Electric Light Company, Messrs. Evered and Co. (Limited), W. McGeoch and Co., B. Verity and Sons, Bayley Bros., and Tucker and Co.

ELECTRIC TRANSMISSION OF POWER.—We recently received from the Electrical Company (Limited) of Charing Cross-road, a well got up pamphlet containing full particulars and prices of all the machinery and apparatus sold by them. Useful instructions are given with regard to systems and the working of the various dynamos, motors, &c., &c., the three-phase system being especially well treated. The manual is well illustrated, and useful tables are plentiful. It contains a good deal of information likely to be required by an intending purchaser of electrical plant.

CATALOGUES.—We have before us the eleventh edition of the Electric Bell catalogue and the sixth edition of the Telephone catalogue of the General Electric Company. These have each been considerably enlarged. In addition to the prices, illustrations, and descriptive letterpress, each list contains a practical treatise upon its particular branch and a copious index.——A comprehensive catalogue of their rocking, stationary and forced-draught furnaces has been forwarded to us by Messrs. Caddy and Co. (Limited), of Daybrook, Nottingham. The book commences with some useful remarks on the use of firebars, and on their efficient and inefficient arrangement. There are a number of well-executed views of the works and apparatus, as well as portraits of members of the directorate, &c., of the Company. Some results of tests are included in the book, and appear to be of a highly satisfactory nature.

ELECTRO-HARMONIC SOCIETY.—A smoking concert will take place at the St. James's Hall Restaurant (Banquet Room), Regent-street, London, W., on Saturday, the 28th inst.

ALLEGED THEFT.—Charles Lucas, described as an electrician, of Hanover-street, Islington, was charged on Monday at the Westminster Police Court with stealing 200 yards of copper wire (valued at £4) from Mr. T. Pritchett, of Soho-square, W. The wire was alleged to have been taken from a house in Wilton-place, Knightsbridge, where the complainant's firm were fitting up fittings, &c., for the electric light. The prisoner, who pleaded not guilty, was sent for trial.

AMERICA CUP.—The Commercial Cable Company provided special means of telegraphic communication between England and France for the International Yacht Race held off Sandy Hook last week. The Company's steamer, "Mackay-Bennett," was specially detailed for this work. The Postal Telegraph Company, from the same steamer, forwarded telegrams to all parts of the United States and Canada. Few sporting events have occasioned more interest—or ended more unsatisfactorily.

ARGENTINE REPUBLIC.—It is stated that the various railway companies have been requested to fix a rate for the transport of all Post Office telegraphic material.

AYR —The Finance Committee recommend that the Commissioners apply to the Secretary for Scotland for authority to borrow an additional sum of £5,000 for electric lighting purposes.

BATH.—At the meeting of the City Council on Tuesday it was decided, on the recommendation of the Lighting Committee, to apply for an electric lighting Provisional Order. Some time ago the City of Bath Electric Lighting and Engineering Company, who have hitherto been supplying electric current in the city, applied for the Council's consent to their application for a Provisional Order, but this was refused. Alderman Clark, who moved the adoption of the Committee's report, said he considered it desirable that the city should be in a position to supply electric current.

BRANDON AND BYSHOTTLES.—A special meeting of the District Council was held on Tuesday to consider the lighting question. The surveyor estimated the cost of lighting the district with oil or gas lamps at £265 or £280 per annum. The Chairman (Mr. W. B. Charlton) thought the question of lighting by electricity should be considered, and added that they might be able to enter into an arrangement by which they could obtain spare steam power from some of the neighbouring collieries, and thus be able to generate and supply electricity at a very cheap rate. After a long debate it was decided to invite the Corlett Electrical Engineering Company to report upon and estimate for the lighting of the principal streets by electricity.

CARDIFF.—A proposal has been made to light the arcade electrically, and the Corporation have instructed the Borough Engineer to report upon the matter.

CHEADLE (STAFFS.).—A public meeting of the ratepayers was held last week for the purpose of considering the proposal of Messrs. Philips and Co. for supplying current to light the "town quarter" by electricity for 14 years at £300 per annum. The Chairman (Mr. T. B. Cull) moved a resolution that the offer be accepted. Dr. Mackenzie moved an amendment that arrangements for lighting the town should be made for one year, but that the Council should in the meantime make inquiries as to the cost of the electric light. Considerable discussion followed, and eventually the amendment was carried by 47 votes to 28.

CHURCH LIGHTING.—St. Mark's Church, Tunbridge Wells, is being wired and fitted up for the electric light. The work has been entrusted to Messrs. Gilbert and Co., 35, High-street, Kensington, W.

CITY AND SOUTH LONDON RAILWAY.—It is stated that negotiations are in progress for the purchase of property necessary for the extension of this railway from its terminus in King William-street to Moorgate-street, near the Metropolitan Company's station. In addition to the terminus at Moorgate-street it is proposed to have an intermediate station on the site now occupied by the church of St. Mary Woolnoth, at the junction of Lombard-street and King William-street. It is added that it will not be possible to carry out the extension within the period allowed by the Act of Parliament, and further time will have to be applied for.

CITY OF LONDON COLLEGE.—We have received a syllabus of the lectures to be delivered in the engineering department of this college during the ensuing session. Mr. H. Adams has charge of the department, and the subjects include civil and mechanical engineering, building and machine construction, &c.

ELECTRICAL COAL CUTTING.—Last week a number of gentlemen connected with the colliery industry were invited to East Plean Colliery to witness the working of an electrical coal-cutter patented by Mr. Hurd. The machine was worked downhill on an incline varying from 1 in 5 to 1 in 10, cutting 3ft. 6in. deep at the rate of about one yard in two minutes. The cutting being carried on at night, the visit was somewhat short, but those present expressed themselves as satisfied with the work done during the limited time at their disposal. The machine has been working at East Plean for some months.

ELECTRIC TRACTION IN SWITZERLAND.—It is proposed to continue the Bremgarten-Wohlen Electric Tramway as far as Fahrwangen. A system of electric tramways is also about to be constructed in Lausanne. The contract for the electrical plant has been secured by the Société de l'Industrie Électrique (Geneva); that for the

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cables by the Société d'Exploitation des Cables Electriques (Cortaillod), while the rolling stock will be supplied by the Neuhausen Works.

Exeter.—The City Council recently decided to purchase the Exeter Electric Light Company's undertaking, and appointed a sub-committee to report on the condition of the plant at the generating station. The city surveyor (Mr. D. Cameron) reported to the Sub-Committee that he found some of the machinery in good order, and, with the exception of a small high.speed engine, it could be economically worked. He estimated the value of the undertaking at £7,556, but recommended that an electrical expert's opinion be obtained. Accordingly Dr. J. A. Fleming, University College, London, was consulted as to whether the Corporation would be well advised to purchase the works for £10,000, and if that sum was a proper value, and if not, whether it would be advisable for the Corporation to acquire the Provisional Order and the undertaking of the Company. In the report just presented by Dr. Fleming he states that, in his opinion, the present works are not calculated to meet all the requirements of a municipal system of electric supply. The plant, with some small possible extensions which he suggested, would not be sufficient to meet more than an additional demand for 2,000 8 c.p. lamps to be added to the circuit, and the limit of the supply capacity would be an additional 8,500 8 c.p. lamps. His general opinion of the generating station and its equipment was that it was not originally planned with sufficient forethought and provision as to future extensions and requirements, that the general design showed a want of engineering skill and care in the utilisation of the available space, and that the electrical plant selected was not up to date in efficiency and design, that some portion of the plant would have to be replaced by more efficient machines if the undertaking was to be put on a sound basis; and, having regard to all these circumstances, he considered the undertaking was not worth £10,000. Concerning the second question referred to him, Dr. Fleming said if the Corporation either possessed or could obtain a Provisional Order he would not advise the purchase of the Company's plant on any terms, as it was not sufficiently modern or efficient, nor was it capable of the extension of which a corporation generating station should be capable; but he was somewhat reluctant to suggest that the Corporation should abandon their present idea of undertaking the supply of electricity, because that might afterwards prove to be a mistake. He had, therefore, carefully considered whether the works could be taken over on any terms, and whether they could be made self-supporting, and, if certain suggestions which he made were adopted, it would be possible to make the revenue exceed the outlay by £200 or £250, and on this basis he estimated the value of the undertaking at £7,110, to which must, of course, be added the cost of obtaining a Provisional Order (£426), or a total of £7,536. After careful consideration of the reports of the city surveyor and Dr. Fleming, the Sub-Committee have decided to offer the Company £7,500 for their undertaking. At the meeting of the City Council on Wednesday the Committee's report was discussed and adopted. It was therefore decided to offer the Company £7,500 for their undertaking, this offer being subject to the approval of the Board of Trade, and to the sanction of the Local Government Board to the borrowing of the money.

Exhibition.—An International Industrial Exhibition will be held in the Agricultural Grounds, Johannesburg (South African Republic) next year. It is to be opened in April and will last for six weeks. The charge for space has been fixed at 10s. per square foot.

Folkestone.—The electric lighting question has been before the Town Council in one form or another for the past 10 years, and matters are in precisely the same state to-day as they were when the subject was first introduced. A special meeting of the Council was held last week for the purpose of (*a*) considering reports from the Special Electric Lighting Committee, (*b*) reconsidering the report of the first Electric Lighting Committee, and (*c*) generally considering the subject of the introduction of the electric light. The report of the Special Committee recommended the adoption of a high-tension alternating-current system, with transformer substations and a low-tension three-wire network of mains for private supply. The principal thoroughfares of the town are included in the area of supply, and it is recommended that the generating station be erected near the Darlington Arch. At the start the street lighting is to be confined to the Lees, and the machinery at the station should be capable of supplying current to 4,500 8 c.p. incandescents continuously for private lighting and 22 arcs for public lighting. The cost of the plant, mains, &c., is estimated at £12,910, and working expenses at £2,936, or a total of £15,846. The probable revenue is put at £3,000 from private and £730 from public lighting, thus leaving a profit of £784. The report further recommended that steps be taken to obtain the necessary licence from the Board of Trade and the sanction of the Local Government Board to borrow a sum not exceeding £15,000 for the purpose of carrying out the scheme, and that Mr. F. H. Medhurst's services be retained to prepare the necessary plans, &c., and to generally superintend the work at a fee to be agreed upon. Mr. Baker, who moved the adoption of the report, said that applications for 3,580 private lights had already been received, and that if even these figures were taken as a basis, and proportionately reducing the working expenses, he calculated that there would be an annual profit of £248. Mr. Thompson adversely criticised the report, and advocated the adoption of the original and more extensive scheme which was prepared by Mr. Mark Parker, and was estimated to entail an initial outlay of £35,000. A long and somewhat incoherent discussion then took place, a proposal to get an independent expert to consider and report upon the rival schemes meeting with little support. The Mayor said he believed the original scheme a good one, but the public had condemned it. It was necessary that they should have the electric light in Folkestone, but he thought the supply should be undertaken by a private company, and the Council could protect themselves by obtaining a Provisional Order. Eventually the motion was lost, and the subject was adjourned *sine die*.

Halifax.—A deputation from the National Telephone Company waited upon a Committee of the Chamber of Commerce on Tuesday in reference to complaints by the Chamber as to the inconvenience arising from the present telephone service in Halifax. The general manager of the Company (Mr. W. E. L. Gaine) promised that local grievances should receive immediate attention, but as to the trunk service he said the Company were not now in a position to erect further trunk wires without the sanction of the Government, and that the Company had repeatedly suggested additions in the Halifax and in various other districts, but the Government had ignored their complaints. He suggested that the Chambers concerned should approach the Postal Authorities and bring pressure to bear upon them to concede what was desired. Mr. Gaine further stated the question of the reduction of the annual charges for the trunk lines was also a matter for the consideration of the Government.

Kalgoorlie (West Australia).—The Municipal Council have granted a concession to Mr. Phillip Hargan, acting on behalf of a syndicate of English capitalists, to light the town by electricity, the installation to be completed within 12 months.

Kettering.—The District Council have decided to appoint an electric lighting committee to consider and report upon the question of lighting the town by electricity. The committee were empowered to employ an expert at a cost not exceeding £30.

Kingstown (Ireland).—At the last meeting of the Town Commissioners it was decided to apply for a Provisional Electric Lighting Order.

Lighthouse Communication.—It is stated that the Mersey Docks and Harbour Board are about to lay a telegraph cable from Formby Light-vessel to Crosby Lighthouse.

Liverpool.—The Special Lighting Committee of the City Council have concluded a supplementary agreement with the Liverpool Electric Supply Company (Limited), whereby the operation of the contract for the purchase of the Company's undertaking is extended to December 31, 1896. This arrangement will enable the Council to present the necessary Bill to Parliament during the next session.

Llanelly.—As the District Council have decided not to proceed with their electric lighting scheme, Messrs. J. C. Howell and Co. (Limited) have approached the Council with a view to transferring to them the Llanelly Provisional Electric Lighting Order.

Manchester.—The Town Council are extending their electric light mains along the Oxford-road as far as Whitworth Park, and also in Stretford-road as far as Ardwick Green.

Mevagissey (Cornwall).—The Lighting Committee of the Parish Council have been making inquiries as to the cost of lighting the district by electricity and gas, and, as they report that the electric light would be the cheaper form of illumination, the Council have unanimously decided that, "Provided an electric light company be formed so as to admit of lighting the streets by electricity during the coming winter, this Council will offer £40 for lighting 30 lamps for 1,500 hours in the ensuing twelve months, and if any further lights be required, payment at the same rate." The Committee are to report further on the matter at the next meeting of the Council.

Montrose.—The Police Commissioners have expressed approval of the suggestion to establish telephonic communication with the Kinnaber Waterworks, but have referred the matter to the Streets and Roads Committee for the purpose of ascertaining the probable cost.

Morecambe.—Negotiations have been for some time in progress for the purchase of the plant and works of the Morecambe Electric Light and Power Company (Limited) by the Town Council. The Finance and General Purposes Committee have now decided to offer £4,125 for the undertaking. This offer is contingent upon the Council obtaining the necessary powers and authority from the Board of Trade.

Plymouth.—The borough surveyor has been commissioned to inspect the Bristol and Walsall electric tramways with a view to the introduction of electric traction on the Ebrington-street lines.

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PRESS TELEGRAMS.—At Bordeaux, on Tuesday last, the Press Congress decided to appoint a committee for the purpose of securing a reduction in the present rates for international Press telegrams.

QUEENSTOWN.—The Town Commissioners and the Local Gas Company are still at loggerheads over the lighting of the town. At the last meeting of the Commissioners the Chairman once more summarised the grounds of the dispute, and added that the Commissioners were endeavouring to formulate a scheme for lighting the town by electricity. Tenders were being at present advertised for, and as soon as these were received they would push on with the matter as fast as possible.

TELEGRAPHIC COMMUNICATION IN THE CHANNEL ISLANDS.—A petition from the inhabitants of the islands of Guernsey and Sark, praying that they be put in full telegraphic communication with each other, has been presented to the Postmaster-General by the Lieutenant-Governor of Guernsey. Pending the reply of the Postmaster-General, a military heliograph system, worked from the Mill at Sark to Fort George, Guernsey, has been established.

TELEGRAPH WIRE EXPORTS.—The value of the exports of telegraph wire and apparatus of Great Britain during August amounted to £29,488, as against £67,550 in the corresponding month of last year, and £176,859 in 1893. The value of the aggregate exports during the first eight months of this year amounted to £338,169, as compared with £1,254,774 in the corresponding period of last year, and £733,359 in 1893.

THE TELEPHONE IN MEXICO.—Telephonic communication is to be established betwen Ario and La Huacana, Michoacán State.

TOTTINGTON (LANCASHIRE).—We are informed that Messrs. S. H. Heywood, Brazenose-street, Manchester, have received the contract for erecting an arc-lighting installation at the mills of Messrs. S. Knowles and Co. (Limited), printers, &c., Tottington. The work is being carried out in accordance with the plans and specifications of Mr. Walter Leake, consulting engineer, Manchester.

WINDSOR.—In reply to an inquiry at the last meeting of the Town Council as to what progress had been made with the electric lighting question, it was stated that the Electric Lighting Committee were awaiting Messrs. Medhurst and Liardet's report as to what water power would be available. The Town Clerk was instructed to write stating that the Committee were anxious to receive the report.

WOKING.—The District Council have decided to light the village and Mayford Ward by means of oil lamps. In explanation of this step the Chairman said that the Electric Light Company would only lay their mains in a small part of the district, while the Gas Company had also declined to supply gas to the district.

WORKS LIGHTING.—The premises of the Newquay Baths and Sanitary Steam Laundry Company, Plymouth, are to be lighted electrically.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

August 31, 1895.

16,350. A. J. BOULT. London. Improvements in or relating to electric batteries. (E. A. Wunderlich, Germany.)

September 2, 1895.

16,427. E. P. C. GIROUARD. London. Improvements in electric bell pushes.

September 3, 1895.

16,439. F. H. ROYCE. Chorlton-cum-Hardy. Improvement in dynamo electric machines.*

16,450. A. SYKES. Huddersfield. Improvements in stage or like arc lamps for alternating currents.

16,482. H. G. WARNER. London. Improvements in electric and pneumatic bell-pushes.

16,494. W. R. LAKE. London. Improvements in and relating to supports for overhead electric conductors. (C. J. Goodwin, United States.)

16,521. W. C. BERSEY. London. Improvements in and connected with the overhead system of electric traction.

September 4, 1895.

16,557. E. ANDREOLI. London. Electro-deposition of gold and silver.*

16,562. H. HIRST. London. Improvements in multiple electrical switches.

16,569. L. EPSTEIN. London. Improvements in the manufacture of electrodes for voltaic batteries.

16,589. F. N. TILTON. London. Improvements in storage battery plate.

September 5, 1895.

16,635. W. L. PAKENHAM and J. C. HOWELL. London. Improvements in the regulation and construction of electric motors.

16,651. E. ROSENBERG (of the firm of H. M. Salmony and Co.). London. Improvements in electric glow lamps. (The firm of von Severen and Schwabe, Germany.)

16,659. R. BELFIELD. London. Improvements in and relating to electric railways. (The Foreign Electric Traction Company.)

September 6th, 1895.

16,700. SIEMENS BROS. AND CO. (LIMITED). London. Apparatus for supplying electrical energy to tramcars from underground conductors. (Messrs. Siemens and Halske, Germany.)

16,701. SIEMENS BROS. AND CO. (LIMITED). London. Contact apparatus and appliances in connection therewith for facilitating the passing of tramcars over crossings and switches in electrical tramways with underground conductors. (Messrs. Siemens and Halske. Germany.)

16,702. P. VANDERSMISSEN. London. An element for secondary voltaic batteries.

September 7, 1895.

16,742. J. W. FIELDING. Derby. Reversible rotary incandescent electric light switch.

16,794. S. EVERSHED. London. Improvements in and relating to the calibration of electric measuring instruments.

16,796. I. A. TIMMIS. London. Improvements in electro-magnets.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

15,575. SMITH. Gasaliers, electroliers, &c.

15,774. SAUNDERS (Greey and another). Electric cables.

16,105. HEATHFIELD and RAWSON. Electrical deposition of zinc, &c.

17,599. HIGGINS. Telephone receivers, transmitters, &c.

18,274. BROCKIE. Arc lamps.

18,274A. BROCKIE. Arc lamps.

19,444. STOUT. Arc lamps.

19,807. OPPENHEIMER. Electric door contact.

20,017. NEW and MAYNE. Arc lamps.

20,043. GEIPEL. Arc lamps.

22,043. HOLLAND. Electrically heating metals.

1895.

13,037. BOULT (Boudreaux). Electrotype printing blocks.

13,388. DEVONSHIRE (Thomson and another). Arc lamps.

13,389. DEVONSHIRE (Wightman). Regulating speed of continuous-current motors.

13,404. ROYCE and CLAREMONT. Dynamo electric machinery.

13,550. ROYCE and CLAREMONT. Dynamo electric machinery.

13,564. BONSOR. Electric regulators.

COMPANIES' MEETINGS AND REPORTS.

Brush Electrical Engineering Company (Limited).

The sixth annual report of the Directors of this Company, to be presented at the meeting to be held at Cannon-street Hotel, London, E.C., on Monday next, at 12 noon, states:—

The profit and loss account shows a gross profit of £37,858. 4s. 5d., after allowing for bad and doubtful debts to the amount of £2,205. 17s. 9d., and writing down the value of shares and debentures in other companies, as shown in the balance sheet. After deducting from the gross profit, general charges, maintenance of buildings, plant and patents, staff bonuses under the Company's profit sharing scheme, and interest on debenture stock, there remains a net balance of profit, including amount brought forward, of £11,329. 12s. 8d. An interim dividend at the rate of 6 per cent. upon the Preference shares, and 5 per cent. upon the Ordinary shares, has been already paid for the half-year ended December 31, 1894, amounting to £12,150. The net profit for the year, exclusive of the amount brought forward, is £7,541. 3s. 8d. The Preference shareholders have already received £5,400 of this sum by way of interim dividend as above, and they will be entitled to receive the balance of £2,141. 3s. 8d. before the Ordinary shareholders receive further dividends. The result of the year's operations shows a decrease of net profit as compared with last year of £19,739. 8s. 5d., which the Directors state is solely due to loss incurred during the second half of the Company's financial year in connection with the contract which the Company is carrying out for the City of London Electric Lighting Company (Limited), and arose out of differences between the two Companies as to the obligations involved under the contract. These differences are, however, now at an end, and work under the contract is being again proceeded with.

During the year the sum of £2,646. 1s. 9d. has been expended upon extensions of buildings and plant at the Loughborough Works, and new patents taken over by the Company. The Company's Austrian business

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yielded improved results during the past year, and is now established upon a thoroughly profitable basis. The Australasian branch also showed a satisfactory profit for the year ended April 30th last, but, with improving commercial prospects in the Colonies, the Directors anticipate correspondingly favourable results from this branch of the Company's business. The contract and installation department has been fully employed during the past twelve months, and electricity supply stations for the Municipalities of Leicester and Worcester, and for the Dover Electricity Supply Company, have been equipped with the Company's electrical plant, and opened during the year. The works at Loughborough are at present fully employed, and sufficient work is in hand and in prospect to maintain them so for some time to come. Plant for the equipment of the St. Luke's (Middlesex) and the Wandsworth electricity supply stations for the County of London and Brush Provincial Company are in course of manufacture in the electrical shops, as is also the plant for the lighting of Valetta and the Government Works at Malta, for which the Company recently received an order. The rolling stock and car departments are engaged upon the construction of locomotives for the Beira Railway, of cars for the Rouen Electric Tramways Company, and other orders.

The Directors report that they have made arrangements for the manufacture of a new high-speed enclosed engine of a novel and simple construction, the invention of the Company's Joint Manager and Chief Engineer, Mr. J. S. Raworth. We have received copies of the reports of Prof. W. C. Unwin, F.R.S., and Mr. W. H. Maw, M.I.M.E., on this new engine.

The bonus profit-sharing scheme introduced among the Company's staff and workmen two years ago is giving general satisfaction among the employés, and the Directors are satisfied that the system is working well.

In order to provide capital to meet the large expansion of the Company's business which has taken place since the last issue of capital in 1893, the Directors have decided to make an issue of £105,000 Second Four and a-Half per Cent. Debenture Stock, which will be allotted at par to the Preference and Ordinary shareholders. The entire interest charge on the Company's debenture stock (including the £105,000 now to be issued) will then stand at £10,350 per annum, while the average annual net profit (including debenture interest) for the past six years, since the formation of the Company in 1889, amounts to £25,337, and the Directors state the stock will be amply secured.

The increase in the Company's business, especially during the past few years, is largely attributable to the development of municipal and private electricity supply from central stations, of which business the Company has been successful in securing a substantial share. The manufacture of steam engines for electrical engineering purposes has also been undertaken during that period, and upwards of 35,000 H.P. have been sold.

The Directors also state that they are giving close attention to electric traction and electric elevator work, in both of which directions an important development appears to be imminent.

The retiring Directors (Messrs. Edward Woods and A. Ayres), being eligible, offer themselves for re-election, as do the auditors (Messrs. Cooper Brothers and Co.).

NEW COMPANIES, STATUTORY RETURNS, &c.

BEST BELTING COMPANY (LIMITED).—This Company has been registered with a capital of £10,000, in £1 shares, to acquire the business of the Best Belting Company, now carried on at 13, Cullum-street, London, E.C. The first Directors are Messrs. H. Muirhead and D. Robinson.

CELLINE ART METAL WORKS (LIMITED).—This Company has been registered with a capital of £5,000, in £5 shares, to manufacture, sell and deal in art metal work in iron, steel, brass, copper, bronze, &c., chandeliers, brackets, electroliers, suspension lamps, &c., for electric light, gas and oil.

JOHNSON MINERS' SAFETY LAMP COMPANY (LIMITED).—This Company has been registered with a capital of £5,000, in £1 shares, to carry on business as manufacturers of and dealers in Johnson miners' safety lamps and similar goods.

ELECTRICAL OIL REFINING COMPANY (LIMITED).—The statutory return to August 22nd has been filed. Of a nominal capital of £5,000, in £1 shares, 2,000 have been taken up, of which 1,493 have been issued as fully paid. The full amount has been called on the remaining 507 shares.

EXCHANGE TELEGRAPH COMPANY (LIMITED).—The annual return to August 14th has been filed. The nominal capital is £246,250, in 8,125 "A" and 16,500 "B" shares of £10 each. All the "A" and 16,200 of the "B" shares have been taken up, and the latter have been issued as fully paid. 2,125 "A" have been issued with £8 per share considered as paid, and £1 additional per share has been called, while £9 per share has been called on the remaining 6,000 "A" shares; £816 has been paid on 102 forfeited shares.

EXETER ELECTRIC LIGHT COMPANY (LIMITED).—The annual return to August 30th has been filed. The nominal capital is £20,000, in 1,500 Ordinary and 500 "A" or £6 per Cent. Preference shares of £10 each; 305 of the former have been issued as fully paid, and the full amount has been called on 820 Ordinary and 75 Preference shares. Negotiations are now in progress for the purchase of this Company's undertaking by the City Council.

GALLOWAYS (LIMITED).—An agreement has been made with the old Company and J. W. Pollitt, Marsden-street, Manchester (its liquidator), for the purchase of the business of the old Company for the sum of £109,170. 3s. 11d. in cash and the allotment of 1,500 fully-paid shares of £100 each in the new Company. This is in addition to an issue of £10,000 debentures secured upon the property of the old concern, which will be transferred to the present undertaking.

GLOBE TELEGRAPH AND TRUST (LIMITED).—The annual return to August 9th has been filed. Of a nominal capital of £5,000,000, in 250,000 Preference and a like number of Ordinary shares of £10 each, 180,042 of the former and 180,227 of the latter have been allotted, and the full amount has been called in each case.

HOBART ELECTRIC TRAMWAY COMPANY (LIMITED).—The annual return to June 25th has been filed. The nominal capital is £105,000, in £1 shares, and 45,000 of these have been taken up; 20,000 of these have been issued as fully paid, and the full amount has been paid on the remaining 25,000 shares.

F. H. ROYCE AND CO. (LIMITED).—The annual return to June 13th has been filed. Out of a nominal capital of £30,500, in 30,000 Ordinary and 500 Deferred shares of £1 each, 14,603 of the former and all the latter have been taken up, and 12,514 of these have been issued as fully paid. The full amount has been called on the remainder.

CITY NOTES.

MEMORANDA.—Bank rate, 2 per cent. (Feb. 22, 1894). Price of silver, 30½d. per oz. (Sept. 19th). Consols (2¾ per cent.) 107½—107⅝ for money, 107$\frac{11}{16}$—107$\frac{13}{16}$ for account (Sept. 19th); 2½ per cent. 106—106¼. Stock Exchange Settling Days: Consols, Oct. 1st; Stocks and Shares Continuation Day, Sept. 25th; Ticket Day, Sept. 26th; Pay Day, Sept. 27th; Mining Shares Carry-over Day, Sept. 24th.

SIR W. G. ARMSTRONG, MITCHELL AND CO. (LIMITED).—The Directors of this Company propose to pay a balance dividend of 9½ per cent., making a total distribution of 11¾ per cent. for the year ended June 30th, carrying forward a balance of £2,285.

BELL'S ASBESTOS COMPANY (LIMITED).—An extraordinary general meeting of the shareholders of this Company was held at the Cannon-street Hotel last week, when it was resolved to divide the present shares of £5 each into five shares of £1 each. Further resolutions approving the draft of the new regulations were also passed.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended September 15th were £808, against £826 in the corresponding week of 1894, a decrease of £18. The total receipts for the half-year amount to £9,316, against £9,402 for the corresponding period of 1894, a decrease of £86.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the Preference shares, an interim dividend at the rate of 4 per cent., free of income tax, on the Ordinary shares, both for the half-year ended June 30th last.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announce the payment on October 15th next of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum on the Preference shares for the quarter ending September 30th, and the usual interim dividend of 2s. 6d. per share on the Ordinary shares, free of income tax, in respect of profits for the quarter ended June 30th. The transfer register will be closed from October 8th to 15th inclusive.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 15th inst. amounted to £1,278. The amount for the corresponding week last year was £1,084; increase, £194.

ROCKHAMPTON (QUEENSLAND) GAS AND COKE COMPANY (LIMITED). The report of the Directors of this Company for the half-year ended June 30th last states that the profits on the electric lighting branch of their business amounted to £303. 13s. 9d., out of which £300 was paid as interest upon the whole of the Company's debentures. The Directors erected additional plant and buildings during the period under review, and they have appointed Mr. E. F. J. Hewlett, electrical engineer to the Company. Dividends of 7 per cent. per annum on the Ordinary shares, and 9 per cent. per annum on the Preference shares were declared.

ROYAL ELECTRIC COMPANY OF MONTREAL (LIMITED).—The coupons due October 1st next on this Company's Four and a-Half per Cent. Debenture Loan of £120,000 will be paid on and after that date by the Bank of Montreal, 22, Abchurch-lane, London, E.C. Coupons must be left three clear days for examination.

SCOTTISH HOUSE-TO-HOUSE ELECTRICITY COMPANY (LIMITED).—The transfer books of this Company will be closed from 19th inst. to the 30th inst. inclusive.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended September 13th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,725.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the half-month ended September 15th are £1,441, as compared with £1,664 in the corresponding period of 1894. The May receipts, estimated at £5,394, realised £5,449.

WESTRALIA (LIMITED).—At the general meeting of the shareholders on Monday, the Chairman (Mr. P. Tibbs) said they had acquired a concession for 21 years for the supply of electric current for lighting and power purposes to the Municipality of Coolgardie, which concession they had sold to the West Australian Electric Lighting and Supply Company (Limited), a company recently formed with a capital of £80,000, and of this sum £35,000 would be working capital. Operations in the terms of the concession had been already begun, and he thought it a matter for congratulation that so young a company should have been privileged to confer on the centre of the mining industry of West Australia the immense advantage of the latest mode of lighting which science had invented, in substitution for the primitive method of illumination at present employed.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price, Sept. 11.		Price Wednesday, Sept. 18.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Sept. 18.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	11/0	Anglo-American	48	50	48	50	4 0 0	Jan., Apr., July, Oct.	49	..
£2,993,560	Stock	22/0	Do. Preferred	89	90	89	90	5 8 0	" "	89¾	89½
£2,993,560	Stock	5/0	Do. Deferred	8½	9	8½	9	..	" "	8¾	8⅝
£173,400	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 16 11	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	13¾	14¼	13¾	14¼	4 11 3	Mar., June, Oct., Dec.	14¼	13 15/16
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 7 9	June and December	..	..
10,000,000	$100	1¾%	Commercial Cable Capital Stock	160	165	160	165	4 4 10	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 0 0	April and October ..	..	–
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10¼	9¾	10¼	4 7 7	" "	..	–
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 4 11	.. ..	..	–
60,710	20	2/0	Direct United States Cable, 1877	9	9½	9	9½	4 4 3	Jan., Apr., July, Oct.	..	..
400,000	10	2/6	Eastern	17⅛	17⅜	17⅛	17⅜	3 14 10	" "	17⅜	17
70,000	10	6%	Do. 6 per Cent. Preference	18	18½	18	18½	3 4 10	" "	18⅛	18
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	129	132	129	132	3 1 2	May and November	130¾	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	105	109	106	109	4 2 2	February & August	..	..
250,000	10	5/6	Eastern Extension	17¾	18	17⅞	18⅛	4 2 6	Jan., Apr., July, Oct.	18 3/16	17 15/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	127	130	128	131	3 1 2	February & August	..	..
£54,100	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	102	106	102	106	4 15 3	January and July ..	..	..
£80,600	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	102	106	102	106	4 15 3	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	106	109	107	110	3 12 11	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	113%	116%	113%	116%	3 9 10	May and November	..	..
180,227	10	3/3	Globe Telegraph and Trust	10¼	10½	10¼	10½	3 13 6	Jan., Apr., July, Oct.	10 7/16	10¼
180,042	10	6%	Do. 6 per Cent. Preference	16¾	17¼	17	17¼	3 9 7	" "	17¼	17
150,000	10	5/0	Great Northern	21¾	22¼	21¾	22¼	3 16 3	Jan., April, and July	22⅛	..
£180,000	100	5%	* Do. 5 per Cent. Debentures, 1883 issue	103	106	103	106	4 14 7	March & September	104½	..
17,000	25	37/6	Indo-European	50	53	50	53	4 14 4	May and November	50½	..
37,548	10	..	London Platino-Brazilian	..		..		..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	104	108	104	108	5 11 4	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	103	111	108	111	3 12 7	..	..	..
11,839	8	4/0	Reuter's	3½	4½	4	5	..	April and October .	4½	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	127	132	127	132	4 12 8	" "	130½	..
15,609	10	2/0	West African Telegraph	5½	6½	5½	6½	..	January and July	..	..
£238,300	100	5%	* Do. 5 per Cent. Debentures (red.)	104	107	104	107	4 13 8	March & September	106⅜	–
30,000	10	2/0	West Coast of America	1	2	1	2	..	January and July ..	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	104	99	104	7 13 10	June and December	..	..
88,321	10	6d.	West India and Panama	¾	1	¾	1	..	..	¾	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¼	10¾	10¼	10¾	5 14 3	May and November	10¼	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	3 13 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110	113	110	113	4 9 3	June and December	..	..
64,242	15	6/0	Western and Brazilian	10	10½	10	10½	4 5 9	May and November	10 5/16	10¼
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	–	..	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4	4½	4	4½	..	..	4 5/16	..
£165,200	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	102	106	102	106	5 13 5	February & August	–	..
£206,400	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	102	106	102	106	5 13 5	" "	..	..
$1,177,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	6 1 9	May and November	..	..
£164,300	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	103	100	103	5 16 10	March & September	..	..
			TELEPHONES.								
44,000	5	2/6	Chili Telephone (fully paid)	3	3½	3½	4	..	..	3 9/16	–
224,850	10/0	1½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	–
171,504	£1	8·215d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	–	..
484,597	5	2/6	National	6⅛	6⅜	6⅛	6⅜	3 18 5	June and December	6 5/16	6 3/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	16	18	16	18	3 6 8	" "	16½	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	" "	15¾	15½
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	6⅛	6⅜	6⅛	6⅜	3 18 5	–	6⅜	6¼
1,100,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	106	108	106	108	3 5 3	January and July ..	106½	106
58,000	5	3/0	United River Plate	2¾	3¼	2¾	3¼	..	" "	..	..
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	92	97	93	98	5 3 4	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	15	15½	14	15	1 13 4	–	15½	15 1/16
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15½	16½	15	16	3 15 0	–	16	15 13/16
£100,000	Stock	5%	* Do. 5% Debenture Stock (red.)	133	137	133	137	3 13 8	June and December	135½	134½
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	–	..	–
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	..	..
8,322	£5	..	House-to-House Electric	..		..		..	–	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		..	–	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July ..	..	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7⅞	8⅛	7⅞	8⅛	..	–	..	..
111,000	5	..	London Electric Supply	..		..		..	–		–
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	12½	13	12¼	12¾	2 7 1	..	12½	12¼
150,000	Stock	4½%	* Do. 4½% Debs.	117	119	117	119	3 16 4	June and December	..	..
6,452	£10	2/0	Notting Hill Electric	8½	9½	8½	9½	..	..	9½	9⅛
..	..	..	Rand Electric	7/16	9/16 prem.	7/16	9/16 prem.	..	–	..	..
19,980	£5	2/0	St. James and Pall Mall	8¼	8¾	8¼	8¾	..	–	–	..
20,000	£5	7%	Do. 7 per Cent. Preference	9	10	9	10	3 10 10		..	..
59,900	5	2/6	Westminster Electric Supply (fully paid)	8¾	9¼	8¾	9¼	2 19 6	..	9	8¾
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	1⅝	1⅞	1½	1¾	3 11 8	–	1¾	1⅝
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	1⅞	2⅛	1¾	2	6 0 0	–	2⅛	1¾
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	111	114	111	114	3 19 1	March & September	112	–
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1	2	1	2	..	January and July ..	..	–
12,139	5	1/6	Edison and Swan United	2	2½	2	2½	..	..	..	–
£100,000	Stock	4½%	Do. 4% Mortgage Debenture Stock	104	107	104	107	4 4 1	..	–	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	–		..		..	..	–	..
120,000	2	..	Electric Construction	½	¾	⅝	⅞	..	..		
12,845	2	2/9¾	Do. 7 per Cent. Cumulative Pref.	2¼	2¾	2¼	2¾	5 1 10	..	2 5/16	2¼
91,195	2	10/0	Elmore's Patent Copper Depositing	¾	1	¾	1	..	..	–	..
20,000	5	..	Fowler-Waring Cables (fully paid)	¼	¾	¼	¾	..	..	–	–
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	19	21	19	21	4 15 3	February & August	20⅛	19¾
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 8 3	March & September	..	–
15,995	£10	..	International Okonite Ordinary	..		..		..	–	–	–
16,000	£10	..	Do. 8 per Cent. Preference	–		..		..	December and June	..	–
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	⅛	⅜	⅛	⅜	..	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	43	45	43	45	4 0 0	March and July...	44½	43¾
£150,000	100	5%	* Do. 5 per Cent. Bonds	104	107	104	107	4 14 4	January and July .	..	–
37,514	£5	–	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	–	–
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	–	–
£100,000	10	6/0	W. T. Henley's Telegraph Works Ordinary	11¾	12¼	12¼	12¾	..	..	12 9/16	12½
£30,000	10	..	Do. 7 per Cent. Preference	15	16	15	16	4 7 6	..	..	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock	104	107	104	107	4 4 1	..	..	–
			RAILWAYS AND TRAMWAYS.								
£330,000	Stock	1½%	City and South London Railway	38	40	38	40	3 2 6	May and November	–	..
7,000	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 4 6	..	–	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	134	136	134	136	2 18 10	May and November	–	..
37,500	£10	2¼%	Liverpool Overhead Railway	11½	11¾	12⅞	13⅛	1 16 0	–	–	–
6,295	10	5%	Do. 5% Preference	15	15½	15	15½	3 4 6	..	–	–
25,000	Stock	4%	Do. 4% Debenture	111	113	111	113	3 10 10	January and July	–	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 906. [No. 22. Vol. XXXV.] FRIDAY, SEPTEMBER 27, 1895. PRICE SIXPENCE.

NOTES.

THE recent peremptory notice of the Electricity and Public Lighting Department of the St. Pancras Vestry anent a 220-volt supply was calculated to cause a considerable flutter in certain electrical dovecots, and it did do so. Below we reprint the circular as originally issued:—

VESTRY OF ST. PANCRAS.

NOTICE TO ELECTRICAL ENGINEERS AND CONTRACTORS.

NOTICE IS HEREBY GIVEN that on and from the 1st September, 1895, the supply to consumers' premises will be delivered at 220 volts, and that no single circuit will be permitted to carry more than 20 amperes.

ALBERT E. PYCRAFT, Chief Clerk.

Electricity and Public Lighting Department, Vestry Hall,
Pancras-road, London, N.W.
Dated this First day of September, 1895.

IT was not unnaturally concluded from this document that 220-volt lamps and corresponding wiring and fittings would be in immediate and immense demand in the district served by the Stanhope-street station. So much the better for trade, said the short-sighted shrewd ones. Others, looking a little more at the general principle of the thing, doubted whether the obvious reading of the ukase was the one intended; and, if it were, doubted still more the legality and expediency of the step contemplated.

AN emended edition of the circular, however, makes it clear that it applies only to *future* customers, so that we may assume that Mr. BAYNES intends, as at Bradford, to connect all additions to the present three-wire network across the outers, and to run all extension feeders at 440 volts.

MR. BAYNES is quite justified in assuming, in his letter to *The Times* of Wednesday, replying to that of Messrs. HANDCOCK and DYKES, which appeared in Saturday's issue, that "those who best understand the subject and its importance on the future of electric lighting are the most desirous of co-operating to render the movement I have introduced thoroughly popular and successful," and as in a matter of this kind the proof of the pudding is most certainly in the eating, *he* is further justified in regarding his Bradford experience as a conclusive answer to all croakers. At the same time the circular was worded so as to cause a maximum of alarm among consumers, and knowing what we do of average electric light fittings and wiring, we cannot consider the fear lest 220 volts may prove too much for them an altogether vain imagining. However, there is, as we understand it, no question, at any rate at present, of putting this matter to the test at St. Pancras. Due warning having been given, there need be no trouble about 220-volt fittings. Mr. BAYNES dismisses the important 8 c.p. 220-volt lamp question by stating that such lamps are on the market. We do not doubt it. The point is, are they reliable? All electrical engineers will wish well to Mr. BAYNES in his 220-volt crusade, and must hope that he will carry it through with the minimum of mishaps and the least possible inconvenience to customers and to the trade.

SANDWICHED between a phenomenally successful meeting at Oxford and a probably large and busy meeting at Liverpool next year, the meeting of the British Association at Ipswich would have been able to find reasonable excuse for weakness and failure had any been manifest. Ipswich has little claim to be considered a centre of scientific interest; it is quite a small town, and the accommodation it had to afford could not rank beside that at any one meeting during the past three or four years or the next two. Yet, in the opinion of many British Association veterans—those who have long been seen in the reception rooms from year to year—the Ipswich meeting certainly has not fallen below the average in quality, and in some sections it has risen above it. In the matter of genuinely novel interest, the palm must be yielded to the Anthropological Section, presided over by the famous Egyptologist, Mr. FLINDERS PETRIE; but though neither Section A, B, nor G produced anything comparable with last year's startling announcement of the discovery of argon, yet there has been for each of these a daily portion of interesting and useful work. It is not for the dramatic announcement of startling discoveries, whether of comets, planets, ancient races, or new elements, that the British Association exists; but it is that all sorts and conditions of scientists may meet together and "rub each other's angles down."

PROBABLY the hardest worked Section is that designated by A, which is devoted to mathematics and physics; and it is a common occurrence, on days when other Sections are out at play, for this branch of the Association to divide itself into two or even three sub-sections, each with its own lengthy programme of Papers. We are glad to hear there is some idea among those who have the control of such things, of permanently lightening the load on A, by the creation of a

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distinct Electrical Section, which should absorb into itself all that is electro-technical in A, B and G. We sincerely hope this proposed new Section may be created; and the earlier it comes into existence, the better will it be for those for whom the chief attractions of the Association are electrical. It is a comfort to find this proposal emanating—albeit unofficially—from within the Association itself; for we had not dared to make the suggestion ourselves, for fear of being told that electricity was only a branch, indeed a mere sprig, of physics. Under the existing arrangements there is necessity for a high-frequency alternating pilgrimage between A and G, the dissipated energy in which is only slightly reduced by the institution of "electrical day" in the latter Section. When the amplitude of the oscillations between A and G is large the energy wasted, heat generated, &c., are enormous; and we sincerely hope and with all humility suggest that, at Liverpool, if the new Electrical Section has not there come into existence, the *loci* of A and G shall be made as nearly to coincide as the properties of three-dimensional space will permit.

A VERY useful task has been imposed, by Section G, on a newly-formed Screw Standards Committee, as the result of the representation made by Mr. R. E. CROMPTON in regard to the want of uniformity of the so-called B. A. screw gauges. This task is no other than to complete the work of the Screw Standards Committee which was formed some ten years ago, the practical outcome of which was the standardisation of a set of small screw threads, such as are used in electrical and other scientific instruments. What remains for the newly-created Committee to do is to set these standards upon the same workable basis as is the case with the larger gauges covered by the Whitworth standards. To so great a pitch of perfection has the standardised manufacture of Whitworth taps, stocks and dies, &c., been carried, that it could only be due to very careless handling of the tools if a bolt made on the Clyde were found not to fit a corresponding nut made, say, in Swansea. But, alas! 'tis not so with B. A. screws. The first to call recent attention to this matter was Mr. ELPHINSTONE, in his letter which we published on August 9th (*The Electrician*, August 9th, p. 497). But we believe that it had been even then Mr. CROMPTON's intention to call attention to the matter, at the Ipswich meeting of the British Association. He has done so, and we hope to good purpose.

AT a meeting of Section G of the British Association, when one who took part in the discussion on Mr. PHILIP DAWSON's Paper on electric traction proposed that our metropolitan underground railway should be worked electrically, Prof. VERNON HARCOURT replied that the insuperable obstacle to the proposed improvement lay in the fact that steam and electrically-propelled trains could not run over the same lines. There is, however, no insuperable obstacle about the matter at all, as is proved by the recent partial conversion of the Kentucky and Indiana Bridge Company's railway into an electric overhead trolley system, both steam and trolley cars running over the same rails. Whatever difficulty there may be in propelling the Circle trains electrically, certainly does not arise from the fact of the Inner Circle being used by trains from many of the main lines running into London

THE ingenious method of delineating alternate-curren wave-forms described before Section A by Mr. JAMES MARK BARR and his two coadjutors, is one of those things about which everyone who has been working at this particular problem will probably exclaim, "Why ever didn't I hit on this idea myself!" By making the contact brush revolve as well as the contact disc one is able, by means of a reflecting galvanometer and a piece of sensitised paper, to secure an exact and permanent trace of the wave-form, and this at a manageable frequency, without interfering with the normal speed of the machine under test.

WE were among the first to compliment the late Postmaster-General upon his granting the Committee of Inquiry into the alleged grievances of the postal and telegraph employees, and upon the constitution of that Committee; we regret the more, therefore, to find fault with the course he subsequently adopted in virtually anticipating their verdict in his Annual Report, which is just to hand. The publication of a defence of the Department against the complaints of its servants is, we believe, a quite unusual course; and to do so while an inquiry into the matter is still proceeding is at once superfluous and unfair. Still worse, the defence, such as it is, though it explains a good deal, is no defence at all, for it never touches the question at issue, namely, whether the men have grievances or not. It is very sad, no doubt, that expenditure outstrips revenue; but this is not peculiar to the Post-Office; and to try to close the mouths of the disaffected by telling them that there are hundreds of aspiring Board School candidates ready to take their places is only adding fuel to the flame. When Mr. ARNOLD MORLEY retired from office the vacancy was not knocked down to the lowest bidder. Probably his Report was penned before that catastrophe occurred.

SOME particulars which we publish to-day from the columns of the New York *Electrical Engineer* relating to the growth and prospects of long-distance telephony are of special interest to this country just now, where a system of trunk lines for telephonic purposes is being inaugurated upon an extended scale and under Post Office control. We cannot adopt all the deductions which our contemporary draws from the statistics it is able to furnish with regard to the relative use of the telephone and the telegraph; still less can we admit that there is any likelihood of the former displacing the latter to any serious degree in popular favour in countries like England and America. Nevertheless, it may be admitted that for a considerable number of commercial requirements the telephone is a rival which the telegraph cannot afford to despise. That this fact was realised so long ago as 1879 by the Western Union Telegraph Company, who demanded and obtained 20 per cent. of the earnings of the Bell Telephone Company as a consideration for not entering into litigious opposition to the then new-born competitor, speaks well for the foresight and business capacity of the older Company. And that its young competitor has gone on prospering in spite of this heavy burden upon its profits is a very complete justification from the business point of view of the corresponding tax placed upon telephone operations

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by the Post Office in this country. The commission under this head paid to the Western Union Telegraph Company already amounts to nearly one and a-half million sterling; a corresponding commission paid to the Post Office, with an unquestionable monopoly, which the American Telegraph Company never possessed, is, therefore, not the extortionate imposition that it has been sometimes represented to be.

We have said that we do not implicitly accept the deductions of our electrical contemporary; and the more we look at the figures the less able are we to accept its conclusions. That there are ten times more telephonic messages than there are telegraphic messages is an interesting fact for the telephone companies, but as most of the former are urban communications of the speaking-tube order we are still left in complete ignorance as to the probable proportions of inter-urban or long-distance messages that are or will be transmitted by telephone when that system is developed to its utmost limits. It seems to us that its employment will, in a manufacturing country where *la petite culture* is almost unknown, always be confined mainly to commercial transactions of a very specia character, and that for general purposes the telegraph must always continue to be the chief means of communication. The difference between them is very like that between a personal interview by appointment and the despatch of letters through the post. The telegraph has not reduced the business of Her Majesty's mails, and we do not believe that long-distance telephony will materially diminish the business done on long-distance telegraph wires.

Stafford.—The Stafford municipal three-wire system comes into operation this week.

Cable Interruptions :—

	Date of Interruption.
Aden-Zanzibar	September 2, 1895.
Cadiz-Teneriffe	September 25, 1895.

Institution of Junior Engineers.—There will be a meeting of this Institution on Friday, October 4th, 8 p.m., at the Westminster Palace Hotel. Annual general meeting to receive the Council's report, elect officers for ensuing session, &c.

Masts for Electric Tramways.—The Mannesmann Tube Company is now producing electric light and tramway masts by their seamless process. The masts for the overhead conductor electric tramways at Stuttgart and at Pankow were supplied by the Mannesmann Company.

Train Lighting.—A successful experiment in train electric lighting was carried out this week by the Great Northern Railway Company of Ireland. A train ran from Dublin to Drogheda and back. The main feature is that each vehicle is provided with its own dynamo, axle-driven, and accumulators to light the lamps when the train is standing.

Exeter.—The Exeter Electric Lighting Company, which has unfortunately got into financial difficulties, recently offered its plant and business to the Corporation for the sum of £10,000. The Corporation, after a lengthy debate, agreed to pay £7,500, and this sum has now been accepted by the Company.

Electric Traction in Bergen.—The town of Bergen, in Norway, will soon be possessed of electric trams, in which respect Scandinavian towns are somewhat behind the times. A company has been formed, with a capital of about Lr.50,000, and the construction of the trams has been entrusted to the Union Electric Company of Berlin.

Monuments and Memorial Tablets.—A memorial tablet in honour of Prof. Helmholtz has been affixed to the house, No. 8, Haditzstrasse, at Potsdam, where he was born, and it is stated, says *Nature*, that it is intended to erect a joint monument to the memory of Werner Siemens and Helmholtz in front of the Technische Hochschule at Charlottenburg.

Leipzic Electric Supply Station.—On August 28th this station commenced regular supply for the public and private lighting of the town. There are so far 46 15-ampere street lamps and 5,000 glow lamps connected, but as the lamps in view already exceed 30,000 16 c.p. lights, the electric plant just put down will very soon have its full load.

Obituary.—Mr. Paul Prince, the head of the signalling department of the Midland Railway, died on Monday, from cancer in the throat at the age of 45.——The death took place, on Tuesday, of Mr. John R. Edwards, superintendent engineer for the North Wales district of the Post Office telegraph system. Previous to 1870 Mr. Edwards was in the service of one of the telegraph companies. The deceased was 58 years of age.

Shock from High-Pressure Mains.—A lineman in the employment of the Rochester Gas and Electric Company of America received a shock from a live wire on August 28th, and was apparently dead for some six minutes, when he recovered consciousness, after being subjected to the d'Arsonval treatment. His right hand and wrist were badly burned, but he was otherwise uninjured. The wire he came in contact with carried 1,600 volts, and it is reported that he received the full voltage by short-circuiting the line with his body.

Electricity in the Navy.—Some few years ago the fine second-class battleship "Barfleur" was fitted with electric motors in connection with the training and elevating gear of her big guns. Experience of the use of electric motors for this purpose has proved so satisfactory that the Admiralty have now, in addition, ordered electric gear for the ammunition hoists of the battleships "Centurion" and "Renown." The 12in. guns on board the first-class battleships "Cæsar" and "Illustrious" are also to be fitted with electrically-driven training and elevating gear.

Electric Railways in Michigan.—The Detroit, Port Huron and St. Clair River Railway Company has, according to the *Electric Railway Gazette* of New York, been formed to construct an electric line which it is announced will be ultimately 65 miles in length. The proposed line is projected for the purpose of giving transportation in the territory east of the Grand Trunk road from Detroit to Port Huron, thus affording communication with numerous St. Clair lake and river towns now without railway communication. The project is an old one, but in its revived form electricity is proposed as the motive power for the road.

British Association Grants.—The following is a list of the grants of money appropriated to electrical and allied purposes by the General Committee of the British Association at Ipswich:—Prof. Carey Foster—Electrical Standards (and unexpended balance in hand), £5; Lord Rayleigh—Mathematical Tables (unexpended balance); Dr. E. Atkinson—Abstracts of Physical Papers, £100; Prof. S. P. Thompson—Uniformity of Size of Pages of Transactions, &c. (renewed), £5; Sir H. E. Roscoe—Wave-length Tables of the Spectra of the Elements, £10; Prof. J. E. Reynolds—Electrolytic Quantitative Analysis (renewed), £10; Prof. A. B. W. Kennedy—Calibration and Comparison of Measuring Instruments (£25 renewed), £30; Mr. W. H. Preece—Introduction of the B.A. Small Screw Gauge, £10.

Steam v. Electric Lines in America.—There exists between the towns of St. Paul and Minneapolis two steam railways and one electric railway, and it is interesting to note the effect the latter has had upon the suburban business of the former. The distance between the two towns is about 10 miles, and is practically the same on all lines. The two steam lines were running trains every half-hour, the single fare being 30 cents and the return fare 50 cents, and the time taken for the single journey was 25 minutes. Against this the electric cars run at six-minutes intervals through the streets of both towns, and stop at any corner. The fare is 10 cents for the whole journey, and the time occupied is 50 minutes. The electric line now takes the bulk of the business, with the result that a large proportion of the suburban trains upon the steam lines have been taken off.

Electric Railway Patent Litigations in America.—The Siemens and Halske Electric Company of America have brought

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an action against the Metropolitan Elevated Railroad at Chicago, alleging that the latter is infringing their third-rail patent granted to Dr. Werner von Siemens in the United States on August 11, 1885, covering the system now in use on the Metropolitan road. The General Electric Company of New York is, of course, the real infringer, and the defence is in its hands. The same Company also brought, on September 5th, a suit against the Baltimore and Ohio Railroad Company, in the United States Circuit Court, District of Maryland, for infringement of a patent granted to Ernst Werner von Siemens on an "Improvement in electric railways." "We understand," says *Electricity* of New York, "that the overhead trolley device used in the Baltimore tunnel is identical with the device described in the Siemens patent."

Proposal to Increase the Demand for Electric Light in Glasgow.—The Glasgow Corporation Sub-Committee on Electric Lighting recently appointed six of their number as a special Sub-Committee to consider and report as to what steps, if any, should be adopted with the view of increasing the demand for electric current. A feeling is growing in Glasgow to the effect that it will be difficult for the electric light, at 6d. per Board of Trade unit, to compete successfully against Corporation gas of excellent quality at 2s. 4d. per 1,000 cubic ft., and with no charge in the shape of meter hire, while in the former case a charge is made for the use of the electric meter. There is also the fact that the consumption of gas by Welsbach incandescent burners is rapidly extending, many people having got the notion into their heads that gas lighting by the incandescent method is practically equal to incandescent electric lighting and much less costly.

New Books.—Prof. Silvanus Thompson has completed the fifth edition of his work on "Dynamo-Electric Machinery," the last edition of which was published in 1892. It will be issued about the end of October, by Messrs. Spon, simultaneously in New York and London. A good deal of old matter has been excised in the process of revision, mainly in the earlier part of the book, to make room for recent developments, particularly in alternate-current work. The number of cuts has been increased to 520, and the lithographed plates have been revised, 12 of those in the new edition being new. Several of the chapters have been entirely rewritten, those on synchronous alternate motors, on asynchronous alternate motors, and on transformers being new.——The Cambridge University Press announce that a book by Prof. J. J. Thomson, entitled "Elements of the Mathematical Theory of Electricity and Magnetism," will be ready very shortly. Price 10s.

Telegraph Revenue and Expenditure.—The following table, taken from the Postmaster-General's Annual Report, shows the revenue and total cost of the telegraph service, taking into account the interest on capital expenditure for each of the last seven years. The deficiency for the past year was £452,803.

Year.	Receipts plus nominal value of work done for other Departments.	Expenditure.			Annual interest on capital.	Deficit.
		Charged to Telegraph vote.	Charg'd to votes of other Departments	Total.		
1888-89	£2,129,965	£1,969,324	£72,037	£2,041,361	£353,787	£265,183
1889-90	2,364,099	2,179,921	99,065	2,278,986	306,016	197,690
1890-91	2,456,764	2,265,338	123,243	2,388,581	299,215	231,032
1891-92	2,545,612	2,507,012	124,883	2,635,895	298,883	389,166
1892-93	2,528,312	2,567,019	125,975	2,692,994	298,888	465,570
1893-94	2,579,206	2,641,020	116,625	2,757,645	298,888	477,327
1894-95	2,646,414	2,675,339	124,990	2,800,329	298,888	452,803

Finsbury Technical College.—The evening classes at the Technical College, Finsbury, will recommence on Monday next, the 30th inst., when the introductory lecture of the advanced course on Electrotechnics (Lighting and Power) will be given by Prof. S. P. Thompson on "Rotating Magnetic Fields." The subsequent lectures of this course will be taken by Mr. O'Keeffe and by Prof. Thompson, who will take up special topics, such as electric meters, design of alternate-current machinery, &c. The Wednesday evening course, by Prof. Thompson and Mr. E. Thomas, will deal with the current, its measurement, and its application to the electro-magnet, &c. There will be the usual practical classes in the laboratories, and Mr. E. Rousseau will later take up a laboratory class on electrotyping and electroplating. In the department of Mechanical Engineering Prof. Perry will give, in addition to the ordinary course on Practical Mechanics, a short special course on Thermo-dynamics as applied in Engineering, on Thursday evenings.

The American Bell Telephone Company and The Western Union Telegraph Company.—In its issue of August 28th the *Electrical Engineer* of New York publishes *in extenso* the famous agreement entered into in 1879 between The American Bell Telephone Company and The Western Union Telegraph Company, by which the former agreed to pay the latter a royalty of 20 per cent. on its gross receipts, and the latter agreed to abandon its existing exchanges and abstain from all telephone business. This agreement nominally terminates in November, 1896. Owing to the growth of telephony, especially of the long-distance order, it is thought in America that the Western Union Company has, so to speak, sold its birthright for a mess of pottage; a truly regal mess of pottage, however, since the sums paid over to the Western Union Telegraph Company during the last 15 years by the Bell Telephone Company under the agreement of 1879 amount to something like £1,500,000. There are many indications, says the *Electrical Engineer* of New York, "that the habit of telegraphing does not gain ground, while the practice of telephonic intercourse grows at an extravagant rate." The average is one telegraph message per year per head, and appears to be steady; in the cities it now falls below that, showing the limiting effect of the telephone assisted by district messengers.

A Curious Lightning Fatality.—On Tuesday, August 6th, during the meeting of the National Artillery Association at Shoeburyness, a somewhat curious lightning-stroke fatality occurred. At 6.50 p.m. Charles Howse was walking along a footpath leading from South Shoebury to Shoeburyness Railway Station, when he was struck by lightning and instantly killed. The footpath is 6ft. wide, having on one side a shallow ditch and a row of tall elm trees and on the other an iron railing about 5ft. high, the rails forming a row of pointed spikes projecting 6 inches above the top bar. There had been no rain for three-quarters of an hour previously. The unfortunate man was struck on the left side of the head and slightly burnt about the body, and some of his clothing was considerably torn. As the deceased had on his person, in addition to some 14s. in silver, no less than 37 sovereigns and 28 half sovereigns, many of which showed signs of fusion, it is possible that this mass of metal had something to do with the direction of the stroke. The silver was in the right pocket of the man's trousers, which were there blown to shreds and the money scattered in all directions. The gold, the separate pieces of which were wrapped in paper, was done up in a purse and tied up in a handkerchief, and placed in the left-hand inside pocket of the man's coat. The discharge apparently struck the man on the left of the central line of the body and left him on the right.

Mr. E. H. Griffiths on a Standard of Heat Measurement.—At the recent meeting of the British Association, at Ipswich, Mr. E. H. Griffiths brought forward the matter of a scientific unit of heat. Mr. Griffiths' experience with water, melting ice, &c., has led him to distrust that compound generally known as H_2O, and to put greater faith in melting silver and other temperature standards. He said that since the year 1879, when Rowland published his monumental work on the mechanical equivalent of heat, there could be little doubt that Regnault's expression for the capacity of heat (at all events at temperatures below 30deg.) could not be regarded as trustworthy. The author's object was to show how vague and uncertain was present knowledge of the changes in the capacity for heat of water, as its temperature varied. He was guided by one general principle—viz., that, however admirable the methods of experiment, or however sound the theories on which they were based, the numerical results were useless unless the observer had devoted sufficient attention to the measurement of the temperature. The second portion of the Paper was in relation to the consideration of certain thermal units other than those dependent on the capacity for heat of water. The third part consisted of practical suggestions, and the author laid it down that the

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ideal thermal unit should be a rational, and not an arbitrary one, and have some real relation with other units of energy. Moreover, it should not be dependent on the observations or conclusions of any one investigator. Any such dependence must certainly result in further corrections and changes. It should also be of convenient magnitude, and cause as little disturbance as possible in the numerical values resulting from the present system of thermal measurements. In conclusion, the author expressed the opinion that further individual effort would avail but little. What was necessary, in his opinion, was the decision of some body having authority whose conclusions would command the respect of the scientific world.

The Retirement of Professors.—The Report of the Committee appointed by the Treasury to consider the question of the desirability of a fixed age for the compulsory retirement of professors serving under the Crown has been published as a Parliamentary paper. The Committee consisted of Lord Playfair, Lord Welby, and the Home Secretary. The following is a *précis* of the Report:—

"Presidents and professors are appointed at a maturer age, and have, by the nature of their employment at seats of learning, less tendency than Civil servants to become inefficient at the age of 65. Indeed, up to that age it is often found that their efficiency increases, by experience in teaching, as their age progresses, though undoubtedly a time does arrive when advancing age weakens the receptivity of the professor to new discoveries in science, and diminishes the inclination to alter his instruction in order to adapt it to these changes. When this occurs the students are the sufferers. Under these circumstances, we are of opinion that there should be fixed rules as to superannuation of presidents and professors, and that they should be made by college statutes and not by an Order in Council. We are of opinion that when a professor reaches 65 years of age the president of the college should be bound to report to the Government the condition and efficiency of the teaching. If these are and continue to be satisfactory, the professor need not be superannuated till 70, but at this age his retirement should be absolute. In regard to presidents, we are of opinion that the age of 70 should be the period of retirement, but there should be power to continue him as president for a certain number of years not exceeding five. We are quite aware that there are cases where professors at 70 and presidents at 75 are fully competent to discharge their duties, but the advantages derived from superannuation would be seriously diminished if, to meet these rare cases, there were uncertainty in regard to the application of a general rule."

The Postmaster-General's Annual Report.—During the year ended April 1, 1895, telegraph offices have increased by 451, bringing up the total to 9,661. The number of telegrams of all kinds forwarded in the United Kingdom amounted to 71,589,064, an increase over the previous year of 689,566. The total value of inland telegrams at the sixpenny rate was £1,880,206, as against £1,851,335 for 1894, the average payment for each message being 7·66d. Foreign telegrams numbered 5,937,715, an increase of 255,890 over the preceding year's total. Press telegrams show a slight decrease, their numbers, however, reaching the magnificent total of 5,401,783, transmitted at rates which are known to be unprofitable. A still more gratifying decrease of worthless traffic is that of free railway telegrams; and arrangements have now been made with nearly all the great railway companies for a further diminution. There has been an increase of 259,832 in the number of metropolitan local messages, an interesting fact considered in relation to the keen competition of the telephone for this class of work. Telegraph withdrawals from the savings bank during the first three months of this year numbered 18,602, an increase of 150 per cent. over the corresponding period last year. Money orders transmitted by the same medium during the whole year increased by 25,567 over the previous year, the respective numbers being 132,457, against 106,890. Nineteen additional shore lighthouses and lighthouse stations were connected by telegraph during the year; and cables were laid connecting the Hasborough and Shipwash lightvessels, and to the lighthouse on the Tasker rock. Other works of a similar kind are in hand. The erection of the new trunk telephone wires provided for by the Act of 1892 has been completed between Plymouth, Exeter, Bristol and the ports of South Wales with Birmingham, Leeds and Newcastle-on-Tyne; and those connecting London with Nottingham, Sheffield, Leeds, Manchester, Liverpool, Glasgow, Edinburgh, Belfast and Dublin, as well as separate lines between Leeds and Hull, Nottingham, Derby and Leicester; London and Chelmsford, Colchester and Ipswich; and London and Brighton. Some of these lines have been opened for traffic.

"Trolley" Excursions.—The Brooklyn Heights Railroad Company, says the *Western Electrician* in a recent issue, gave its first "illuminated trolley excursion" on Wednesday evening. The cars were beautiful in bunting and coloured electric lights. City Hall-square was alive with people to see the start of the six cars at eight o'clock, and the excursion went through crowded streets all the way from the City Hall through Court-street to Hamilton-avenue, to Third-avenue, and thence along to Bay Ridge, Thirteenth and Twenty-fifth avenues to Ulmer Park. Each car carried 175 lights. The cars were those ordinarily used on the Second-avenue line, and differ from the Company's other rolling stock only in their length. Along the top of the cars over the ventilator spaces was a row of red, amber and green incandescent lamps; below, on the edge of the roof, was another row of lights, and still further down on the uprights another string. Around the front of the roof were rows of red, white and blue lights. Under the roof over the motorman's head were rows of the same colour. On the dashboard a half-moon-shaped frame held coloured lights set close together, and in the centre of this device was a white disc with five lights in a cluster. The fronts and rears of the cars were similarly decorated. The fenders were wound about with bunting. Behind the motorman was draped a flag, and bunting was used along the tops of the cars inside and out with beautiful effect. The trolley poles and ropes were decorated with small flags. When the cars moved off they looked like miniature ferryboats on wheels, only far prettier. The trip to Ulmer Park was made without accident or incident to mar the pleasure of a large party of prominent persons who were the guests of the Company. At the park the Company's guests were seated at reserved tables, and refreshments were served. On the return trip the cars reached the City Hall at 11:30 p.m. President Rossiter and Secretary Williams, of the Company, looked after the comfort of their guests. Six cars were run, each having a seating capacity of 60 people.

Long-Distance Telephony in the United States.—In its issue of August 28th the *Electrical Engineer* of New York publishes a map showing the long-distance telephone lines now in operation in the United States, and also a short article giving some facts and figures connected with the growth of this branch of telephony. According to the last report of the Chairman of the American Bell Telephone Company, the total sum invested in telephone property in the United States amounts to £14,500,000 sterling. It would appear that no less than one-tenth of this large sum is represented by long-distance telephone investments. The long-distance work is carried out by the American Telephone and Telegraph Company, the gross earnings of which for 1894 amounted to over £200,000, an increase of nearly 13½ per cent, on those of 1893. The first inter-urban wire was constructed in 1885 between New York and Philadelphia. The system now includes 55,000 miles of line and 265,000 miles of wire, all of the very latest and best type of construction. Between such cities as New York, Boston and Philadelphia there are as many as 40 wires to the line. The standard wire employed has been 0·104 inches diameter, hard-drawn copper 5·2 ohms to the mile, supported on poles 40ft. high and 130ft. apart. According to the writer of the article in our New York contemporary, the talking is everywhere remarkably clear, and the author has frequently conversed with New York from parts as remote as Chicago and Milwaukee and obtained perfect results, even in the wet months of October and November. It will be remembered, moreover, as one of the incidents of the memorable blizzard of 1889, that the only practical exchange of news between New York and points outside was by means of the long-distance wires, and that while *telegrams* between New York and Boston were sent *viâ* Ireland over the Atlantic cable, people in New York and Boston offices were quietly chatting over the telephone as if nothing had happened. It is admitted that the present rates are high, but it is contended that good value is obtained for the money. During the day a five-minutes talk between New York and Chicago costs £1. 16s., and half that amount during the night. It is asserted in the States that the growing use of long-distance telephony is seriously affecting long-distance railway traffic and interfering with the prosperity of hotels in the large commercial towns.

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THE MAGNETIC FIELD OF A RECTANGULAR CURRENT.

BY PROF. G. M. MINCHIN, M.A., F.R.S.

In a previous Paper (see *The Electrician*, September 6th), has been given a simple expression for the magnetic force-intensity at any point in the plane of a rectangular current, together with a graphic construction which enables us to calculate with ease the value of the force-intensity at all points in the plane. The object of the present Paper is to show that this graphic rule, and the expression on which it is founded, hold even for points infinitely close to the sides of the rectangle. An extension of the result to the case of a rectangular coil will also be made.

To show that the result (5) (see *The Electrician*, September 6th) holds for points very close to the sides of the rectangle, let us revert to a few elementary facts.

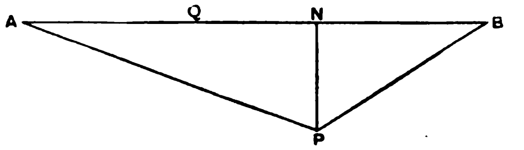

Fig. 1.

Supposing a current of strength i to flow in the *right line* B A (Fig. 1) while a unit pole is at any point P, the force exerted at P by an element of length ds of the current at any point Q is

$$\frac{i\,ds}{r^2}\sin\theta, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where $r = \mathrm{PQ}$ and $\theta = \angle \mathrm{BQP}$. Now if the perpendicular P N from P on B A is denoted by p, a simple integration of the expression (1) gives the total force at P equal to

$$i \cdot \frac{\cos \mathrm{A} + \cos \mathrm{B}}{p}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where A and B denote the angles B A P and A B P respectively.

If the line B A is so long with respect to p that A and B are practically zero, this becomes $\frac{2i}{p}$; and if P is infinitely near A B, this expression for the force becomes infinite.

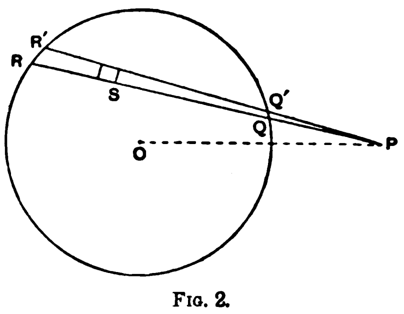

Fig. 2.

We know, of course, that even when P is on A B, the force is *not* infinite, so that the mathematical expression appears to be erroneous. But observe that if A B is a *wire*, and not a mere Euclidian line, the diameter of its cross-section must be taken account of when P is near its surface, and that in order that (2) should be applicable in the calculation, we must break up the wire into an infinitely great number of infinitely thin filaments, each of which conveys a current of infinitely small strength. If, then, these filaments are taken by such a rule that the cross-section of the filament *on which* P *actually lies* is zero, the current running in this filament is zero, so that the expression

$$\frac{\text{current in filament}}{\text{perp. from P on filament}}$$

is not infinite; and obviously this is the only legitimate method of calculation. Similar instances occur perpetually throughout the theory of attraction. Thus, if B A (Fig. 1) is a homogeneous and uniform bar, attracting according to the Newtonian law, and a unit mass is placed at P, we know that the attraction at P is proportional to

$$\frac{1}{p} \cdot \sin \frac{\mathrm{APB}}{2},$$

which is infinity if P is on the bar, whereas it is evident to common sense that the force cannot be infinite. In this case also the true value of the force at P must be obtained by breaking up the bar into infinitely thin filaments.

Now, in the present case, let Fig. 2 represent an enlarged view of the cross-section of the wire B A, its centre being O, its radius being a, and the distance P O being c. Draw P Q R making the angle θ with O P; take any point, S on P R; let $\mathrm{PS} = r$, and construct the usual element of area $r\,dr\,d\theta$ at S by drawing P Q′ R′ inclined at $d\theta$ to P Q R, &c. If i is the total current passing through the whole cross-section, the quantity passing through the element at S is

$$\frac{i}{\pi a^2}\, r\,dr\,d\theta,$$

and if P is so close to the wire that the extremities of the filament whose cross-section is $r\,dr\,d\theta$ are very distant from P, the extreme angles A, B in (2) for this filament are practically zero, so that the force at P due to this filament is, by (2),

$$\frac{2i}{\pi a^2}\, dr\,d\theta.$$

This acts perpendicularly to S P, and as the perpendicular to O P at P is the direction of the resultant force due to the whole current, we must take the component in this latter direction, multiplying the result by 2 because the semicircle below O P gives the same result as that above O P. Thus, then, the whole force at P is

$$\frac{4i}{\pi a^2}\iint \cos\theta\,d\theta\,dr, \quad . \quad . \quad . \quad . \quad . \quad (3)$$

in which we first integrate from $r = \mathrm{PQ}$ to $r = \mathrm{PR}$, so as to get the effect due to the strip Q Q′ R′ R; and then integrate from $\theta = 0$ to $\theta = \sin^{-1}\frac{a}{c}$, the latter corresponding to the tangent from P to the circle. Now $\int dr = \mathrm{RP} - \mathrm{QP} = 2\sqrt{a^2 - c^2\sin^2\theta}$, and the force is

$$\frac{8i}{\pi a^2}\int \sqrt{a^2 - c^2\sin^2\theta}\,.\cos\theta\,d\theta = \frac{2i}{c}, \quad . \quad . \quad (4)$$

which, therefore, is the true value of the force-intensity at P. Hence, if P is actually *on* the wire, the force is $\frac{2i}{a}$, which is far from being infinite.

It follows therefore from (4) that when P is close to the wire, as in Fig. 3, *the whole current* i *may be considered to be condensed into an infinitely thin filament coinciding with the central axis of the wire*, and that for a wire bent into the form of a rectangle we may consider the actual physical wire to be replaced by *a mere Euclidian rectangle coinciding with the core of the wire*, and represented by the dotted lines in Fig. 3. It is here assumed, of course, that the density of the current is the same at all points in the cross-section of the wire—which will not be true at corners or bends. Except in the case of a *straight* wire, it is not strictly allowable to replace the actual current by one of the same strength flowing along the central core of the wire, although this mistake is often made.

Thus, then, for any point P close to the wire, but not near a corner, the expression

$$i\,\Sigma\frac{1}{p}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

previously given in (5) (see *The Electrician*, September 6th) for the force holds if we use the rectangular core of the wire as the rectangle A B C D in Fig. 2.

It may be worth while to point out that the expression (5), or (5) (see *The Electrician*, September 6th) which we have deduced by the potential method, follows from the more elementary application of the result (2). For, in Fig. 1 (see *The Electrician*, September 6th), consider the force-intensity at any point Q. Let the angles $\mathrm{QAB} = \alpha$, $\mathrm{QBA} = \beta$, $\mathrm{QCD} = \gamma$,

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Q D C $=\delta$; then the sum of the forces at Q due to the currents in the sides of the rectangle is i multiplied by

$$\frac{\cos\alpha+\cos\beta}{QR}+\frac{\sin\beta+\sin\gamma}{QM}+\frac{\cos\gamma+\cos\delta}{QS}+\frac{\sin\delta+\sin\alpha}{QL}; \quad (6)$$

and taking the two terms in α, we have $\dfrac{QL\cos\alpha+QR\sin\alpha}{QR\,.\,QL}$ of which the numerator is evidently equal to Q A, so that this term is equal to the reciprocal of the perpendicular from Q on the line L R. Similarly for the other terms in (6), and thus the expression (5) is deduced.

The same application of (2) to the case of a current i running in any *triangle* A B C easily gives the force-intensity at any point P in the plane of the triangle equal to

$$i\left(\frac{\sin A}{p_1}+\frac{\sin B}{p_2}+\frac{\sin C}{p_3}\right), \quad . \quad . \quad . \quad (7)$$

in which p_1, p_2, p_3 are thus defined: from P let fall P L, P M, P N perpendicular to B C, C A, A B, respectively; then p_1 is the perpendicular from P on M N, p_2 on N L, p_3 on L M.

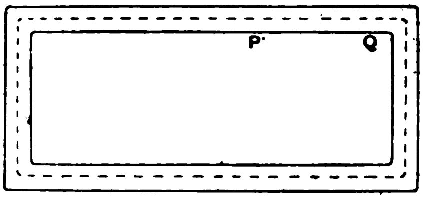

Fig. 3.

Returning to the rectangular current, if the point P in Fig. 3 is taken near a corner, as at Q, the case requires a special examination, and the replacement of the wire by its central rectangular core is not strictly justifiable. The result (5) (see *The Electrician*, September 6th), together with the graphic method, will still, however, be approximately correct, as we shall see.

Let us suppose Q to be actually on the wire at the corner and in the plane of the central rectangular core (dotted line in Fig 3). Then if p is the length of the perpendicular from a corner of this rectangle on the opposite diagonal, the expression (5) gives the force at Q equal to

$$i\left(\frac{1}{p}+\frac{2}{a}+\frac{\sqrt{2}}{a}\right), \quad . \quad . \quad . \quad . \quad . \quad (8)$$

of which the first term is negligible in comparison with the others. Now, if the lines of flow in the wire could be assumed

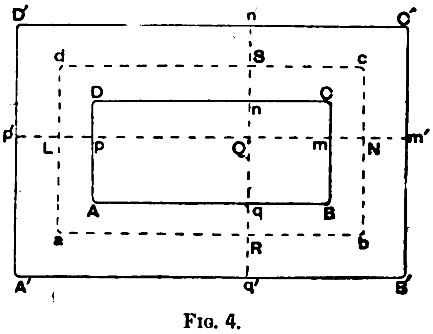

Fig. 4.

to be rectangles, *even at the corners*, the force at Q due to that part of the current which lies in the corner—*i.e.*, the part cut off by two planes at Q parallel to the sides of the rectangle and perpendicular to the plane of Fig. 3—is found without difficulty to be $\dfrac{4\,i}{\pi a}$, and the total force at Q would be, on this supposition,

$$i\left(\frac{1}{p}+\frac{2}{a}+\frac{4}{\pi a}\right), \quad . \quad . \quad . \quad . \quad . \quad (9)$$

which is somewhat less than (8), and evidently less than the true value, since the tubes of flow round the corner at Q are curved and not portions of rectangles; and since, moreover, the current density in these tubes will be greater near Q than in the tubes lying near the outside of the corner.

It would appear, then, that, in the absence of an accurate calculation founded on a knowledge of the lines of flow round the corners, the expression (8), or (5), and the graphic construction previously given, may be accepted as sufficiently accurate even for points very close to the corners. (I do not know whether or not the nature of the lines of flow round the bends, together with the current densities in them, have been investigated. Possibly Mr. Heaviside may have considered this matter.)

Take now the case of a flat rectangular coil, Fig. 4, consisting of any number, n, of rectangular windings, the innermost being the rectangle A B C D, and the outermost A′ B′ C′ D′. Let the diameter of the wire be h (a small quantity); let Q be any point in the plane of the coil; from Q let fall perpendiculars on the sides, meeting them in points m, m', n, n', &c.; let $Qm=\alpha$, $Qn=\beta$, $Qm'=\alpha'$, $Qn'=\beta'$, &c. Now take any rectangular current, $a\,b\,c\,d$, of the series; let $mN=nS=x$; then if p is the length of the perpendicular from Q on N S, we have

$$\frac{1}{p}=\frac{\sqrt{(\alpha+x)^2+(\beta+x)^2}}{(\alpha+x)(\beta+x)}, \quad . \quad . \quad . \quad . \quad (10)$$

and the contribution to the expression (5), or (5) (see *The Electrician*, September 6th), given by the portion $m\,m'$ C′ $n'\,n$ C of the coil will be obtained by giving x in (10) the values $0, h, 2h, 3h, \ldots (n-1)h$. (By each rectangle, $a\,b\,c\,d$, we understand strictly the *central core* of the corresponding winding.) There will, of course, be similar expressions for the contributions of the other gnomons, $n\,n'$ D′ $p'\,p$ D, &c.

Now we may calculate only the portion due to the first gnomon, and this will be typical of the rest; and it is obvious from the elements of the integral calculus that $\Sigma\frac{1}{p}$ for this gnomon, multiplied by h, will be the integral of the expression at the right-hand of (10) from $x=0$ to $x=m\,m'$. Denoting $\Sigma\frac{1}{p}$ for this part of the coil by f, we have, then,

$$f=\frac{1}{h}\int_0^b\frac{\sqrt{(\alpha+x)^2+(\beta+x)^2}}{(\alpha+x)(\beta+x)}\,.\,dx, \quad . \quad . \quad (11)$$

where $b=m\,m'=$ breadth of the coil.

This integral can be found in various ways. Thus, if we put $\alpha+x=(\beta+x)\tan\theta$, it becomes

$$\int\frac{d\theta}{\sin\theta\cos\theta(\cos\theta-\sin\theta)},$$

which is the same as

$$\int\left(\frac{d\theta}{\sin\theta}-\frac{d\theta}{\cos\theta}+\frac{2\,d\theta}{\cos\theta-\sin\theta}\right),$$

or

$$\int\frac{d\theta}{\sin\theta}+\int\frac{d\phi}{\sin\phi}+2\int\frac{d\theta}{\cos\theta-\sin\theta}, \quad . \quad . \quad (12)$$

where $\phi=\frac{\pi}{2}-\theta$; and obviously $\theta=SQc$, $\phi=NQc$. The first two of these integrals give $\log_e\tan\frac{\theta}{2}\tan\frac{\phi}{2}$, while the third is $-\sqrt{2}\log_e\tan\left(\frac{\pi}{8}-\frac{\theta}{2}\right)$.

This last integral in very inconvenient, because if Q is such that $\theta=\frac{\pi}{4}$ it gives us an infinite term to deal with, and obscures the true result. Hence in the last integral in (12) we shall use the original x instead of θ. Doing this, we have

$$\frac{d\theta}{\cos\theta-\sin\theta}=\frac{dx}{\sqrt{(\alpha+x)^2+(\beta+x)^2}}$$

$$=\frac{1}{\sqrt{2}}\cdot\frac{dx}{\sqrt{\left(x+\frac{\alpha+\beta}{2}\right)^2+\left(\frac{\alpha-\beta}{2}\right)^2}}$$

$$=\frac{1}{\sqrt{2}}\log_e\left\{x+\frac{\alpha+\beta}{2}+\frac{1}{\sqrt{2}}\sqrt{(x+\alpha)^2+(x+\beta)^2}\right\}$$

$$=\frac{1}{\sqrt{2}}\log_e(QN+QS+\sqrt{2}\,.\,Qc), \quad . \quad . \quad (13)$$

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since $\frac{1}{\sqrt{2}}\log 2$ is merely a constant which disappears in the integration between limits.

Again, by elementary trigonometry $\tan\frac{\theta}{2}\tan\frac{\phi}{2}=\frac{a+\beta-r}{a+\beta+r}$, where $r=Qc$; so that we have

$$f=\frac{1}{h}\left\{\log_e\frac{a+\beta-r}{a+\beta+r}+\sqrt{2}\log_e(a+\beta+r\sqrt{2})\right\}, \quad . \quad (14)$$

in which the term in brackets is to be taken between the limits denoted by the rectangle $Q\,m\,C\,n$ and the rectangle $Q\,m'\,C'\,n'$.

Hence, then, if we take the other gnomons of the figure, and denote the product of the four values of $\frac{a+\beta-r}{a+\beta+r}$ given by the inner boundary A B C D by $\Pi\frac{a+\beta-r}{a+\beta+r}$, the total force at Q produced by a current of strength i flowing in each winding of the coil is obtained by taking the value of the expression

$$\frac{n\,.\,i}{b}\left\{\log_e\Pi\frac{a+\beta-r}{a+\beta+r}+\sqrt{2}\log_e\Pi(a+\beta+r\sqrt{2})\right\} \quad (15)$$

for the outer rectangle A′ B′ C′ D′ and its value for the inner, A B C D, and subtracting the one from the other. (Thus, for example, the second term in (15) means, for the inner rectangle, $\sqrt{2}\log(Qm+mC+QC\sqrt{2})\,(Qp+pD+QD\sqrt{2})\,(Qq+qA+QA\sqrt{2})\,(Qq+qB+QB\sqrt{2})$, with a similar meaning for the first. These terms occupy much more space in writing out in symbols than they do in actual numerical calculation when the lengths $Q\,m$, $Q\,n$, &c., are numerically assigned.)

In actual numerical work we shall use logs to base 10 instead of logs to base e, and then the multiplier outside the bracket in (15) will be $2{\cdot}302\frac{n\,.\,i}{b}$.

The result at which we have arrived will be more accurate, of course, the smaller the diameter of the wire in the coil and the thinner the insulating coating, since the process of *integrating* (10) will be the more allowable.

Obviously at the centre of a square coil the first term in (15) contributes nothing to the result, since it is the same for the outer as for the inner boundary of the coil.

To calculate the force, then, we require nothing but the easily measurable lengths $Q\,m'$, $Q\,n'$, &c., the breadth b of the coil, and the simplest use of a table of logarithms.

MOLECULAR ELECTRICITY.

BY J. H. POYNTING, SC.D., F.R.S.

(Continued from page 671.)

We must now attempt to give some account of the action at the source of a voltaic current. As we simplified the electrolyte so we shall simplify the active liquid of the voltaic cell by imagining that we have merely sulphuric acid, that is, we shall neglect the solvent, water. We shall take as the two metals zinc and copper.

We know that the result of putting the copper and zinc in the acid is that the air above the acid tends to become the seat of tubes of induction running from copper to zinc. This will be neutralised by the oxidising tendency of the air on the zinc—at any rate that is the "chemical theory" of voltaic action. To eliminate this action of the air we shall suppose the zinc to have a copper terminal in the air, as it always has in practice. Experiment shows that these tubes of induction always run from copper terminal to zinc terminal with a fall of potential which may be as much, say, as a volt and a half. To represent the establishment of this induction let us imagine the cell initially to consist of such molecules as are shown in Fig. 9 (a), where we represent the acid molecules as consisting of $+H_2$ paired with $-SO_4$, and the copper and zinc plates as $\pm$Cu and $\pm$Zn.

Of course, the molecules in each substance are evenly distributed in all directions, but only those are shown in the figure which are suitably directed for the action which is going to occur. The first stage is represented in Fig. 9 (b), where change of partners has occurred between metal and acid both with copper and zinc. The H_2Zn molecules do not reverse, for it is an experimental fact that the hydrogen does not rise up where it is first turned out. The reversal may perhaps be prevented by the presence of the $ZnSO_4$ molecules, but it is

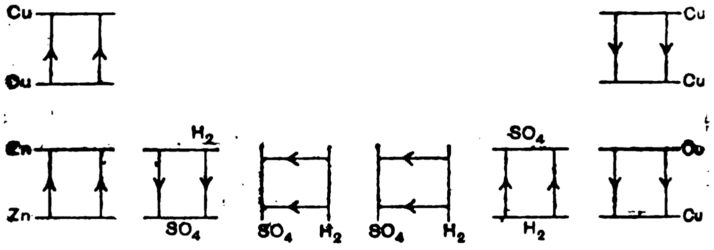

FIG. 9a.

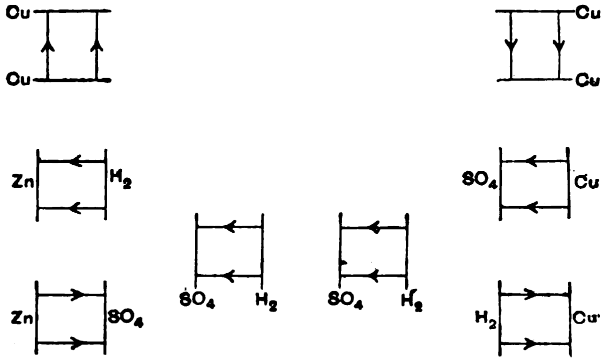

FIG. 9b.

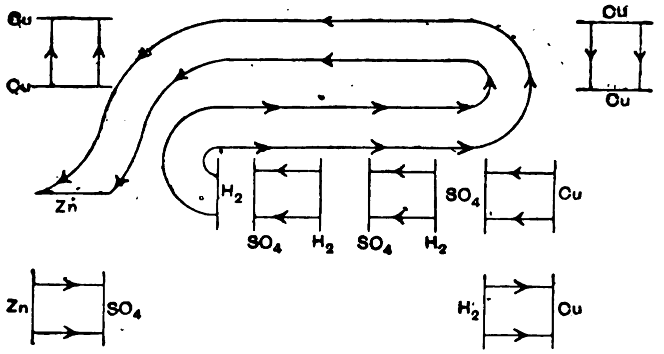

FIG. 9c.

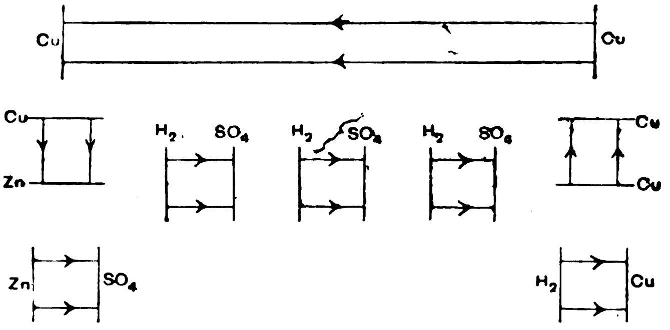

FIG. 9d.

more probably due to the electrical energy put into the H_2Zn. For the $ZnSO_4$ contains much less energy than the H_2SO_4 it replaces; so that the H_2Zn contains much more than the ZnZn it replaces. The electrical energy put in makes the atoms separate too widely, we may imagine, to allow of the contact needed for reversal. Probably at first there is no reversal in the H_2Cu molecules at the other plate, and for similar reasons.

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The electrical energy in the H_2Zn and H_2Cu molecules will imply that the acid is at a higher potential than the metals and tubes of induction will spread out from the H_2 atoms. Since the H_2Zn molecules contain the most energy, we may represent their tubes as spreading rather than those of the H_2Cu, and in Fig. 9 (*c*) we have the tubes shown as going out towards the copper and then doubling back again. In (*d*) the tubes have entered into the neighbouring molecules by coalescence with oppositely-directed tubes, and we are left with two tubes running from the + to the − terminal with a $ZnSO_4$ molecule and an H_2Cu molecule, the $CuSO_4$ molecule having been dissociated in the process. The molecules of acid have changed partners, but still have the same constitution.

If the action is not continuous, but merely goes on till the terminals are charged, we must suppose that H_2Zn and H_2Cu pairs are left against each plate with an average fall from H to metal of, say, $1\frac{1}{2}$ volts. The pairs against the copper plate are no doubt the agents in polarisation. The reverse current which we get on replacing the zinc by a fresh copper is to be set down to the straying out of the tubes of induction of these H_2Cu pairs. If the action is made continuous by connecting the terminals with a wire, the hydrogen rises up from the copper plate, and we must suppose that half the H_2Cu pairs have reversed and have then changed partners with the other half. Perhaps this reversal is rendered possible by the resolving of the $CuSO_4$ molecules, perhaps by the outlet provided for the energy of the H_2Cu pairs in the external circuit.

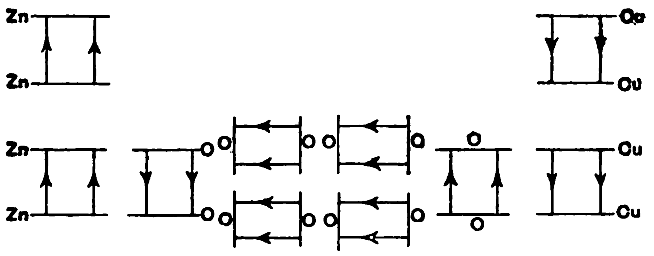

FIG. 10*a*.

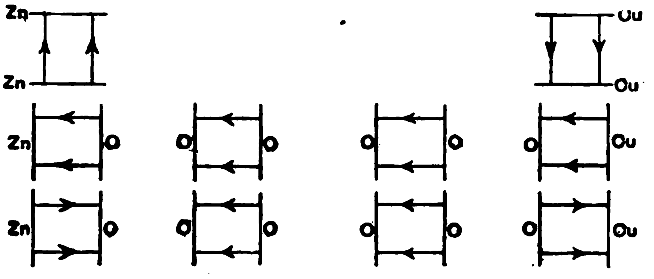

FIG. 10*b*.

In a very similar way we may account for the contact difference of potential of copper and zinc in air. We know that if the two metals are brought into contact a fall of potential occurs from the air near the zinc to the air near the copper; that is, electric induction passes from the neighbourhood of one to the neighbourhood of the other. Both metals can be oxidised, but zinc by far the more readily. Let us suppose the oxygen molecules in the air to be made up of pairs of opposite atoms, and that *before contact* we have a state of affairs, represented by Fig. 10 (*a*), developing into (*b*) by the actions at the metals. On each metal we have the normal oxides ZnO CuO where the positive atom comes first, and the unstable molecules OZn and OCu. If the tubes of induction of these unstable molecules stray out they have to double back on themselves, so that as long as there is no contact there are equal numbers in the two directions passing through the air, and no fall of potential except from the surface layer of the air to the surface layer of the metal close to it. This fall will be greater at the zinc than at the copper, since there is presumably more energy given up at the zinc surface. Probably reversal is prevented either by the presence of the normal oxides or by the want of outlet for the energy. If, however, it does occur in some of the unstable molecule there will be re-pairings and the formation of new metal molecules and new oxygen molecules, with the net result that each metal is left slightly oxidised. But let us make the two metals touch as at J in Fig. 11 (*a*). If the tubes of induction of the OZn molecule now move out like those of the H_2Zn molecule in Fig. 9 (*c*) the upper returning part can enter into the continuous metal bridge and there be dissipated; while the lower outgoing part will thread the oxygen molecules, as shown in Fig. 11 (*b*), and decompose the CuO molecule already found. We shall as a net result have ZnO on the surface of the zinc, a fall of potential from O on the zinc surface to O on the copper surface, and the unstable OCu, which possibly reverses and re-pairs, leaving the copper surface unacted on. If it remains then the copper is polarised, and if the zinc were suddenly removed and replaced by a new copper it would appear that the old copper should show a fall of potential towards the new. But any such

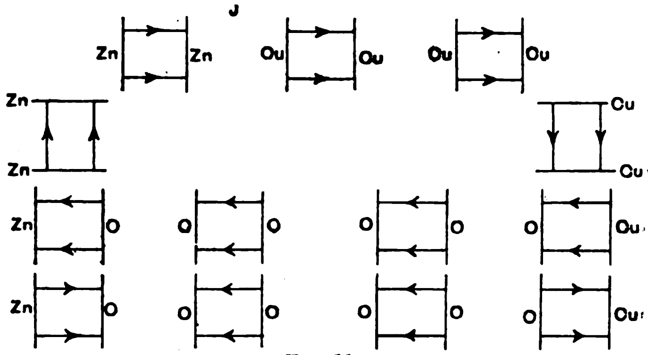

FIG. 11*a*.

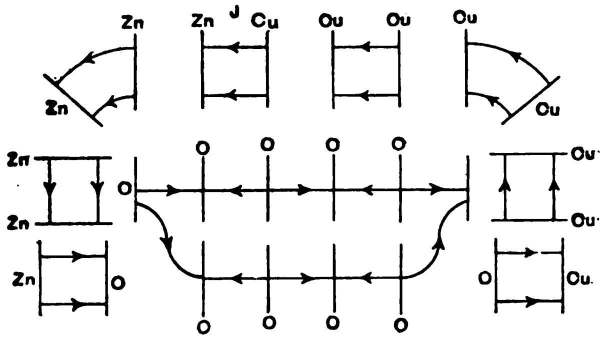

FIG. 11*b*.

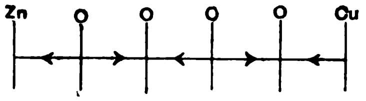

FIG. 11*c*.

fall would probably be disguised by the induction ending in the O atoms next to the copper. We have probably gone too ar in this account in supposing that *all* the induction of the OZn molecules goes out in this way. If, for example, we suppose that only half goes out, we get a chain extending from Zn to Cu, as in Fig. 11c. Probably some such supposition must be made in order to explain how the +O atoms remain at the zinc surface and the −O atoms at the copper surface after the break of contact. That they do remain is shown by the + electrification of the zinc and the − of the copper when tested by an electrometer. But our account must be regarded as a first attempt and not a complete explanation.

Leaving electrolysis, let us consider how an ordinary insulator may be affected by induction, and how we may represent the condition of affairs leading up to spark discharge. We shall thus get some useful ideas which will supplement our account of electrolysis and make it somewhat easier to understand the true nature of the process.

We shall suppose that we are dealing with a dielectric consisting of paired + and − atoms, and we shall suppose, further, that these molecules are initially self-contained—that is to say, that their tubes do not stray out to surrounding molecules. This is, no doubt, a simplification not existing in nature; but, as with electrolysis, so here also we must be content to begin

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with an abstract case. When there is no apparent electrification in the system the axes of the molecules will be equally distributed in all directions. But if electrification is communicated to a pair of conductors bounding the dielectric, tubes of induction move into the dielectric, and, selecting the suitably arranged molecules, connect these in chains. It will be convenient now to suppose at least four tubes of induction to pass from atom to atom in a molecule. Let Fig. 12 (*a*) represent a number of molecules ready for a tube of induction to affect them. In (*b*) it has moved in and formed the molecules into a chain stretching right through the dielectric. If we suppose another tube to move in, as in (*c*), we get a condition of instability, for now we are just half-way to a change of partners all along the line. A third tube will give

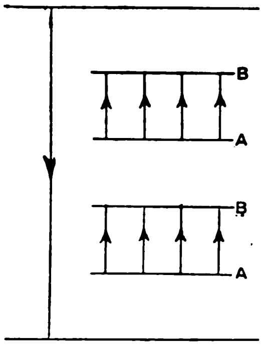

Fig. 12*a*.

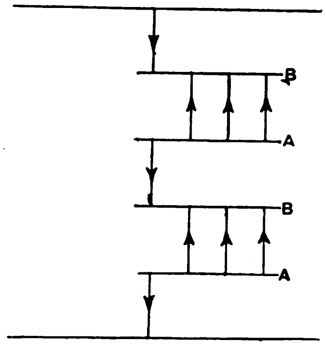

Fig. 12*b*.

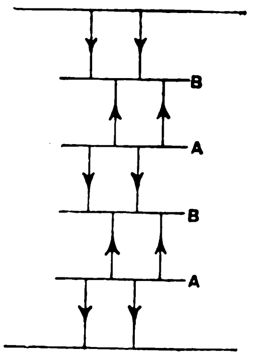

Fig. 12*c*.

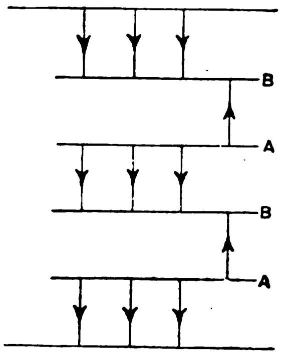

Fig. 12*d*.

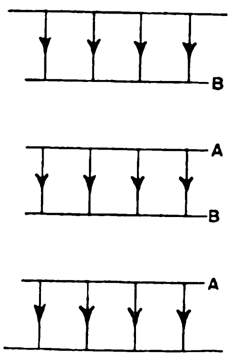

Fig. 12*e*.

us (*d*), a configuration with the same amount of energy as (*b*), since the molecules in the two cases are similar, the axes only being reversed. Hence in passing from (*c*) to (*d*) energy is given up, another way of saying that (*c*) is unstable. A fourth line entering will change (*d*) to (*e*), where the change of partners is complete, and where electrolysis has occurred.

We may usefully follow out the process by the aid of a diagram representing the relation between energy put in and induction. Beginning with an ordinary condenser, let distances along O X (Fig. 13) represent induction put in per unit area cross-section, distances along O Y difference of potential between the end plates.

At first we have

$$V = \frac{4\pi \sigma d}{K},$$

where V is the potential difference, *d* the thickness, σ the surface density, and K the specific inductive capacity.

But since the induction $D = \sigma$,

$$V = \frac{4\pi d}{K} D.$$

If then K is constant, the relation between V and D is represented by a straight line, which makes with O X an angle θ, given by

$$\tan \theta = \frac{4\pi d}{K}.$$

The energy stored per unit cross-section is equal to $\frac{\sigma V}{2}$, or equal to the area from the origin up to the ordinate V, and bounded by the line representing the relation between V and D. We may indeed regard the diagram as showing the relation between induction and energy stored, and this is probably a better point of view, since we cannot attach much idea to potential in the later parts of the process now to be considered. From this point of view the abscissa is the induction through unit area and the ordinate is the energy added per unit addition of induction.

All experiments hitherto made appear to show that K *is* practically constant so long as the medium can continue to store up energy, though the Kerr effect shows that K does alter slightly as D increases, apparently sometimes increasing

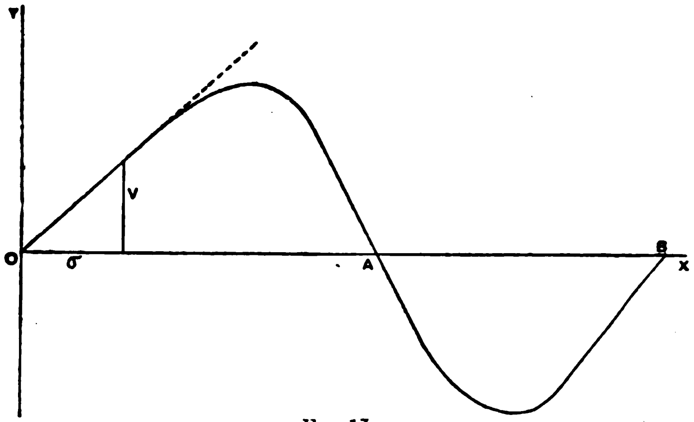

Fig. 13.

and sometimes diminishing, or, perhaps, always increasing, but sometimes most along the lines of induction, at other times most at right angles to them.

Sooner or later, however, a point of instability is reached —sooner in gases, later in liquids and solids; and discharge occurs along one track and all the energy is dissipated. We can see how the curve in Fig. 13 must run in order to represent this instability. Making the unit area small enough to represent the cross-section of a molecule, the curve expresses the relation between induction going right through a chain of molecules from plate to plate and energy put in. At first, while only a small part of the induction is continuous, as in Fig. 12 (*b*), we know that the energy stored is proportional to the square of the induction, and the curve is, as we have seen, a straight line. But as more induction becomes continuous from plate to plate, and as the atoms are pulled in both ways, the force resisting separation does not go on increasing so rapidly, and the curve falls below a straight line.

At some point on the way to instability and subsequent change of partners the force will reach a maximum, and after that the curve will turn down, successive equal additions of induction requiring diminishing additions of energy. At last, when the lines of induction from each atom run half one way, half the other, as in Fig. 12 (*c*), the energy put in is a maximum, and the curve crosses the X axis, as at A. The configuration is now unstable, and will of itself pass through (*d*) and (*e*), absorbing two more positive lines or extruding two negative lines till we arrive at (*e*), represented by the point B on the

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diagram, when the condition is again stable, like that at the beginning. The energy put in between O and A is given out again between A and B in part, no doubt, as the light, heat, and so on of the discharge. The curve O A B may be termed, perhaps, a molecular characteristic. It should be noted that the passage from (*c*) to (*d*) (Fig. 12), or past A (Fig. 13), may be effected either by absorbing more positive tubes, or by sending out negative tubes. If the passage through the position A occurs with a rush then we may regard the chain as sending out negative tubes by some such process as is illustrated in Fig. 14 (*a* to *d*). Though the instability of a single chain will not be reached till its condition is represented by A (Fig. 13), the instability for a great number of parallel chains is reached as soon as they are all at or near the highest point of the characteristic. In the ascending part of the curve all the parallel chains will tend to have the same amount of induction through them, for if any one has more than another, energy will be yielded up by a redistribution between them. Thus let one chain have induction O M (Fig. 15), another near it induction O N, the energies stored being O M P, O N Q. If L bisect M N the second chain may give up induction L N = L M to the first, and at the same time there will be a yield of energy equal to the difference

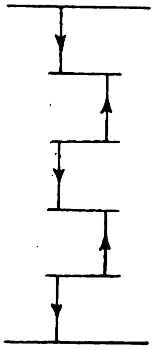

Fig. 14*a*.

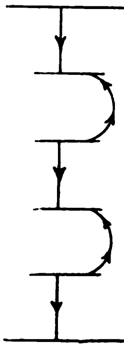

Fig. 14*b*.

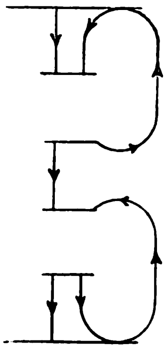

Fig. 14*c*.

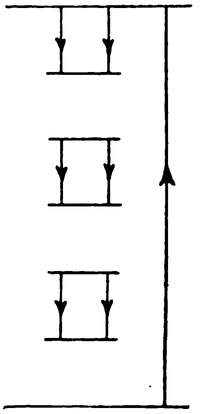

Fig. 14*d*.

between the areas P L and Q L. Probably the induction is really distributed about an average, some of the chains having more, others less, for no doubt the condition is kinetic, and when there appears to be equilibrium it is not static but "mobile."

If the average condition is represented by a point far up the slope and near the crest, and if any one of the chains gets past the crest, as far below it on the other side as the average is below on the first slope, then this advanced chain will at once receive induction from the others, and continue to move down the second slope towards the point of unstability. Thus, let there be n chains in all. Let O H A (Fig. 16) be the characteristic of that with the greatest induction, O K A^1 the sum of the other $n-1$ characteristics. If the first chain is at P while the others are at p on the same level, by a transfer of induction mn = M N from the general body in the first chain, there is a yield of energy, since the area of $p\,m\,n\,q$ is greater than the area of P M N Q, for the two slips are of the same breadth, but the slope of P Q is steeper than that of $p\,q$. The transfer will therefore take place, and the chain moves from P to Q. At Q, *à fortiori*, a new transfer will take place, and so on, and the chain will move towards the position of instability. This will all probably occur even when the average is far below the crest if the induction is widely distributed about that average, for as soon as one chain gets over the crest it will probably find others between it and the average ready to hand on their induction and energy to it, and send it down the second slope.

As, then, the general average rises towards the crest, the most advanced chains, as soon as they pass the crest, tend to discharge the rest, and there will at a certain point be a rush in sideways on to these advanced tubes. They will move down to the condition of instability represented by A on the diagram. They can of themselves move past this point, extruding negative tubes, till they arrive at the point B, where the change of partners is complete.

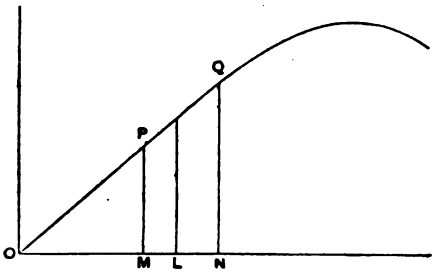

Fig. 15.

It appears at least probable that this yield of negative tubes gives the opposite charging of the medium which takes place in the second quarter period of the oscillation accompanying rapid discharge, now made so familiar by the work of Hertz. We may, perhaps, think of the process somewhat as follows: If the inrush of positive tubes during the first stage is rapid they will concentrate on the chains in the neighbourhood of that which began the breakdown, and carry them past the unstable point. Then will begin the outrush of negative tubes, and when this is complete the central chains will be discharged and in the condition of Fig. 12 (*e*), while the surrounding medium will contain negative induction. There will be now an inrush of negative induction into the *locus* of

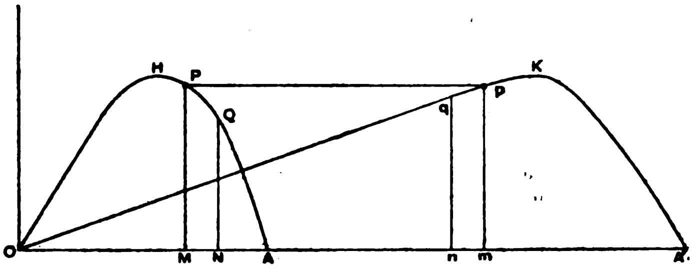

Fig. 16.

the first discharge, for not only is this free from induction, but also its molecules are suitably arranged to take up negative tubes, and during the second half-period of swing from negative to positive there will be a second change of partners along the same line. And so on with the successive alternations of charge, and there is a tendency, evidently, to keep the same line of discharge. Each change will give atoms at the two end plates, which will combine either with each other or with the electrodes, or perhaps be taken again into the chains in the following changes. In the sudden changes of partners some of the energy goes to atomic vibration, and we have evidence of this in the atomic radiation which we call spark. There is also energy of translation of the atoms from one partner to another, which appears as heat in the molecules. This heat possibly produces the sound of the spark through the sudden expansion. We have then dissipation of energy as well as the radiation out to space in the Hertzian waves, and the two gradually reduce the electrical energy of the system.

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We can see, too, how the amplitude of charge may lessen in the process. For if the negative tubes begin to move out at the middle of each oscillation before the positive tubes have all moved in, or *vice versâ*, then the first of the issuing kind will destroy the last of the incoming kind, and the final charge will be diminished by the amount of this overlap. In the extreme case of slow discharge, as through a wet thread, the issuing tubes are neutralised as they come out by the incoming ones, and the motion is dead beat.

These negative tubes turned out may also supply the negative tubes required in the theory of Prof. J. J. Thomson ("Recent Researches," Chapter I.).

(*To be concluded*)

THE VELOCITY OF ELECTRIC WAVES.*

BY JOHN TROWBRIDGE AND WILLIAM DUANE.

The direct determination of a velocity implies the measurement of a length and of a time. So far as we know, no direct measurement of the velocity of electric waves has been hitherto published. A number of experiments have been performed on the velocity of single pulses of electricity travelling over long metallic circuits by Wheatstone, Fizeau and Gounelle, Siemens, Blondlot† and others, but the results obtained are very discordant. Blondlot's method is not open to the objections that have been raised against some of the others, for his electric pulses theoretically were short, and had steep wave fronts. Blondlot‡ also described a method of determining the velocity of a system of electric waves. He measured the distance between the nodes on a metallic circuit, but, in order to get the time, he calculated the period of oscillation of another circuit that was in resonance with the first. His determination, therefore, was not a direct measurement.

Early last year the following direct method of measuring the velocity of electric waves suggested itself to us:—Increase the size, and, if necessary, change the shape of a Hertz vibrator until the period of oscillation is sufficiently long to be determined by photographing the spark; measure the length of the waves induced in a secondary circuit tuned to resonance with the vibrator; and the quotient of the wave-length by the time of a complete oscillation will be the required velocity.

The first apparatus experimented with was that used by Mr. St. John in investigating the peculiarities of waves along iron wires. For a detailed description of this apparatus see the *Philosophical Magazine* for November, 1894. It has been assumed by certain writers that the reaction between the circuits, arranged in the manner employed by Mr. St. John, is, to a large extent, what would be called in the older theory of electricity electromagnetic rather than electrostatic. Certain phenomena, however, which appeared in the early part of our investigation seemed to point to the view that the greater portion of the action was electrostatic; and we therefore concluded to arrange the apparatus so that the reaction should be wholly electrostatic, thinking by this means to obtain a more powerful oscillation and a more regular wave than with the electromagnetic arrangement described and used so successfully by Blondlot. The first attempt arranged on the electrostatic principle proved a complete failure. A second trial about a fortnight later, however, was so successful that we fully determined to adopt the electrostatic method.

The first point in the course of the investigation worth detailed description is the production of electric waves along parallel wires in such a manner that they are actually visible to the eye. The arrangement of the apparatus to accomplish this was as follows:—

A primary condenser, A B (Fig. 1), was held with its plates in vertical planes by means of suitable wooden supports (not represented in the figure), and was joined in a circuit, B C, consisting of two wires about 75cm. long, placed 4cm. apart. In reality this circuit B C should be represented as perpendicular to the plane of the paper (which is taken as the horizontal plane passing through the centre of the apparatus). The plates of the condenser A B were sheets of tinfoil 101 × 40cm. glued to hard-rubber sheets, and the dielectric between them consisted of other similar sheets of hard rubber sufficient in number and thickness to make the distance between the condenser plates 4·2cm. Outside the primary condenser plates and separated from them by hard-rubber plates (total thickness 0·6cm.) were two secondary plates, E and F, each 40cm. square. To these plates was attached the secondary circuit E G J H F, the form of which is represented in the figure. This latter circuit consisted of copper wire, diameter 0·13cm., and its total length from E to F was 4,200cm. A spark-gap with spherical terminals 2·5cm. in diameter was placed at C in the primary circuit, and another spark-gap with pointed terminals was sometimes inserted at J in the secondary circuit, although this latter spark-gap had no effect upon the phenomena to be described. The primary condenser was charged by means of a large Ruhmkorf coil excited by five storage cells with a total voltage of ten volts. The current from these cells was made and broken by the automatic interrupter used by Mr. St. John and described by him in his Paper above referred to. Every time the primary condenser was charged a spark passed at C, causing an oscillatory discharge. A convenient method of forming a mental picture of the oscillation excited in the secondary circuit is the conception of Faraday tubes elaborated by J. J. Thomson, in his "Recent Researches in Electricity and Magnetism." The oscillations of the primary acted inductively upon the secondary and sent out groups of Faraday tubes which travelled along the secondary circuit, with their ends on the wires, and lying chiefly in the space between them. At the end J they reversed their direction and travelled back along the circuit. The period of oscillation of the primary circuit was altered, until by trial it was found that groups of returning tubes met groups of advancing tubes between the points G and H. As the two sets of moving tubes were oppositely directed, they annulled each other and produced a node. Thus a system of stationary waves was set up with a node at J, another node at G H, and a ventral segment at K L. The method of discovering when the circuits were in tune and of investigating the shape of the waves will be described later. The point to be noticed here is that the vibrations were sufficiently powerful to cause a luminous discharge on the surface of the wire where the accumulation of tubes was a maximum, *i.e.*, at K L, while at the nodal points J and G H the wire was entirely dark. Still further, the wave formation could be made apparent to the sense of hearing as well as that of sight; for placing the ear within a few centimetres of the wire and walking beside it, a distinct crackling sound could be heard at the points K and L, whereas no such sound could be heard

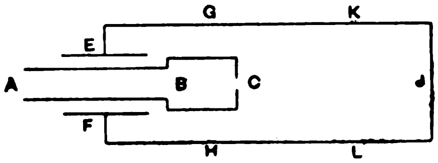

Fig. 1.

at G, J and H. By placing bits of glass tubing on the wire the sound was much intensified at the points K and L, and the phenomena made more striking. It might be supposed that by decreasing the capacity of the primary condenser, and therefore the period of its oscillation, the secondary circuit could be broken up into a new set of shorter stationary waves, with nodes at J and at points somewhere near K, L, G and H, and ventral segments between them. This we tried with perfect success, except that it was not possible to cause the light at K and L to actually disappear. There was decidedly less light at these points, however, than on either side of them. The light, of course, is simply that which always appears around wires carrying very high potential currents, the interesting point being that it appears in some places on the circuit and not in others. The experiment showing how the circuit breaks up in several different ways would form a most beautiful lecture experiment.

As a means of ascertaining when the circuits were in resonance, and of investigating the form of the wave in the secondary circuit, a bolometer similar to that designed by Paalzow and Rubens* was used.

The bolometer as an instrument for measuring electric waves is so well known, that it is not necessary to state here more than its fundamental principles. It consists essentially of a well-balanced Wheatstone bridge, to one of the arms of which are metallically connected two small conductors. These conductors are brought near the circuit to be tested, and the oscillating charges induced in them and sent through the arm of the Wheatstone bridge develop enough heat to throw the bridge out of balance. By moving the conductors along the circuit different deflections are produced according to the magnitude of the charges on the wire in their neighbourhood, and thus an excellent estimate of the wave formation can be obtained. In the present case the conductors that were brought near the secondary circuit consisted of two pieces of wire insulated with rubber, bent into circles of about 2cm. radius, and fastened to a bit of pine-wood by means of a heavy coating of paraffin. The two wires of the secondary circuit

* Abstract of a Paper communicated by the authors to the *Phil. Mag.*, August, 1895.
† *Comptes Rendus*, 1891, Tome XIII., p. 638.
‡ *Ibid*, 1894, Tome CXVII., p. 543.

* "Anwendung des Bolometrischen Princips auf Electrische Messungen," Wied. *Ann.*, XXXVII., p. 529.

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passed through holes in this bit of wood in such a manner as to pass through the centres of the two circles. In the early part of the investigation the bolometer and galvanoscope were placed at a sufficient distance from the oscillating circuits to prevent any direct action of one on the other, and the leads running from the circular conductors to the bolometer consisted of long fine wires. Later, when longer circuits and longer waves were experimented with, great inconvenience was experienced from the long leads, since their relative position had considerable effect upon the galvanoscope deflections. In order to obviate this difficulty short leads of heavily insulated wire were used, and the bolometer was placed on wheels and moved along from place to place. A bolometric study of the circuit just described showed the character of the oscillation to be that mentioned, namely, nodes at the points J and G H, and a ventral segment at K L. A careful run was made from one end of the circuit to the other, which furnished data from which a very regular curve was drawn.

The insertion of a small spark-gap (1mm. to 3mm.) at the point in the secondary circuit marked J (Fig. 1) had no appreciable effect upon the position of the nodal point G H, or of the point of maximum accumulation K L. The form of the wave was slightly altered for a metre on each side of J, and the bolometer showed a slight accumulation in the immediate neighbourhood of the spark-gap. This was probably due to the charging of the spark terminals to a sufficiently high potential to break through the dielectric. The fact that the insertion of a spark-gap into a secondary circuit in the manner described has no effect upon the length of the waves set up in that circuit was tested for a number of different cases (in none of which, however, was the length of the waves greater than in the present case), and found to be true in each one of them.

In order to determine the time of vibration, we used a concave rotating mirror, and the images of the oscillating sparks were thrown on a sensitive plate. If the mirror rotated about a horizontal axis the photographs showed bright horizontal lines, perpendicular to which at their extremities extended two series of dots. The distance between successive dots was the distance on the plate through which the image of the spark-gap moved during the time of a complete oscillation. Hence, by determining the speed of the mirror, and measuring the distances from the mirror to the plate, the time of oscillation could be calculated. To measure the sparks we used a sharp pointer moved at the end of a micrometer screw under a magnifying glass of low power. The instrument was originally intended for microscopic measurements, and was very accurately constructed. The rotating mirror was driven by an electric motor by means of a current from a storage battery of extremely constant voltage. To give great steadiness a heavy fly-wheel was attached to the axis of the mirror. The speed of the mirror was determined to within about one part in 500 by means of an electric chronograph. This apparatus, requiring great technical skill, was made for us by the mechanician of the laboratory. The mirror consisted of a thick piece of glass with a concave surface accurately ground for this research by the well-known optician Alvan Clark, and silvered by ourselves. For the extremely sensitive dry plates which were used we are indebted to Mr. Gustav Cramer, of St. Louis, Mo.

There are many advantages in photographing the secondary spark rather than the primary. In the first place, to properly photograph a spark it is necessary to use pointed terminals; but experiment has shown that the waves excited in a secondary circuit depend to a large extent upon the character of the primary spark, and that the most active sparks are those between metallic spheres with polished surfaces. It is true that waves can be produced by sparks between points, but the oscillations are not so powerful or well marked. In the second place, from the results obtained by Bjerknes one would expect the oscillations in the secondary circuit to be much less damped than those in the primary. This expectation has been fully realised. Photographs show from ten to twelve times as many oscillations in the secondary as in the primary. The longest secondary spark we counted indicated 60 complete oscillations. In the third, and by no means the least important case, the question how close the resonance is does not affect the accuracy of the results. By photographing the sparks in the secondary the period of oscillation is determined, not of a circuit that is altered until by trial it is found to have as nearly as possible the same period of vibration as the circuit on which the length of the wave is measured, but that of the circuit along which the wave itself is actually travelling; and hence the conclusions in regard to the effect of damping reached by Bjerknes in his admirable Paper on "Electric Resonance"* do not affect the accuracy of the results.

The great difficulty to be overcome is the production of secondary oscillations that will produce sparks sufficiently bright to photograph. It is comparatively an easy task to photograph the primary spark, but in order to photograph the secondary the dimensions of the circuit must be chosen with great care.

With a view to increasing the light of the spark, together with the length of the waves, it seemed desirable to lengthen the period of oscillation by enlarging the condensers rather than by increasing the self-induction of the primary circuit. A castor-oil condenser, therefore, was designed and constructed on the following plan:—Eight plates (25cm. by 20cm.) were cut out of sheet zinc, and were held in vertical planes side by side 2cm. apart by a suitable hard-rubber frame. The plates were entirely immersed in castor-oil contained in a glass jar. They were connected together in the manner shown in Fig. 2. The plates marked *a*, *c* and *e* were fastened to the conductor A B, and formed one armature of the condenser. Those marked *d*, *f* and *h* were joined to C D, and formed the other armature. The two ends of the secondary circuit E, G, J, H, F were fastened to the plates *b* and *g*. The plane of the secondary circuit was 50cm., and that of the primary 3cm. above the upper edge of the condenser plate. The total length of the secondary circuit from one condenser plate through E, G, J, H, F to the other plate was 6,338cm. The circuit consisted of copper wire (diameter 0 215cm.) supported at each end by suitable wooden frames, and also once in the middle by hard-rubber hooks, fastened by long pieces of twine to a wooden crossbar above. The distances from F to E and from K to L were 30cm., and a spark-gap with pointed tin terminals was inserted at J. The primary circuit consisted of copper wire (diameter 0·34cm.). The distances between the two parts A B and C D were 45cm. The portion B D contained a spark-gap with platinum-faced spherical terminals, and was made so as to slide back and forth, to and from the condenser. The motion of this movable piece varied the self-induction, and therefore the period of oscillation of the primary circuit. By this means the circuits were brought into resonance. With certain arrangements of the condensers the resonance was very sharp, and the position of the movable portion could be determined to within 0·25cm. In the arrangement which was finally adopted, the resonance was not so sharp. Even in this case the distance of the sliding part from plate *a* could not have been in error by more than 2cm. The length 65cm. was finally chosen for its value.

The automatic current interrupter that worked so beautifully in connection with the Hertz vibrator would not function well when used to excite the circuits just described. After trying many

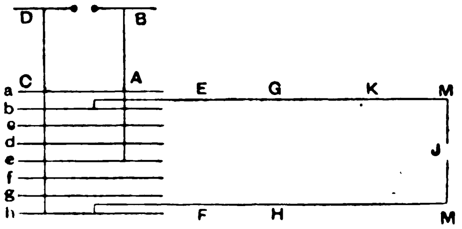

FIG. 2.

devices, we finally adopted an ordinary reed interrupter with a comparatively large hammer-and-anvil arrangement, which gave little trouble.

At first it was found impossible to produce anything but a complex vibration in the secondary circuit when the spark-gap was open. Some slight evidence of resonance was obtained, but nothing of a decided character. When, however, the spark-gap was closed, very good resonance ensued, and a wave the length of which could be measured to within 0 4 per cent. was excited. Some photographs were taken of the spark in the secondary circuit, and they showed immediately the character of the complex wave formation. The secondary circuit could and did oscillate in three different ways, and the ratios of the periods were those of the notes in an open organ-pipe, namely 1:2:3. Usually the lowest or fundamental oscillation together with one of the overtones was present; but several sparks were noticed that furnished unmistakable evidence of the simultaneous existence of all three. We have observed in a circuit 10,000cm. long the same peculiarities of oscillation, excited by a primary circuit that, judging from its dimensions, could not have been in resonance with the secondary. It was evident that the oscillation having a node between the points marked E and F (Fig. 2) is that whose period is one-third of the fundamental.

A number of measurements of this period have been made, and from these values the velocity of the waves has been calculated. The results appear in the table on next page. As an average of five measurements of the wave length, none of which differed from the mean by more than 20cm., the value 5,888cm. was chosen. The distance from the mirror to the photographic plate in each case except the last was 300·1cm. Each of the first five values in the second column of the table is an average of 30 measurements of distances ranging in the neighbourhood of 1cm.

The last line in the table contains the results of measurements on photographs of the primary spark instead of the secondary. In this case the distance from the mirror to the photographic plate was 311·5cm.

* "Ueber electrische Resonanz," Wied. *Ann.*, LV., p. 121 (1895).

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These results we published as a preliminary record in the *American Journal of Science* for April, 1895. At that time we did not think, judging from the table as it stood, and from a consideration of the possible errors in the various measurements, that the total error in our determination could have been as great as the difference between the average just quoted and $2{\cdot}998 \times 10^{10}$, which is generally accepted as the velocity of light. Since then we have succeeded in producing much better waves and much more regular sparks, and have discovered a phenomenon which renders a measurement on a photograph over a space where the dots are obliterated a questionable proceeding. The new data have given a value for the velocity more in accord with theory.

Number of revolutions of mirror per second.	Distance between two successive points on plate. Centimetres.	Velocity of waves. Centimetres.
71·2	0·05608	$2{\cdot}819 \times 10^{10}$
70·85	0·05600	$2{\cdot}810 \times 10^{10}$
70·7	0·05532	$2{\cdot}835 \times 10^{10}$
71·3	0 05637	$2{\cdot}808 \times 10^{10}$
70·8	0·05611	$2{\cdot}808 \times 10^{10}$
	Average......	$2{\cdot}816 \times 10^{10}$
69·2	0·05340	$2{\cdot}988 \times 10^{10}$

Since the waves in the secondary were not well formed when the spark-gap was inserted, it seemed desirable to try to find an arrangement that would produce simultaneously a good wave and a photographable spark. A number of condensers with plates of different sizes and shapes and different substances for the dielectric were tried, and the apparatus to be described was finally adopted. The difficulties to be overcome were these. Too strong a reaction between the primary and secondary condensers could not be employed, because the increase in the damping of the primary due to the large amount of energy drawn off by the secondary made good resonance impossible. The amount of energy in the primary at full charge must be much greater than that in the secondary. On the other hand, the capacity of the primary condenser must not be too great; for the self-induction of the primary circuit would have to be proportionately small, and this, too, means an increase in the damping. The secondary condenser, too, must have a capacity of less than a certain magnitude in order that the node may fall on the circuit and not in the condenser plate. These points seem to indicate that small condensers are preferable to large ones; but a decrease in the size of the plates means a decrease in the light of the secondary sparks, and the sparks are at best barely photographable. Practically, therefore, our choice was much limited, and the particular arrangement to give the best results had to be selected by experiment after a long series of trials. The arrangement and dimensions of the apparatus finally adopted were as follows :—

Two metallic plates, *a* and *b* (Fig. 3), 30 × 30cm., placed in vertical planes, formed the primary condenser. The dielectric between them consisted of the best French plate glass obtainable (K=8+ probably) and was 2cm. thick. Outside the plates *a* and *b*, and separated from them by a hard-rubber dielectric (K=2+about) 1·8cm. thick, were the secondary plates, 26 × 26cm. The primary and secondary circuits were joined to the condenser plates as indicated in the figure. The primary circuit lay in the horizontal plane passing through the centres of condenser plates, and consisted of copper wires 0·34cm. in diameter. In order to control the period of oscillation of the primary circuit, the portion B D containing a spark-gap with spherical terminals was made, as before, so as to slide along parallel to itself. The distance between the straight portions A B and C D was 40cm., and the lengths of A B and C D finally chosen for best resonance were 85cm. Most of the secondary circuit lay in a horizontal plane 16cm. above that of the primary. The lengths G E and H F, however, were bent down and fastened to the middle points G and H of the secondary plates. The circuit consisted of copper wire (diameter 0·215cm.), and its total length from G through J to H was 5,860cm. At J was a spark-gap with pointed terminals. With this apparatus we succeeded in producing a very regular wave formation, as indicated by the bolometer, even when there was a spark-gap at J. So many curves have been plotted and published to illustrate the characteristics of electrical waves that it does not seem worth while to add to the number here. It will be sufficient to state that the ratio of the maximum and minimum deflections in the bolometer was about 15 : 1, and that there was a node at J, and another about 40cm. to the right of E and F.

Upon photographing the secondary spark some curious phenomena were observed. In the first place, the dots usually appeared in pairs. There would be two black dots followed by a space where two or three dots either appeared faintly or were absent altogether; after that two black dots would reappear, followed again by a faint space, and so on for six or seven repetitions. All this, of course, occurred in a single spark.

The explanation that first presents itself is that the two black dots are the result of the first two oscillations in the primary circuit, which, owing to the damping, are much more powerful than the others. If this were the true reason, the first of the pair of dots always ought to be blacker than the second, and every third dot ought to be the first of a pair. This is not the case, however. On the other hand, the phenomena cannot be explained as the result of a complex vibration, for the bolometer readings, taken only a few minutes before the photographic plates were exposed and with exactly the same arrangement of apparatus, indicated extremely regular waves. A clue to the mystery was furnished by several sparks in which the dots made by one spark terminal had the characteristics just described, whereas those made by the other were quite regular. Following out this hint, we found that the particular substances used for the secondary spark terminals had a large effect upon the characteristics of the photographs. We tried spark terminals made of a number of different metals—tin, aluminium, magnesium, fuse-metal, &c.—and finally adopted cadmium as productive of the best sparks. In the case of cadmium the characteristics described are much less marked, and we have succeeded even in producing a few sparks in which no difference in blackness could be detected between one dot and the next. The photographs from cadmium terminals, too, are far more distinct and far more easily measured than those from terminals of any other metal that we tried.

An interesting question arose here as to whether the distance between two successive dots would depend upon the period of oscillation of the primary circuit if the secondary were unaltered. To test this point the circuits were brought into resonance, and a photograph taken. The self-induction of the primary circuit was increased by about 20 per cent. of its value, and a second photograph taken. In the first case the distances between successive dots were all within 2 or 3 per cent. of the average obtained by measuring over several dots and dividing by the number of intervening spaces; whereas in the second case the measurements of some of the single spaces were from 8 to 12 per cent. greater than before, the average from long measurements being the same. This indicates that the vibrations of the secondary circuit are not necessarily perfectly regular, and at a distance apart fixed by the character of the circuit, but are to be looked upon as a series of

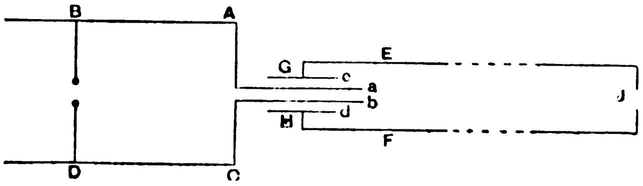

Fig. 3.

pulses started travelling along the circuit and keeping at a distance from each other that is determined by the exciter. Owing to the fact that the damping of the primary is much greater than that of the secondary, the seventh and eighth pulses started are too weak to obliterate the first and second, which have travelled the length of the circuit and back. We should expect from this that the bolometer throws, which measure the average length of the wave, would not indicate a shifting of the node when the circuits are thrown slightly out of resonance, but that the minimum throws would be greater than when the circuits are exactly in resonance. This, as is well known, is what happens.

The improved sparks which the new arrangement of apparatus and the use of cadmium as material for the spark terminals have enabled us to produce, have brought to light another interesting fact, namely, that even when the best resonance is obtained and the most regular wave formation is excited, the distances between the first three or four dots are slightly greater than the distances between three or four dots taken farther down the spark. The explanation we offer for this is the following, and it applies as a criticism to all cases in which waves are excited in a circuit by a neighbouring circuit possessing a much larger damping factor. The fact that the secondary waves last longer than the primary oscillations means that the last times that the waves travel over the circuit they do so under different end conditions from the first few times. The capacity of the secondary plates is slightly less after the primary spark has stopped than it was before, and therefore the length of the wires equivalent to the secondary plates is slightly less, and it takes a shorter time for the waves to travel along the circuit and back. Hence the observed decrease in the distance between the spark points and a certain mixing up of the dots, which occurs after the sixth or seventh oscillation (see Fig. 2). The sixth dot in the figure, apparently following its predecessor after about half an interval, is not a usual characteristic. In the vast majority of sparks the first few dots are far more powerful than those that follow them, and only occasionally

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do sparks occur that indicate more than five or six good complete oscillations. Hence these first few oscillations have the preponderating influence in fixing the length of the waves as indicated by the bolometer. In examining the sparks, therefore, we measured from the first oscillation as far down the spark as we could without passing over a space where dots were obliterated; and hence in every case we knew the number of dots between the points from which measurements were taken, and did not have to assume that good oscillations had occurred without affecting the plate.

The following table, containing the results of our measurements with the improved apparatus, explains itself. The distance from the mirror to the photographic plate was 302cm. in each case:—

Number of revolutions of mirror per sec.	Distance between successive points on plate. Centimetre.	Time of oscillation. Seconds.	Length of wave. Centim.	Velocity of wave. Centim. per sec.
70·8	0·05028	$1{\cdot}871 \times 10^{7}$	5,670	$3{\cdot}030 \times 10^{10}$
73·7	0·05247	$1{\cdot}876 \times 10^{7}$	5,670	$3{\cdot}022 \times 10^{10}$
75·2	0·05536	$1{\cdot}940 \times 10^{7}$	5,670	$2{\cdot}923 \times 10^{10}$
69·5	0·05002	$1{\cdot}897 \times 10^{7}$	5,690	$3{\cdot}000 \times 10^{10}$
68·9	0·04900	$1{\cdot}874 \times 10^{7}$	5,690	$3{\cdot}036 \times 10^{10}$
69·0	0·04974	$1{\cdot}899 \times 10^{7}$	5,690	$2{\cdot}996 \times 10^{10}$
71·2	0·05075	$1{\cdot}878 \times 10^{7}$	5,660	$3{\cdot}014 \times 10^{10}$
Average Value of Velocity..................				$3{\cdot}003 \times 10^{10}$

With the exception of three preliminary trials, which gave values differing from the mean by 10 per cent. or by 12 per cent., these are the only determinations we have made. In some cases the waves in the circuit were just as good with the spark-gap as without it. In others there was a decided wave formation when sparks occurred, but the node was not quite so well marked. For this reason, and since it did not appear to make any difference in their length, the waves usually were measured without the spark-gap. As the sparks were quite regular, the difference in the bolometer readings must have been due to Faraday tubes that were reflected from the spark-gap without forming a spark and reversing themselves. The variation in the number of revolutions of the mirror per second is due to the fact that different cells were used to drive the motor on different occasions.

As an example of the data taken to ascertain the position of the node we give the following table. The top line contains the distances of the bolometer terminals from a pair of arbitrary fixed points on the circuit:—

Distances from fixed points . .	20cm.	40cm.	60cm.
Bolometer deflections	4·3	4·0	4·3
	4·5	4·1	4·4
	4·5	4·0	4·2
Average deflections	4·43	4·03	4·3

From these deflections the position of the node was estimated. It appears from the best results that we have obtained, that the velocity of short electric waves travelling along two parallel wires differs from the velocity of light by less than 0·2 per cent. of its value. It has been shown theoretically, that the velocity of such waves travelling along a single wire should be the velocity of light approximately. Our results, therefore, in a certain sense confirm the theory to an accuracy within their probable error. Theoretically, too, the velocity should be approximately equal to the ratio between the two systems of electrical units. The average of the best measurements of this ratio is 3·001, which is nearer the average velocity obtained by us than the velocity of light.

ELECTRIC CABLE APPARATUS.

We illustrate this week two handy machines by Messrs. John Davis & Son, of Derby, intended for wire manufacturers, contractors and others. Fig. 1 shows a machine for measuring wires and cables from 40g. to 1in. diameter. It consists of a strong but light steel wheel, mounted on a steel spindle in a cast-iron frame, and having a fine worm cut on the spindle geared into a worm wheel and driving a train of clockwork connecting the hands of the dials which indicate units, tens and thousands of feet or yards, or metres, &c., according to requirements. To prevent error due to slipping, or similar causes, it will be noticed that there is a small roller on the top of the wheel upon which the wire or cable to be measured runs. This roller presses the wire or cable on to the wheel. The shaft of the roller projects through the frame, and on this shaft sufficient weights are fixed. In the case of very small wires it is best to lap the wire once round the measuring wheel. In the case of less flexible cables their own weight and the small roller is sufficient to prevent any slip. The machine should prove a great convenience to manufacturers and contractors, as by means of it cables and wires can be automatically measured during or after process of manufacture, and before being sent out to a job and returned

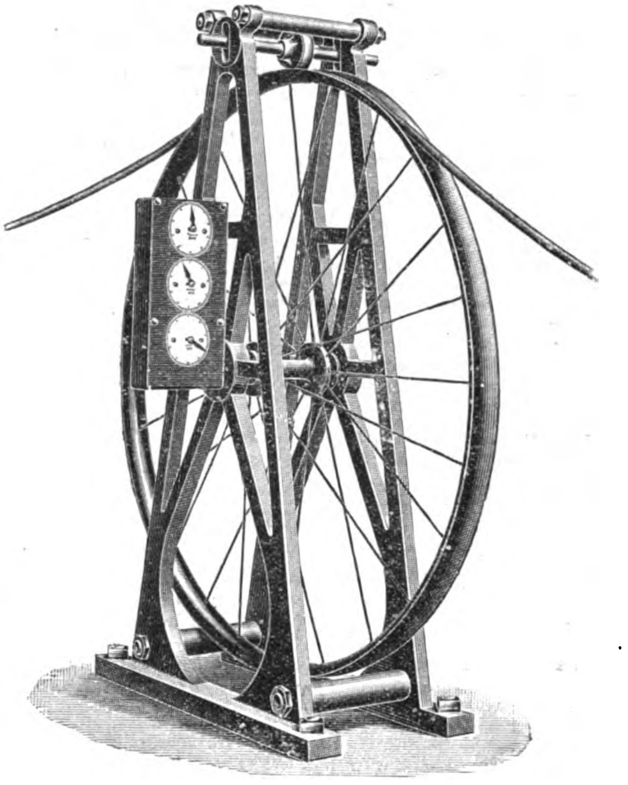

Fig. 1.—Cable-measuring Machine.

lengths before being put into stock. Adjustable contacts are also fitted to the dials to ring a bell when any desirable length has passed.

Fig. 2 indicates a light cable drum mounted on a steel spindle in a cast-iron frame, which is found to be a useful and simple time-

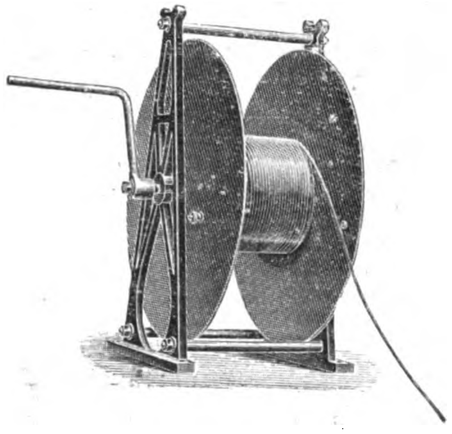

Fig. 2.—Wire Drum.

saver for putting wires and cables into neat coils before being sent out. It is also very useful in telling out cables and wires in installation work. If used for coiling cables, one side takes off, and the drum is made slightly taper so as to allow the cable to slip off.

The Willans Engine in France.—The recently-formed Company known as the Société Industrielle des Moteurs Electriques et à Vapeur, which has taken over the Heilmann electric locomotive patents, has also acquired the exclusive rights in the Willans engine in France and the French colonies. The French-made Willans engines will be constructed at Havre, in the works of the Company.

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Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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ELECTRICAL MANUFACTURING IN ENGLAND.

The annual reports of the Directors and the meetings of the shareholders of the three electrical manufacturing companies whose capital is held to any considerable extent by the public are now matters of history, and have been duly chronicled in our columns. We refer to those of the Brush Electrical Engineering Company, Crompton and Co., and the Electrical Construction Company. It must be admitted that if these reports reflect accurately the general commercial results of electrical engineering and manufacturing the outlook is far from rosy. In the first case, an interim dividend amounting to 2½ per cent. for the year was paid on the Ordinary shares, but it was declared owing to a sanguine view having been taken of the prospects of the Company, a view which unfortunately was not realised; whilst a dividend at the rate of nearly 4½ per cent. was earned, and was payable to the Preference shareholders. In the second case no dividend was paid on either the Ordinary or Preferred shares. In the third case a dividend at the rate of 7 per cent. was paid on the Preferred shares, the amount being trifling, and none on the Ordinary, though it is fair to state that an amount was added to the balance of revenue account, which would have paid 2¾ per cent. on the Ordinary capital. Owing, however, to the large debenture and loan capitals with which all these companies are working, the payments on the share capitals give no criterion of the earning capacity of any of the businesses. The only way to make any comparison is to take the total capital used in each business, comprising paid-up share capitals, debenture capitals, loan capitals, adding trade creditors (this last item being in some cases a means of providing working capital), and to set against these the total earnings in the year, which have or might have been properly paid to the owners of the capital. Reviewing in this light the three businesses concerned, we arrive at the following figures: The Brush Company, on a total capital sum of £697,888, earned 2·2 per cent.; Crompton and Co., on £291,174, earned 2·38 per cent.; the Electric Construction Company, on £551,366, earned 4·6 per cent.

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The Chairman of the meeting in each case had an explanation to offer as to why better results had not accrued. The Brush Company had lost over a dispute arising out of the City of London contract; Crompton and Co. were very slack for six months; the Electric Construction, by implication, had taken contracts at too low a figure, but having plenty of work in hand, were raising prices. But the fact remains that all these are contingencies, which may and must occur in turn to all such concerns, and the average profits must allow for them before the results can be considered satisfactory. In the absence of any figure in the reports or balance sheets as to the actual turnover it is difficult to form an opinion whether the above unsatisfactory result arises from the rate of profit on the turnover being too small, or the proportion of capital to turnover being too large. Some of the figures given, however, throw very suggestive lights on the question. Nearly 25 per cent. of the whole assets of the Electric Construction Company consists in shares and debentures of other companies, which only produce a little over 4 per cent.—less than the average rate paid by the Company for interest on its secured loans. This proportion of its capital is therefore a dead weight on the concern. Then comes that item which, like charity, covers a multitude of former errors—"goodwill." A speaker at the Crompton meeting urged the Directors to face facts, and purge the balance sheet of such items. It is almost impossible for anyone to judge of the reality of such an asset except Directors who know the business intimately. In the case just named, for example, patents, preliminary expense accounts and goodwill form nearly 20 per cent. of the capital account. Are they of such value that the profits of the Company are 20 per cent. greater than those of a manufacturer who does not possess them? In these days of lowest tenders to specifications it is open to question. And thus we might pursue our way through the other accounts, but to little purpose. More general considerations will prove better worth following.

It must never be forgotten that notwithstanding the doubtful financial policy that has at times distinguished these businesses, they have had a difficult task to perform, and have, on the whole, acquitted themselves well; they have done pioneering work to their own credit, and to the lasting benefit of the whole electrical industry and profession, and the cause of the poor pecuniary return is not to be found in the value of particular items of their balance sheets. What is wanted to make all these concerns pay is more work, and in spite of the fact that the last year or so has seen the closing of some manufacturing concerns, there are still too many in the trade for the existing amount of business, and this tells more on the electrical trade than on any. It is a trade requiring a larger proportion of skilled supervisors than almost any other, and these cannot be reduced at every fluctuation of business; hence periods of slackness tell with unusual severity. Then there is the competition of those who combine electrical work with other engineering work, so as to decrease the weight of this disadvantage; and this point has been evidently realised by the Directors of the Brush Company, who are adding a new item in the way of a high-speed engine to their collateral industries; and in this direction we cannot help thinking all will be eventually forced, unless great strides are made in stimulating demand. Talk there is, and has been for years, of *raising* prices; but the fact is that if motors and electrical appliances are to become part of our daily life, prices must *go down*. The countershaft holds its own over the distributing motor because of its cheapness, and this reason also in numberless cases determines the scales in favour of gas-pipes instead of an electric installation. The public and engineers have been educated to understand the advantages of electric systems, but price bars the way.

Prof. George Forbes, in his recent article in *Blackwood* on "Harnessing Niagara," states that he was the first consulting engineer that the American manufacturers had had to deal with. Happy American manufacturers! The influence on cost that is exercised by consulting engineers in this country by insistence on alterations to standard patterns to meet fads can hardly be exaggerated. But competition is so keen that the manufacturers cannot make a firm stand; and this is one reason why municipal work, which might at the present time be a tower of strength to the trade, is really hardly worth touching for the profit it brings. And yet so small, apparently, is the reliance placed by public bodies on the consulting engineer, that the payments for such contracts are prolonged on the principle that the proof of the pudding is in the eating—in other words, the payments are prolonged till the working of the plant has proved that it is what is wanted.

"What are you busy with now?" was the inquiry addressed by an English engineer to the President of one of the largest American manufacturing concerns a year or so ago. "I am busy trying to keep the receiver off the doorstep," was the reply. That has unfortunately been very nearly the truth with some of our English electrical businesses. Things are a little better now; we can only hope that the energies thus liberated will be utilised in doing that which alone will bring money to the shareholders, viz., increasing the demand for electrical goods, either by overcoming the terrible prejudice in this country against the electric tramway, or by so cheapening manufacture that markets at present barred will be available. Next year's annual reports will then be more palatable reading for those to whom they are addressed.

OBITUARY.

SIGMUND SCHUCKERT.

On Monday, September 16th, Herr Sigmund Schuckert, founder of the well-known German firm of Schuckert and Co., died, after a long illness, at the early age of 49. Owing to Herr Schuckert's great modesty, the important part he played in connection with the development of electrical engineering has, perhaps, never been fully recognised. He was not only the creator of one of the earliest and largest electrical engineering establishments in the world, but he was also largely responsible for the development of the continuous-current arc lamp.

Sigmund Schuckert came of an old Nuremburg family, and was born in that town on October 18, 1846. He received his mechanical training in a workshop in his native town, and afterwards spent five years in various workshops in Stuttgart, Hanover, Berlin, and Hamburg. At this period of his life a longing to see foreign lands came upon him, and in May, 1869, he went to America. During the next four years he was employed at New York, Baltimore and Philadelphia, and made the acquaintance of Thomas Alva Edison. In the year 1873 he returned to Germany on a visit, but was persuaded to remain and start a workshop in his parent's house. Very soon, however, he moved his shop to an old mill where water power was available. He had at first only one assistant, and made instruments of precision. A new type of pedometer dates from this time. Meanwhile he paid great attention to his education in theory, and the numerous marginal annotations in the books of the Schuckert library give ample proof of his diligence.

It was at this time that he designed and constructed his first dynamo. Speaking of this machine in later days, he related how at the time of construction a well-known physicist told him that it would never work, but the machine, never-

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theless, worked for 20 years, and was then bought back by Schuckert as a memento of days gone by. This dynamo and several more of the same type were used for electro-deposition. Electric lighting at that time was very little known, but Schuckert was continually working at it. In 1875 he was rewarded for his labours, and erected his first arc-lighting plant on the occasion of the Sedan *fêtes* at Nuremburg. This arc-lighting machine, of the flat-ring type, was designed with great judgment, and proved of great importance in later years, as was shown by the position it held in the technical world. At that time it was not generally known that by using laminated iron and large field-magnets, the heating of the armature could be to a certain extent avoided, and amongst the then existing machines, which had more copper in the armature than in the field-magnets, a well-ventilated and easily repairable type of armature was of the utmost importance. A great impetus was given to the Schuckert undertaking by the progress of continuous-current arc lighting. At that time the alternate-current arc lamp of Siemens and Jablochkoff almost monopolised the market and Schuckert endeavoured to construct a continuous-current lamp which should succeed equally well. He was ultimately successful, and after acquiring the patents of Krizik, brought out a lamp, known later in England as the Pilsen arc lamp. In 1883 he was employing 100 hands, and in 1886 this number had doubled itself. Schuckert improved the system of the parallel running of arc and glow lamps, and put two arcs in series across a 100-volt circuit. All these things appear now a matter of course, but at the time great opposition was experienced, and his manager, Herr Alexander Wacker, who is to-day Chief Director of the Company, bravely helped him to fight against public prejudice. The Schuckert establishment grew steadily, and in the year 1890 he was employing 1,000 men. He showed good judgment in the selection of his assistants, among whom were the well-known electricians Uppenborn and Hummel, the commercial part of the concern being left in the hands of Herr Wacker. As the business grew, new departments were taken in hand, town lighting, tramway work, and power transmission being made a speciality. To-day, in the Schuckert dynamo, arc lamp and instrument shops alone over 2,000 men are employed.

How persistent Herr Schuckert was in bringing new inventions to a practical shape is shown by the introduction of the projector with parabolic mirrors for military and naval purposes, and which later attracted so much attention all over the world. When Prof. Munker suggested the use of this pattern of projector, Herr Schuckert at once took up the idea, and although many a disappointment was experienced while the experiments were being carried out, he ultimately succeeded in producing a workable apparatus. Afterwards the Schuckert projector was tried before a military commission, and proved far superior to any then existing, and the late Dr. Werner von Siemens, who was always ready to acknowledge the merits of others, shook hands with the indefatigable experimenter, and said, "Siemens humbles himself before Schuckert."

With all his success, Sigmund Schuckert preserved a simplicity and modesty which became proverbial amongst all who knew him. He was always ready to extend a helping hand to those under him, and during his long illness he was working out a scheme for the benefit of his employees. In the death of Herr Schuckert the electrical engineering industry has sustained a severe loss, and it is lamentable that so active a mind should have been extinguished whilst still in its prime.

Electric Road Carriages in America.—A *Herald* correspondent reports that two electric carriages are being built in Camden, N.J., for the *Chicago Times-Herald* race from Chicago to Milwaukee in November. No names are given, "but some rather strong claims are made for the vehicles." They are to be equipped with a storage battery which will run the vehicle 500 miles before requiring to be recharged, at a speed of 17 miles an hour, and this "at a cost of but 13 cents for each 50 miles."

THE BRITISH ASSOCIATION AT IPSWICH.

(*Concluded from page 680.*)

Tuesday, September 17th.

An attractive Paper was read on Tuesday, in Section G, which met in the Public Hall—where the Presidential Address had been delivered—for the purpose of hearing it. This was a Paper on "The Field Telegraph in Chitral," and was read by Mr. P. V. Luke, the Deputy Director-General of Indian Telegraphs. The author commenced by describing the usual expedition equipment, as supplied by the Indian Civil Telegraph Department. All the equipment is arranged for pack carriages, in packages of not more than 80lb. each, *i.e.*, half a mule-load. The total equipment for one office, including tents, &c., comprises seven mule loads, but can on occasion be reduced to four such loads. Telephone apparatus is always carried, in addition to the sounder telegraphs. Two classes of line wire are carried: iron wire weighing 150lb. to 300lb. per mile, and stranded copper wire weighing 80lb. per mile. These are strung to such poles as the resources of the country permit of; but in barren districts, light iron poles are conveyed to the route. These latter are of tubular sheet iron, constructed to close up telescopically. In the Waziristan campaign, a single line of this form was erected at the rate of nine miles a day for five consecutive days. Special arrangements for rapid repair are always made; for this purpose it is necessary to have a telegraph office at every 10 miles, with a trained line staff. For the signalling staff trained British soldiers are mainly used; these men are employed at other times at different telegraph offices throughout the country, usually where their regiments are quartered. The Field Telegraph forms a distinct department in the field, under a civilian telegraph officer appointed by the Director-General of Telegraphs, and taking his orders from the chief of the staff. Information of the siege of Chitral came from Gilgit over the line which was only completed in 1894. This line is carried over two passes, one 11,600ft., the other 13,500ft. above sea level, where the snow lies from 10ft. to 18ft., yet it worked well all through the winter. The staff at the observation stations close to these passes are entirely cut off from the rest of the world except by wire for seven months in the year. The place selected as the base of operations was Holi Mardan; best material for a two-wire 200-mile line with 20 offices was at once collected, together with the necessary staff for constructing and working. From this point the wire was pushed on as fast as possible, and a field office was opened on the Malakand Pass a few hours after the battle. At first it was a single-wire line, but it was afterwards made a three-wire line as far as the Swat Valley, then a two-wire to Dir, and finally one wire to Chitral Fort. Great difficulties with transport occurred at Lowari Pass, owing to the Pass not being passable for camels; but for this the wire would have been into Chitral by May 12; as it was it did not reach there till midnight of the 17th. On account of the scarcity of timber it was necessary to use iron poles very extensively; at the Lowari Pass, however, there is a fine pine forest; wooden poles were afterwards used. After May, cutting the wire became very frequent, and even very difficult to stop. After the start the traffic, which was exceedingly heavy, was dealt with, with but little delay; in April 24,370, and in May 58,935 messages were dealt with, and their length was much above the average. Shortly after the Malakand fight, by clearing the line right through to Simla, the Commander-in-Chief was enabled to talk direct to Gen. Low, and in spite of heavy rains at the time the communication was excellent. To give some notion of what was accomplished, it may be stated that a telegram dated Chitral Fort, May 19th, was published in the London papers of the same date. The Telegraph Department also assisted in defending camps by running wires round the camp, so arranged that an alarm was at once given by the ringing of a bell in the Quarter Guard should a night surprise be attempted, and in many other ways much aided and assisted the military authorities

Meanwhile, in Section A, a long programme of electrical Papers was being commenced. The proceedings opened with a further description, by Lord Kelvin, of the researches on the

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"Electrification and Diselectrification of Gases," which he and Messrs. Maclean and Galt have undertaken for some years past. Some account of this communication will be found in another column. In the discussion, it was suggested by Dr. Oliver Lodge that there would be considerable interest in testing the effect of bright light projected upon the polished metal surface of the electric filter. The influence of violet and ultra-violet rays on electric discharges is well defined, under certain conditions, and it might be instructive to test their influence on the diselectrification of gases.

The next Paper sought to answer the question, "Do Vertical (Earth-Air) Electrical Currents Exist in the United Kingdom?" and was read by Prof. Rücker, by whom researches on the subject have recently been undertaken. At the Oxford meeting of the British Association, last year, Dr. Adolph Schmidt gave an expression for the earth's magnetic force at a place, one term in which expression seemed to be "due to electric currents traversing the earth's surface." To test whether any such currents exist in the United Kingdom, Prof. Rücker has taken a circuital round a number of well-defined areas—dealing with each one separately—and has investigated whether the line-integral of the horizontal magnetic force in this circuital is or is not a vanishing quantity. The results of his researches go to show that there is not within the United Kingdom, under normal conditions, any vertical current of so great a magnitude as that proposed by Dr. Schmidt. There may possibly be a current one-tenth of that amount, or about 0·01 ampere per square kilometre. It was pointed out that these results do not necessarily upset Dr. Schmidt's hypothesis, as there may be such electric currents in other countries, or it is possible that they exist between the water and the bed of an ocean. In the discussion Lord Kelvin stated that he had found that no less than 36 times the normal fine-weather electrification would have to be given off from the surface of the earth by upward air currents, if this hypothetical earth-air current is to be explained on the theory of electrified air convection streams.

Mrs. Ayrton now contributed a Paper "On the Equation connecting the Potential Difference, Current, and Length of the Electric Arc," in which she reviewed in a lucid and interesting manner the history of the investigations which have been made in the past, in regard to the law connecting these three functions of the electric arc. The researches of Edlund, Peukert, Thompson, Frölich and others were criticised in the light of most recent investigations, and the present state of knowledge of the subject, as embodied in the refined and well-nigh exhaustive researches of Mrs. Ayrton herself, was briefly summarised. For further particulars of this important line of electro-technical research, we cannot do better than refer our readers to the series of articles now being communicated by Mrs. Ayrton to our columns. In the discussion which followed the reading of this Paper, some uncertainty seemed to exist as to the proper mode of measuring the length of an electric arc. Mrs. Ayrton had taken the distance between the tip of the negative carbon and the plane of the crater edge of the positive carbon, as the length of the arc; but Prof. FitzGerald suggested that possibly if the actual distance between the carbon surfaces were taken, there might be better agreement between the results of various experimenters. Mr. F. G. Baily remarked that with the method of measurement chosen, it was possible to have a negative length; viz., when the tip was pushed well up within the crater. Dr. Thompson stated that he had measured the arc length in the same way as Mrs. Ayrton, and suggested that it might be well to see what order of results would be obtained if the slant distance from tip to crater edge were measured, instead of the normal distance to the plane of that edge.

Prof. Ayrton next read a Paper "On the back E.M.F. and True Resistance of the Arc," in which he showed that the evidence which had from time to time been put forward in favour of a steady back E.M.F. in an electric arc was inconclusive. He and Mr. Mather, a joint author of this Paper, had obtained evidence of a species of negative resistance of the arc; indeed, a physical quantity of which it is not easy to have a clear comprehension.

After Prof. Ayrton had described an instrument for testing the strength of a magnetic field in air, a Paper "On the Velocity of Light in Rarefied Gases through which an Electrical Discharge is Passing" was contributed by Mr. E. Edser and Mr. S. G. Starling. Researches had been undertaken to discover whether any effect on the velocity of light through gases, of various degrees of rarefaction, takes place when an intermittent current is passed in the direction of the rays of light, or in the opposite direction, through the gas. Negative results were obtained.

The proceedings for the day were concluded by the reading of a Paper "On the Hysteresis of Iron in an Alternating Field," by Mr. F. G. Baily, in which the author described some researches on the relation of hysteresis to the limits of the magnetic induction cycle, but at this late stage of the sitting only scant justice could be done to this useful Paper.

Wednesday, September 18th.

The chief item of electrical interest on the Wednesday programme, in Section A, was the suggestion, by the Electrical Standards Committee, of a set of new units and names for magnetic quantities. Unfortunately, however, the far-reaching interests of this subject were not effective in bringing the practical man to Ipswich; and, except that he had already spoken through the medium of the technical press, his opinions in this matter would have been unknown to those who took part in the creation for him of these new units. It is to be regretted that dynamo builders and other practical electrical engineers were not present, to hear and take part in the discussion. It is for the convenience of the practical engineer that these units have been proposed; scientific men, if they are left to consider only their own scientific interests, would probably vote in favour of the much more rational system of units with which the name of Mr. Oliver Heaviside is inseparably connected. One of the most striking features of the discussion, in fact, was the leaning shown by many of the speakers, towards these Heavisidian units; and the general impression seemed to be that, though it might be too late to introduce them commercially, yet they carried great scientific weight. The units proposed by the Committee have already been summarised in our columns, last week; and this week we give an abstract of the discussion.

After the conclusion of the proceedings in connection with the proposed magnetic units, Mr. J. M. Barr read a Paper "On Some New Methods and Apparatus for the Delineation of Alternate-Current Wave Forms," which he had contributed in conjunction with Messrs. W. B. Burnie and Chas. Rodgers. An abstract of this Paper will be found in our columns. In the discussion which followed, Prof. Ayrton gave a lucid and interesting account of the various forms of wave tracers which have been devised, including that described in the Paper and one invented by himself in conjunction with Mr. Mather. Prof. W. M. Hicks called attention to the utility of these instruments, in that they enabled the form of the alternate current wave to be directly read by an unskilled person, such as a man in charge of a small station.

The proceedings in Section A were brought to a close by the reading of a Paper, by Mr. E. H. Griffiths, "On Some Recent Improvements in Measurements of High Temperatures." The Paper described a number of electrical thermometers and pyrometers which have recently been acquired by Kew Observatory, and which were on exhibit. It is a matter for congratulation that the authorities of Kew Observatory have arranged thus for the standardisation of platinum electrical thermometers, and the best thanks of the electrical profession are due to Mr. Griffiths for the energetic action he has taken in getting this department established.

ON SOME NEW METHODS FOR THE DELINEATION OF ALTERNATE-CURRENT WAVE FORMS.*

BY JAMES MARK BARR, W. BECKIT BURNIE AND C. RODGERS, B.SC.

With the progress of alternate current research it becomes more and more necessary to have a reliable, rapid and accurate means of determining the wave forms of currents and potential

* Abstract of Paper read before the British Association at Ipswich, Section A.

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differences. The method now generally in use—namely, the determining of a number of points on the curve and subsequent drawing of a line through these points—though accurate, is tedious, and requires a skilled experimenter. What we need is an apparatus which will automatically record the shape of the wave.

Some years ago Dr. Frölich attempted to use an optical arrangement for showing the shape of the wave. This apparatus consisted of a telephone receiver, the coil of which carried the alternating current, and to the diaphragm of which a mirror was fixed. The diaphragm vibrated with the variations of the current and a beam of light reflected from the mirror, at any moment indicated by its deflection, the intensity of the current in the coil of the receiver. This beam of light fell upon a revolving mirror which imparted to it an independent motion at right angles to that due to the vibrations of the telephone diaphragm. By this means there was traced upon a screen a luminous wave form. Had this arrangement worked satisfactorily, the wave form could have been photographed, and a permanent record instantaneously obtained; but it was rendered totally useless for ordinary frequencies by errors due to the inertia of the moving parts.

In the present Paper we propose to describe an apparatus which we believe overcomes these difficulties, and automatically records with great rapidity the wave form. We employ a combination of two motions at right angles of a spot of light relatively to a screen. An ordinary contact disc is used *but the contact brush is moved slowly and continuously through its successive angular positions.* Contact is thus made each time at a slightly different position of the armature. Thus the potential difference at each contact differs slightly from that at the preceding contact. This potential difference is used to charge a condenser across the terminals of which is connected either a reflecting electrometer or a high-resistance galvanometer.

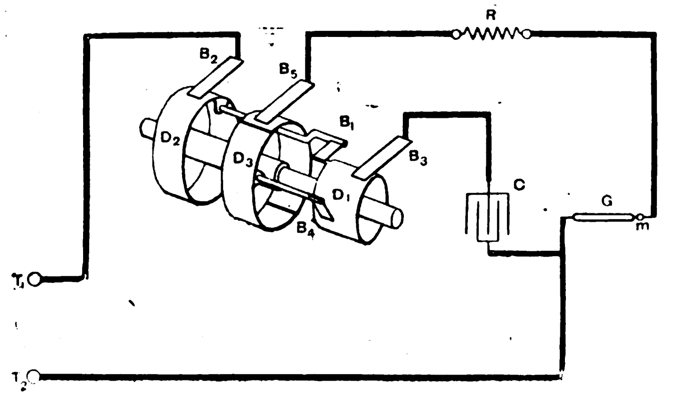

Fig. 1.

The deflection of the instrument so used follows the value of the potential difference of the wave form to be determined, and accurately follows it, for the mean rate of variation of the potential differences between the terminals of the condenser is exceedingly small in comparision with the rate of change of the electromotive for to be investigated. This deflection gives us one of the component motions. The other motion of the light spot is made to be proportional to the angular movement of the contact brush.

Fig. 1 shows the arrangement of the contact disc and accessories, a galvanometer being used—for which an electrometer might be substituted. In this diagram, for the sake of clearness, the vulcanite foundation work is omitted and the brass only shown. Our motor having four poles, we have used two knife-edge contacts placed diametrically opposite, which give us one contact per wave.

D_1 is the contact disc, which is rigidly fixed to the shaft of the dynamo or motor, and to it are attached the knife edges just mentioned.

The rings D_2 and D_3, and the rods and brushes B_1 and B_4, are mounted on one piece of vulcanite loose upon the shaft, and are revolved slowly.

The brush B_1 is joined to the ring D_2, with which the brush B_2 is in permanent connection, so that when the brush B_1 makes contact with the knife edges the condenser C is charged to the potential difference between the terminals T_1, T_2.

The condenser is throughout the whole revolution of the disc D_1 discharging through the galvanometer G by way of B_1, B_4, B_5, and the resistance R.

As the brushes B_1 and B_4 are moved slowly round, a succession of charges passes through the galvanometer, the value of each of which is proport onal to the instantaneous electromotive force, and the required movement of the galvanometer is obtained. The relative movement of the spot of light at right angles to that due to the galvanometer may be produced in a variety of ways—by a moving screen, by a revolving mirror, or, as in the apparatus which we have constructed, by an oscillating mirror. This mirror is shown in Fig. 2, which is a plan of the general arrangement, and is marked M. Mechanically connected with the disc D_2, D_3 (Fig. 1), and moving with the same angular velocity, is a cam marked K, which is shown in Fig. 2. The mirror M is pivoted about a horizontal axis, and is oscillated by the arm *a*, which bears on the cam. The arm is kept pressed against the working edge of the cam by the spring S. If the edge of the cam is properly shaped, the horizontal motion of the spot of light in synchronism with the angular motion of the brush is obtained.

We have now two motions at right angles, and by combining them during the oscillation of the mirror M in one direction we cause the spot to trace out a wave form on the screen P. The spot of light, however, during the return oscillation, would trace the wave reversed, and interfere with the true wave image. In order to prevent this the ring D_3 (Fig. 1) is discontinuous, so that the brush B_5 during the return oscillation, and the galvanometer circuit being incomplete, *the spot draws the zero line.*

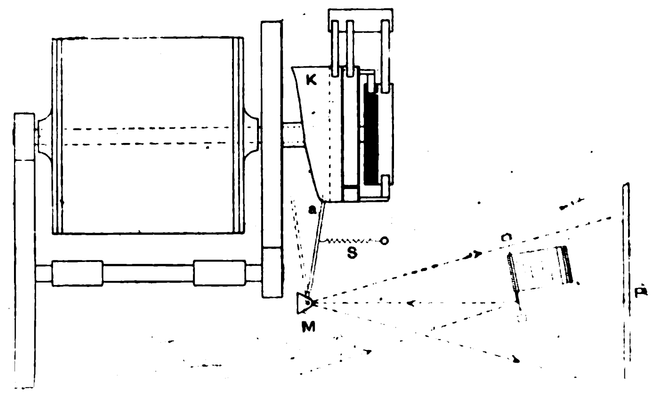

Fig. 2.

By placing a piece of sensitised paper or a sensitive plate on the screen, a permanent record of the course of the spot is obtained. The angular velocity of the moving brushes may be made so small that a well-damped instrument, even of long period, may be used. For use with an ordinary electrometer the plane mirror may be made to oscillate about a horizontal axis, and a curve drawn the zero line of which is vertical.

The cam may be dispensed with, and the screen itself moved either horizontally or vertically with gearing. Or a cylinder covered with sensitive paper may be attached to the moving brushes, and the deflection of this made to move the spot axially on the cylinder. But there are certain disadvantages attached to this method of experimenting which made us decide to construct the apparatus with the cam. There have been brought out lately several methods for building up current and electromotive force wave shapes. In using this apparatus during the process of building up wave forms the required shape may be drawn upon the screen, and the course of the spot of light observed, it being noted wherein it differs from that curve, and steps being taken to ensure a close coincidence. With the form of apparatus in which the cam is not used this process is more difficult.

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A short time ago Dr. Fleming published a new and ingenious method of plotting wave forms with polar co-ordinates, and of directly obtaining therefrom the root mean-square value. Our apparatus may be easily modified so as to obtain a record of one of these polar waves. For this purpose the slow-moving disc must be mounted on the extreme end of the shaft, and a sensitised screen must be fitted thereon. The instrument must be so placed that the zero position of the spot of light on the centre of the disc and the deflection along one of the radii. The curve traced will then be of the required form. By a system of mirrors it would be possible to obtain the same result with the screen fixed, but this appears to offer no special advantages.

The galvanometer which we have up to the present used with our apparatus is of the Ayrton-Mather type, with a horizontal coil, but no silver tube for damping. The coil is wound with 260 turns of wire 1·4 mils in diameter with a resistance of 400 ohms. The period is small, being about $\frac{1}{30}$th of a second. The damping is effected by a light glass arm dipping into an oil vessel, the height of which can be adjusted.

An electrometer would have been preferable, but it is difficult to obtain an electrometer of sufficiently small period. For tracing the wave very slowly an electrometer may be used, but one of the advantages of our method over the methods in

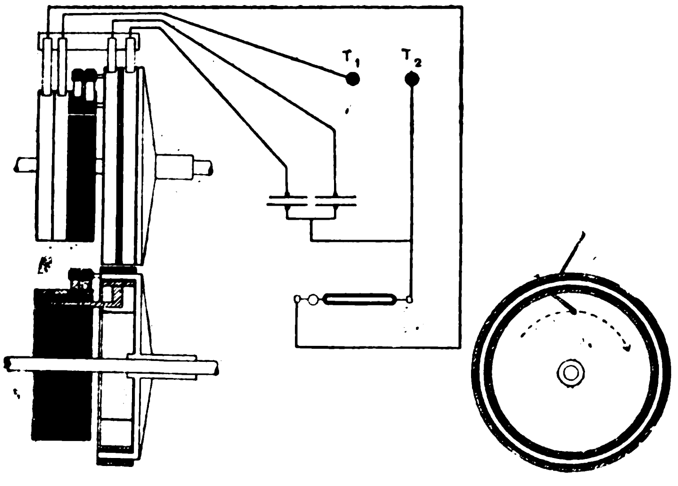

Fig. 3.

ordinary use is the rapidity with which the wave may be traced. In many experiments there is a variation of speed with time, against the effects of which it is necessary to guard, but in tracing a wave in a few seconds no appreciable variation of speed can take place.

If the spot of light were made to tr ce out the wave form sufficiently rapidly the curve would appear as a continuous luminous line. This can be effected with the apparatus, as it now stands, with *high* frequencies. With low frequencies, however, that is impossible. For instance, with a frequency of 80 alternations per second we obtain 80 contacts per wave. But since for the line to appear continuous the slow-moving disc must make at least five revolutions per second, the number of contacts cannot exceed eight per complete period or four per half wave, an obviously insufficient number.

We have in Fig. 3 a diagram illustrating a method by which this difficulty is overcome. As before, the apparatus consists of two discs—one moving at the speed of the motor and the other a slow-moving one. The slow-moving disc carries two collecting rings, two brushes, and an internal four-part commutator. Each collecting ring is connected to a pair of opposite commutator segments, and the slow disc carries two brushes, which bear on the fast disc and are connected one to each collecting ring. The fast disc also carries two collecting rings—one connected to the knife edge and the other to the fast revolving brush, which bears on the four-part commutator of the slow-moving disc. The two brushes carried by the slow-moving disc are slightly in advance the one of the other, and the slow-moving disc is rotated so as to have a definite speed relation to the fast disc. The two condensers are charged in rapid succession as the knife edges pass the brushes, and during the remainder of the half revolution are discharged in succession through the four-part commutator, the fast revolving brush and the galvanometer. The effect is to get twice as many discharges through the galvanometer per wave as is obtained with the apparatus shown in Fig. 1. Three or more condensers can be used, the total number of contacts per wave obtained being proportional to the number of condensers used. For all ordinary purposes, however, the apparatus with one condenser will be found not convenient.

In conclusion, we must acknowledge our indebtedness to Prof. Ayrton and Mr. Mather for their kind advice and to Mr. W. Duddell, one of our fellow students, for his help during the construction of the apparatus.

MAGNETIC UNITS.

BRITISH ASSOCIATION DISCUSSION.

After the recommendations of the Electrical Standards Committee on the subject had been read and amplified by Dr. Oliver Lodge, a communication "On the Choice of Magnetic Units" was made by Dr. Silvanus Thompson. An asterisk denotes that the speaker has revised the report of his remarks.

*The subject, he said, was of such importance that he thought it desirable it should be discussed as fully as possible before any definite conclusions were arrived at. With this object the views of men who daily use magnetic quantities had been invited, and were freely expressed in letters to *The Electrician*, copies of which had been distributed to members. The ohm, volt and ampere had taken root, because their magnitudes were suitable for practical requirements. If, however, magnetic units were chosen of unpractical size, such units would die at once, and never be of service to the industry. In his opinion the *magnitudes* of the units were of far greater importance than the *names*, for the names were only details. No doubt they were important details, and unless judiciously chosen might give rise to international jealousy.

For industrial purposes a unit for "total lines" was greatly needed, since a good idea of the dimensions of a plant was given to practical men if the number of lines be known. At the Chicago Exhibition the largest machine shown had a total flux of 15 million (15×10^6) C.G.S. lines, whilst the smallest had about forty thousand (40,000), the former being a large generator and the latter a small fan motor. Since that time larger machines have been built, having, say, 60 to 80 million lines. The usual density at which wrought iron was worked being 15,000 to 17,000 C.G.S. lines per square centimetre, or between 90,000 and 100,000 per square inch, the total flux gave a fair idea of the section of the magnets. At present the *line* was the unit of magnetic flux, and originally this small unit was of convenient size, because only small quantities of magnetism were then dealt with. The chief objection against its use now was that we had no prefix to carry us beyond the sixth power of 10 (megaline = 10^6, or 1 million lines). The Electrical Standards Committee now suggested 10^8 C.G.S. lines as the unit, and this he (Dr. Thompson) thought ought not to be accepted without good reason. The reason *for* proposing this unit had been stated by Dr. Oliver Lodge to be because it fitted in with the system of practical units at present in use, for a volt is generated when lines are cut at the rate of 10^8 per second. *Against* the adoption several reasons might be given. In the first place, the unit was too big, and would result in all fluxes being expressed as fractions, usually very small fractions. In his opinion it would be much better to have a small unit, and express larger fluxes by prefixes, such as *kilolines* for 1,000 C.G.S. lines, and *megalines* for 1,000,000 such lines. Another reason was that the American Institute of Electrical Engineers had already suggested a system of magnetic units not the same as that now proposed by the Committee, and had moreover used the name "weber" to mean one C.G.S. line. He did not see why the "line" need be rechristened, but this might be left open to further discussion, and we certainly had already the right to use the terms kiloline and megaline.

Speaking of the second unit to be defined, Prof. THOMPSON said the "ampere-turn" had been already adopted universally by practical men as the unit of magnetic potential, although Dr. Hopkinson and others multiplied by $4\pi/10$ to get C.G.S. units. In most cases curves were employed to pass from cause to effect (magnetic potential to magnetic lines), so why not adopt such a scale in plotting the curves so as to pass direct from ampere-turns to magnetic lines? Even if the "gauss" proposed (one C.G.S. unit) be adopted as the unit, he believed practical men would still scale their curves in ampere-turns. For some purposes, no doubt, the ampere-turn would be ridiculous, as, for example, in work relating to permanent magnets, and here the "gauss" would be appropriate. A reason *for* adopting the unit and name proposed by the Committee was that they met a want. *Against* the proposition was the fact that a name had never been given to a C.G.S. unit before, but only to multiples or submultiples of such units. At the

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B. A. Committee, in 1881, one of the reasons why one-tenth of a C.G.S. unit of current was taken as the practical unit (the ampere) in preference to the C.G.S. unit, was to avoid giving a special name to a C.G.S. unit; the fact that glow lamps required currents of about one-tenth a C.G.S. unit was another reason. In America the name "gilbert" had been proposed for the unit now under discussion, and it was a pity to come into conflict with our friends across the Atlantic on this point. At the same time a word of one syllable, such as gauss, was preferable for magnetomotive force, and a word of two syllables for the resulting flux; because the quantities were somewhat analogous to electromotive force and current, for which words of one and two syllables respectively (volt and ampere) were in common use. Consequently he thought our "gauss" should be retained and the American definition of "weber" agreed to.

In his opinion it would be a great pity to attempt too much christening at once, and he recommended that only the two units for flux and magneto-motive force be settled, and the rest be allowed to settle themselves. Unless this was done some of the units would soon become antiquated.

Referring to the system of "rational" units proposed by Mr. Oliver Heaviside, Dr. THOMPSON said the more he read of Mr. Heaviside's work the more was he impressed by the importance of the suggestions made. Mr. Heaviside's units were based on *action in the medium* instead of *action at a distance*, the foundation of the C.G.S. system. If absolutely pure substances could be got and the temperature reduced to absolute zero, then the properties of electric currents *in* wires would disappear, and all the phenomena be *in the medium* surrounding the wires. Apart from chemical action at electrodes in a gap in the circuit, the only action of the current then remaining was the magnetising force it excited in the medium. In any rational system of units the unit of magnetic potential would be the same as the unit of current. Instead of defining magnetic pole by the equation

$$f=\frac{m_1 \times m_2}{d^2},$$

Mr. Heaviside uses

$$f=\frac{m_1 \times m_2}{4\pi d^2},$$

and consequently his unit of magnetism was smaller than the C.G.S. unit in the ratio of 1 to $\sqrt{4\pi}$. If the 4π be omitted in the above equations, it kept cropping up elsewhere. In order to form a consistent system of units, Mr. Heaviside had put in the 4π at the beginning in the fundamental equations, and so saved it from producing further interference. Starting from this basis, a new set of derived units resulted, which were related to the present units as shown below:—

1	"rational"	volt	=	3·544	present volts.
1	"	ampere	=	2·822	" amperes.
1	"	ohm	=	1·257	" ohms.
1	"	unit of magnetism	=	0·28205	" units of magnetism.
1	"	magnetic line	=	"	" magnetic lines.
1	"	unit of magnetic potential	=	"	" units of magnetic potential (gauss).

A coil having 10,000 "rational" ampere-turns will exert magnetic potential of 10,000 "rational" gausses, and will be equivalent to 28,205 of our present ampere-turns which $\left(\times \frac{4\pi}{10}\right)$ exert a potential of 35,440 gausses.

By adopting this system of units the relations between the magnetic units would be simplified. In his (Dr. Thompson's) opinion the change would not be very difficult. But the fact that we might at an early date have to remodel our whole system of C.G.S. units on the plan suggested by Mr. Heaviside was a very strong reason for taking at the present time a minimum of action. He therefore hoped we should proceed very slowly.

*Prof. AYRTON said Dr. Thompson in his excellent address had given reasons why the recommendations of the Electrical Standards Committee should not be adopted. He himself wished to look at the question from the opposite standpoint. Referring to the fact that the American Institute of Electrical Engineers had already chosen units and names for the more important magnetic quantities, he said, although he had the greatest admiration for American methods and American "goaheadedness," he thought they had gone ahead too fast in this matter. For at the International Congress held in their own country in 1893 it was unanimously decided by the Chamber of Delegates that the C.G.S. system of magnetic units was sufficient for practical requirements. Shortly afterwards the American Institute of Electrical Engineers made a communication to the Institution of Electrical Engineers suggesting names for magnetic units, although the recent Congress said such action was unnecessary. In reply, the Institution of Electrical Engineers, acting in accordance with the decision of the Chicago Congress that the time was not yet ripe for selecting practical magnetic units and giving them names, deprecated the proposals made by the American Institute, but in spite of this the names had been given. Under these circumstances he did not think we were bound to accept the names and definitions provisionally adopted on the other side of the Atlantic, especially as the units chosen did not form a consistent system with the volt, ampere and ohm. Dr. Thompson had complained that a "weber," equal to 10^8 C.G.S. lines, was a unit much too big for practical use. On the other hand, he admitted that since the Chicago Exhibition the total flux of the largest machines made had increased from 15,000,000 C.G.S. lines to something like 80,000,000. If this rate of increase continued we should soon have machines with total fluxes equal to one or more "webers" (100,000,000 lines), and the objection as to size of unit became of less importance. The adoption of the "fared" as the practical unit of capacity had never been found inconvenient, although it was a unit so huge that no commercial condenser had ever been made, or was ever likely to be made, having a capacity approaching the unit. The submultiple "microfarad" proved quite satisfactory in practice. Surely it was best to have all the practical units of one system. As "farad" caused no difficulty, he did not see why the proposed "weber" should. In Dr. Thompson's opinion the 1881 Congress did not change the unit of current so as to make it equal to the C.G.S. unit, because one-tenth of that unit was approximately the current taken by glow lamps then used. Being a member of that Congress, he (Prof. Ayrton) could say that the true reason for adopting the present ampere was so as not to change the size of the unit then in practical use, for such a change would have caused great inconvenience to the industry. Now, however, Dr. Thompson had suggested a far more radical change in proposing to alter, not merely the size of a unit, but the fundamental character of the equations on which the C.G.S. system was based. Interesting as the suggested alteration was from a theoretical standpoint, the question to be answered was not what might have been done 30 years ago, but what would be best under present circumstances. He was pleased to hear that Dr. Thompson was at one with the Standards Committee as regards the definition of the "gauss."

*Dr. JOHNSTONE STONEY thought the differences expressed by the previous speakers could be reconciled by the simple expedient of using suitable terminations. All the terms hitherto given to electromagnetic units derived from the names of investigators, such as "ohm," "volt," "ampere," "farad," belonged to one consistent series of systematic units, commonly called the "ohm" system or the "practical" system. This established a very convenient practice, which he thought it undesirable to infringe by giving terms derived from the names of scientific men to any units not belonging to that particular series. At the same time it was an inevitable consequence of keeping to systematic units that some would be far too large or far too small for business or laboratory practice. This difficulty he proposed to meet by decimal multiples or submultiples of units of the ohm series, wherever the units of that series were inconveniently large or small, indicating multiples by the affix *-ane* or *-ain*, and submultiples by *-et* or *-ette*. Thus the *faradet* would signify some decimal submultiple of the farad. The microfarad in common use is the sixth of these faradets, but throughout an investigation it would be sufficient to say that the capacity of the condenser or cable under consideration was so many faradets, it being stated once for all that the sixth of the decimal series of faradets was being employed. In some laboratory work he had found it convenient to use a measure a thousand times smaller than a microfarad, but still called it a faradet. It was quite enough to record once for all in his note-book that the ninth faradet was being used. In the proposed nomenclature

The C.G.S. unit of	resistance	=	the	ninth ohmet.
"	" electromotive force	=	"	eighth voltet.
"	" current..............	=	"	first amperane.
"	" capacity	=	"	ninth faradane (a truly immense unit),

and so on.

On the foregoing grounds he dissented, as a member of the Committee, from the proposal of the Committee to give such names as weber or gauss to any other than units of the ohm series. He proposed that the Committee should pick out those decimal multiples and submultiples of the ohm series of units which were most convenient in practice, and give them such names as gaussane or gaussette, reserving names such as gauss for the units of the ohm series. The suggested affixes with slight modification of spelling would answer in German, French and English; and if in any other language *-et* or *-ane* were unsuitable, other affixes consonant with the genius of the language might be substituted without risk of misunderstanding.

Dr. FREDERICK BEDELL, of Cornell University, Ithaca, N.Y., agreed that the two positions were reconcilable, and thought it very desirable that national prejudices should not come into the question. He did not wish to take credit for what the Americans had done, nor be held responsible for their sins, but hoped that a satisfactory agreement could be arrived at. The 4π question was not now before the meeting, for they were not quite ready to take it up yet. He might, however, mention that the question was analogous to whether unit cube, or a sphere of unit radius should be taken as the unit of volume. Referring to magnetic units he said that, in the equation

$$\text{induction}=\frac{\text{magnetomotive force}}{\text{reluctance}},$$

the American Institute of Electrical Engineers used the C.G.S. units with names, thus:—

$$\text{webers}=\frac{\text{gilberts}}{\text{oersteds}},$$

whilst Prof. Thompson would employ the same quantities with different names, viz.:—

$$\text{webers}=\frac{\text{gauss}}{\text{units of reluctance}},$$

The proposal of the Committee was to use a large unit of magnetic flux and call it a weber, and choose the unit of reluctance so that the latter equation held good. The suggestions made by the American Institute were the same as those of Prof. Thompson except as to names. In America "gauss" had been used as the unit of flux density, *i.e.*, webers per square centimetre. In conclusion, Dr. BEDELL said he endorsed Prof. Thompson's views, for the units he proposed were best suited in size for practical purposes.

Prof. EVERETT said the question must be considered from both the theoretical and practical side. No doubt the present system of units was not so perfect as it might be, but in the meantime we must use the best obtainable. He agreed with Mr. Oliver Heaviside in theory, but if his

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system of electrical and magnetic units be adopted the harmony that existed between all absolute systems of units (gravitation, &c.) would no longer hold. The present absolute system defined unit pole (or mass) so that the mutual force between two poles was equal to their product divided by the area of the square on the line joining them, whereas Mr. Heaviside divided the product by the area of the sphere whose radius was equal to the line joining the poles. One of the most important results in the theory of attraction (whether gravitational, electric, or magnetic) was that *the surface-integral of normal attraction over any closed surface was equal to* 4π *times the quantity within the surface*, or $\int F\,ds = 4\pi M$; and so long as the square on the line between two poles be used in defining unit pole, the 4π must come in somewhere. If, however, Mr. Heaviside's definition be used, the 4π disappeared, and the surface-integral became equal to the quantity within the surface. On this account "rational" units simplified formulæ, and might often be used with advantage. On reading the discussion on magnetic units which had appeared in *The Electrician* he observed that the "weber" proposed by the Committee was used in practice; but, referring to the connection between weber-turns and voltage in a transformer, he gave the expression $N = \epsilon/2\pi$ (or unit frequency), where N = maximum number of webers threading the electric circuit and ϵ the square root of mean square voltage per turn. As to the suggested unit of magnetomotive force—the gauss—he thought there was no need for the name, as the C.G.S. unit was well known. The word "voltage" had, however, been found convenient, and "gaussage" would be useful.

*Prof. PERRY agreed with the recommendations of the Committee, and expressed regret that only the authority of the British Association had been utilised to bring them forward. In his opinion a general congress should have been called to settle the matter on a satisfactory basis. Six years ago (see *The Electrician*, July 31, 1891, Vol. XXVII., p. 355) he suggested to the Standards Committee the units now proposed for adoption, but did not mention names, for these were points on which great difference of opinion might reasonably exist. He was sorry to think that the Committee did not boldly face a difficulty which became greater by delay, and adopt at once Mr. Heaviside's suggestions as to rational units. He thought that it was quite possible to make the change now.

*Mr. TREMLETT CARTER said the present system of units was not such as would gain the approval of posterity, and to enlarge that system was not the proper course to pursue. All agreed that the "rational" system proposed by Mr. Heaviside was better, and this should be adopted. It would not be more difficult to do this than to introduce the metric system of weights and measures.

Mr. F. G. BAILY said there was no object in hurrying on the christening of the gauss, for he could see no use for it. The ampere-turn was already used in practice. Whether the name "gauss" or ampere-turn be given to the unit was a matter of no importance. Regarding the "weber," the general opinion seemed to favour 10^8 C.G.S. units, Dr. Thompson being the only one who preferred the little weber.

*Dr. THOMPSON, in reply, pointed out that the American Institute of Electrical Engineers said they did not want to create new units, but required names for the old ones. The names, however, had only been provisionally adopted in America. Although the ampere-turn would be used by practical men, he hoped the gauss, as proposed by the Committee, would be the unit of magnetic potential. As to the choice of the magnitude of the ampere, he said that at the York meeting of the British Association the fact of glow lamps requiring currents about one-tenth of a C.G.S. unit was brought prominently forward as an argument why one-tenth should be chosen as the practical unit, and this found favour on the Continent as being nearly equal to the current sent by a Daniell's cell through one Siemens unit. Dr. Johnstone Stoney had objected to naming units not belonging to the ohm system, and suggested affixes for multiples or submultiples of those units. He (Dr. Thompson) thought this might lead to difficulty, for terminations were not the same in all nations. He instanced the circumstances that the Italian electricians would not use the word *volt*, but called it the *volta*.

*Dr. OLIVER LODGE called attention to the fact that in the report the Committee said they wished to come to no hasty decisions, but recommended for tentative adoption the terminology which had just been discussed. The Committee had no wish to slay the ampere-turn, for it might give place to the "gauss" gradually. Similarly, both "line" and "weber" might for a time be used, and practice would decide survival. Any quantity familiarly dealt with demanded units of different magnitude; it would be inconvenient to have to state the price of an estate in coppers, or of an orange in pounds. He recollected Prof. Perry opening up the whole question of magnetic units several years ago, but did not remember exactly what his suggestions were. As to the 4π question, he himself feared that the time had grown too late for so radical although so desirable a change, but he was interested in seeing how many seemed to favour it. If there were really anything like a consensus of opinion in favour of effecting the improvement it might seriously be attempted. Perhaps some day even the objectionable decimal system of arithmetic might give place to the far more convenient duodecimal system. Prof. Ayrton had confessed to conservative feelings so strong as to cause him, so long ago as the Paris Congress, to adhere to one-tenth C.G.S. as a unit of current, because that had been for a short time in use, although there were manifest disadvantages in such usage, and although its name was then being changed from weber to ampere—a most favourable opportunity for revision; so he was not surprised to find him strongly opposing any such now serious change as that involved in putting the factor 4π into its proper place. If done at all it should be done thoroughly, and the change applied to electrical, to magnetic and to gravitational units. Perhaps, however, the best time for a revolution would be the epoch when the real nature of the etherial constants, κ μ and ν, became understood.

On the motion of the PRESIDENT (Prof. Hicks) the thanks of the meeting were accorded to those who had taken part in the discussion.

ELECTRIFICATION AND DISELECTRIFICATION OF AIR AND OTHER GASES.*

BY LORD KELVIN, MAGNUS MACLEAN, AND ALEXANDER GALT.

Experiments were made for the purpose of finding an approximation to the amount of electrification communicated to air by one or more electrified needle points. The apparatus consisted of a metallic can 48cm. high and 21cm. in diameter, supported by paraffin blocks, and connected to one pair of quadrants of a quadrant electrometer. It had a hole at the top to admit the electrifying wire, which was 5·31 metres long, hanging vertically within a metallic guard tube. This guard tube was always metallically connected to the other pair of quadrants of the electrometer and to its case, and to a metallic screen surrounding it. This prevented any external influences from sensibly affecting the electrometer.

The experiment was conducted as follows: One terminal of an electric machine was connected with the guard tube, and the other with the electrifying wire, which was let down so that the needle was in the centre of the can. The can was temporarily connected to the case of the electrometer. The electric machine was then worked for some minutes, so as to electrify the air in the can. As soon as the machine was stopped the electrifying wire was lifted clear out of the can. The can and the quadrants in metallic connection with it were disconnected from the case of the electrometer, and the electrified air was very rapidly drawn away from the can by a blowpipe bellows arranged to suck. This released the opposite kind of electricity from the inside of the can, and allowed it to place itself in equilibrium on the outside of the can and on the insulated quadrants of the electrometer in metallic connection with it.

Different lengths of time of electrification and different numbers of needles and tinsel were tried, but the experimenters found that one needle and four minutes of electrification gave nearly maximum effect. The greatest deflection observed was 936 scale divisions. It was found by experiment that the quantity of electricity giving 936 scale divisions was $\frac{1}{435} \times \frac{936}{122} = 1{\cdot}7637$ electrostatic units. The capacity of the can was 16,632 cubic centimetres, which gives, for the quantity of electricity per cubic centimetre, $\frac{1{\cdot}7637}{16{,}632} = 1{\cdot}06 \times 10^{-4}$. The electrification of the air in this case was positive; it was about as great as the greatest obtained, whether positive or negative, in common air when electrified it by discharge from needle points. This is about four times the electric density which the authors roughly estimated as about the greatest given to the air in the inside of a large metal vat, electrified by a needle point and then left to itself, and tested by the potential of a water dropper with its nozzle in the centre of the vat, in experiments made two years ago and described in a communication to the Royal Society in May, 1894.

In subsequent experiments, electrifying common air in a large gas holder over water by an insulated gas flame burning within it with a wire in the interior of the flame kept electrified by an electric machine to about 6,000 volts, whether positively or negatively, the authors found as much as $1{\cdot}5 \times 10^{-4}$ for the electric density of the air. Electrifying carbonic acid in the same gas holder, *whether positively or negatively*, by needle points, an electric density of $2{\cdot}2 \times 10^{-4}$ was obtained. About the same density ($2{\cdot}2 \times 10^{-4}$) of *negative* electricity was found in carbonic acid gas drawn from an iron cylinder lying horizontally, and allowed to pass by a U-tube into the gas holder without bubbling through the water. When carbonic acid gas was drawn slowly from the liquid carbonic acid in the iron cylinder placed upright, and allowed to pass, without bubbling, through the U-tube into the gas holder over water, no electrification was found in the gas unless electricity was communicated to it from needle points.

The efficiency of the electric receivers used was approximately determined. The efficiencies of two different receivers were respectively 0·77 and 0·31 with air electrified positively or negatively by needle points; and 0·82 and 0·42 with carbonic acid gas electrified negatively by being drawn from an iron cylinder placed on its side. Each of these receivers consisted of block tin pipe 4cm. long and 1cm. diameter, with five plugs of cotton wool kept in position by six discs of fine wire gauze. The great difference in their efficiency was no doubt due to the quantities of cotton wool being different, or differently compressed in the two. The authors have commenced and hope to continue an investigation of the efficiency of electric receivers of various kinds.

In addition to experiments on electric filters, the authors have made many other experiments to find other means for the diselectrification of air. It might be supposed that drawing air in bubbles through water should be very effective for this purpose, but this is far from being the case.

* Abstract of a Paper read before the British Association at Ipswich, Section A.

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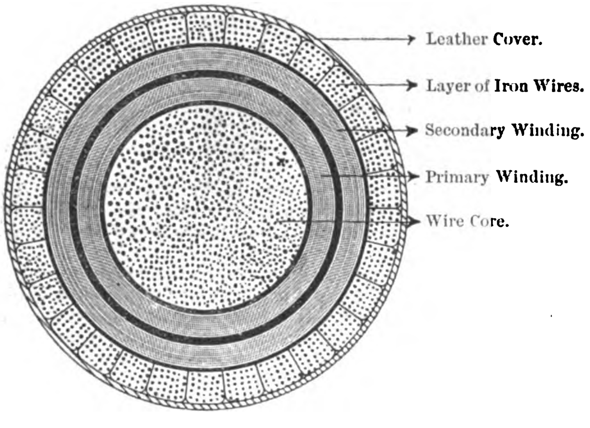
To test the effects of heat the authors drew air through combustion tubes of German glass about 180cm. long and 2½ or 1½cm. bore, the heat being applied externally to about 120cm. of the length. It was found that, when the temperature was raised to nearly a dull red heat, air, whether positively or negatively electrified, lost little or nothing of its electrification by being drawn through the tube. When the temperature was raised to a dull red heat, and to a bright red, high enough to soften the glass, losses up to as much as four-fifths of the whole electrification were sometimes observed, but never complete diselectrification. The results, however, were very irregular. Non-electrified air never became sensibly electrified by being drawn through the hot glass tubes, but it gained strong positive electrification when pieces of copper foil, and negative electrification when pieces of carbon, were placed in the tube, and when the temperature was sufficient to powerfully oxidise the copper or to burn away the charcoal. Through the kindness of Mr. E. Matthey the authors were able to experiment with a platinum tube 1 metre long and 1mm. bore. It was heated either by a gas flame or an electric current. When the tube was cold, and non-electrified air drawn through it, there were no signs of electrification. But when the tube was made red or white hot, either by gas burners applied externally or by an electric current through the metal of the tube, the previously non-electrified air drawn through it was found to be electrified strongly positive. With stronger currents, raising the tube to white-hot temperature, the electrification seemed to be considerably less.

THE MÜNCH INDUCTION TRANSMITTER.*

This instrument has been invented by Herr Postrath Münch, and is now being introduced by the German Post Office for the general use in telephony. The transmitter, of which a section is shown in the accompanying figure, contains an iron core 13cm. long and



3cm. in diameter, the wires of which are varnished with shellac. The whole core is insulated with a layer of paper, then follows the primary winding, again double paper insulation, and then the secondary winding. Each winding consists of about 10 layers, or 4,000 turns of silk-insulated copper wire 0·2mm. in diameter. To increase the effect of the transmitter, a 5mm. layer of fine iron wire is wound parallel to the iron core round the secondary winding. The resistance is about 200 ohms in the primary, and about 250 ohms in the secondary. In making experiments, a small alternator, giving 2·5 volts, was used, and by altering the periodicity from 350 to 700, the following results were obtained :—

Secondary open.	Increase of the apparent resistance of primary.
(a) Open	from 5,500 to 12,000 ohms.
(b) Closed through a resistance of 500 ohms...	„ 910 „ 940 „
(c) Short-circuited........................	„ 460 „ 490 „

The self-induction in the primary changed as follows :—

(a)	from	2·240	to	2·440 henries.
(b)	„	0·081	„	0·047 „
(c)	„	0·042	„	0·040 „

The electrostatic capacity between the two windings is extremely small, and an average of tests has given 0·00185 microfarad.

The exact "efficiency" of the apparatus in the transmission of telephone currents has so far not been ascertained, but preliminary experiments have given very satisfactory results. It has been found that even an experienced ear cannot discover the slightest difference upon the "sound-effect" of a receiver when used alternately direct or with the transmitter in the circuit. When double transmission is necessary, a slight difference is observable in the sound when the transmitters are either in or out of circuit. The ratio of the volume of the sound in the two cases is about 95%.

* From the *Elektrotechnische Zeitschrift*.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *September 13, 1895.*

The American Association for the Advancement of Science.—At the annual meeting of the American Association for the Advancement of Science, at Springfield, Mass., last week, several electrical Papers were read, of which two by Dr. Pupin were, perhaps, the most important. One of the latter was on the "Flow of Alternating Currents in Cables," in which Dr. Pupin supplies a missing term in Lagrange's equation of condition expressing the law of a vibrating cord, thereby taking into account both the effect of the receiving and transmitting apparatus. The other Paper was on "The most general Relation between Electric and Magnetic Forces and their Displacements," in which an additional law is laid down, deduced from the existing two experimental laws upon which the Maxwellian theory of electricity and light rest. The theory as thus expanded, Dr. Pupin states, will explain all the various phenomena of light and electricity without any added hypotheses. Prof. C. D. Childs gave an account of some unfinished work concerning a Hertz effect corresponding to that of a diffraction grating on light, which, he believed, had thus far not been observed. The grating was made by fastening strips of tin on a wooden frame, and with two different gratings thus made, wave lengths were determined by the new diffraction method and their accuracy checked by the Righi interference method. In a Paper on "Solar Magnetic Radiation and Weather Forecasts," Mr. Frank H. Bigelow maintained that magnetic radiations demonstrate the existence of an earth crust about 800 miles in diameter, and that the sun has also a crust, thus controverting the current idea that it is wholly vaporous or fluid. The method by which these inferences are arrived at will, it is claimed, lead to means of forecasting the weather years in advance. An exuberant Paper, by R. P. Williams, was read on "An Electrolytic Process for the Manufacture of White Lead." The process as described consists of, first, an electrical preparation of nitric acid and sodium hydro-oxid; second, the action of nitric acid on lead forming lead nitrate; third, the action of lead nitrate and sodium hydro-oxid to form lead hydro-oxid; fourth, the combination of lead hydro-oxid and sodium bi-carbonate to form lead carbonate. The author claims that by this process the cost of making white lead will be but a fraction of the cost by present methods, and that the process is almost instantaneous, instead of occupying from two to six months as at present; other advantages claimed are the small area occupied as compared with the older processes, and a better quality of the product. Prof. H. S. Carhart read a Paper on the "Experimental Investigation of the Rotary Field," which consisted in the examination of the magnetic flux of the rotary field by means of iron dust phantoms.

Underground Conduit Street Railway Traction.—The statement made by President Crimmins, of the Metropolitan Street Railway Company of New York, a few weeks ago, concerning the great saving in operating expenses demonstrated on the Lenox-avenue electric line, has resulted in announcements from all the large street railway companies in New York City of their intention of adopting electric traction. President Crimmins stated that the result of operations on the Lenox-avenue road, which employs the Budapest underground conduit system, shows a saving of four cents per car mile over cable traction and eight cents per car mile over horse traction. The Third-avenue line, which is one of the most extensive in America, sprung a surprise on the public in the announcement of its intention of adopting electric traction, by stating that on a half mile addition to the present cable, now almost completed, it would employ the Budapest system. The conduit employed on this extension is so nearly a duplicate of that used in cable traction that no one, until the announcement was made, was aware that electric conductors were to be installed in it.

The Buffalo-Niagara Franchise.—The Niagara Falls Power Company has refused to accept the terms of the franchise offered it by the City Council, permitting the introduction of current from Niagara into Buffalo, which is distant about 26

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miles from the Niagara plant. The proposed franchise was recently revised, and important concessions granted to the Niagara Company, but the latter apparently thinks that it is in a position to impose its own terms. In this connection it may be said that many well-informed people believe that the Niagara electrical enterprise is merely part of a huge land-jobbing scheme, the generation of power being secondary to the building up of an industrial city on the grounds of the Company.

CORRESPONDENCE.

MAGNETIC UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A certain amount of correspondence has been received since and during the oral discussion at Ipswich, and it would probably be satisfactory to the authors that their letters should appear in your columns. Accordingly I enclose them.

To those who were present at the discussion it may be convenient to say that the "unofficial" sentence, which was practically quoted from Mr. Baily's letter reproduced by you on page 451 of your issue of August 2nd, should have run thus: Weber-turns = $\frac{1}{4}$ mean volts per cycle; or, more accurately, the mean voltage developed in a transformer coil supplied with sinuous currents is equal to its weber-turns divided by four times the frequency of the magnetic alternation; it being understood that "weber-turns" means the total field through the coil under consideration multiplied by the number of times it is surrounded by the wire of that coil.

But manifestly the numeric 4 requires modification whenever the magnetisation deviates from a sine law. The *maximum* sine voltage would, of course, be got by using the factor 2π instead of 4.

It would be of interest if you could get from Prof. Perry, and publish, the letter which he addressed to the Electrical Standards Committee some five or six years ago, wherein he first officially raised the whole question of magnetic units.—Yours, &c., OLIVER J. LODGE.

September 19, 1895.

P.S.—I find in the minute book of the Electrical Standards Committee (which happens to be in my hands during Mr. Glazebrook's absence), under date September 7, 1888 (at Bath), the following record:—

"Prof. Perry was requested to draw up a report for the consideration of the Committee on the definition and name of a practical unit of magnetic field."

On April 15, 1889 (at Albemarle-street), Prof. Perry's report was read and afterwards circulated among the Committee; and on December 2, 1890, it was "ordered to be printed after revision by the author."

Accordingly it makes its appearance in your columns on page 355 of Vol. XXVII., under date July 31, 1891, where it may readily be referred to.

It is interesting to note that Prof. Perry advocated the adoption of the precise unit now christened the weber, and was otherwise in fair harmony with the present action of the Committee.

The following are the letters above referred to:—

MY DEAR GLAZEBROOK: As there is some uncertainty as to my ability to attend the meeting at Ipswich, I desire to submit some remarks on the proposed new units.

The immediate and primary business before the committee is the acceptance of a definition of unit inductance. We have agreed to its name *henry*, but we have not accepted the definition based on that which was decided on at Chicago in the following terms:—

> "Resolved,—That the several Governments represented by the delegates of this International Congress of Electricians be, and they are hereby recommended to formally adopt as legal units of electrical measure the following. . . . As the unit of induction, the *henry*, which is the induction in the circuit when the electromotive force induced in this circuit is 1 international volt, while the inducing current varies at the rate of 1 ampere per second."

The why-not is not clear from Prof. Oliver Lodge's remarks. It was sanctioned by Helmholtz, Mascart, Rowland, Ferraris; and adopted unanimously by all the other delegates, European and American, present at Chicago. It is said to be lacking in simplicity, to fail in emphasising the variability of L, and to be detached from the permeability of the circuit. Prof. Lodge would rather define it with reference to magnetic units as expressed by the equation **N** = LC, **N** being total induction, whose practical unit 10^8 C.G.S. lines he proposes to call a "weber." Thus the "henry" can be defined as a "weber" per unit C.G.S. current. But surely this is more complicated than the Chicago definition, which really implies variation, and is independent of any further additions to our practical units. The "henry" filled a want. It is already in daily use and is much appreciated. Nothing has been gained by the delay in accepting the Chicago definition. But do we want any further nomenclature?

The American Institute of Electrical Engineers, a very large and influential body to whom we are indebted for the "henry," have provisionally accepted the following units:—

> *Gilbert.*—C.G.S. unit magnetomotive force.
> *Weber.*—C.G.S. unit of induction.
> *Oersted.*—C.G.S. unit of reluctance.
> *Gauss.*—C.G.S. unit of induction density.

Prof. Lodge has ignored these proposals, and discusses the *gauss* as applied to unit magnetomotive force, and the *weber* as applied to 10^8 C.G.S. lines of induction.

The American proposals are certainly a departure from our past practice. We have not hitherto christened the C.G.S. electrical or magnetical units, but only the practical ones. Moreover, it is by no means clear that we want a gilbert, an oersted, or a gauss as defined by the American Institute of Electrical Engineers. The weber, however, made equal to 10^8 C.G.S. lines, is both practical and useful. The real practical unit of magnetomotive force is the ampere-turn. Do we want to change this, or even to give it another name?

The system of B.A. units is by no means perfect. If we commence to tinker it we may spoil it. We have lost the lead chiefly by our own dilatoriness. Changes can now be effected only through International Congresses. The principal defects of the system are:—

(1.) The unfortunate selection of 10^8 C.G.S. units as the practical unit of E.M.F. The volt ought to have been 10^9 C.G.S. units. It would have made the ampere and C.G.S. unit current the same and minimised labour.

(2.) We have assumed both μ and κ (specific electric inductivity) to be unity in air, which is not only quite artificial, but absolutely wrong. We have no accepted definition of μ, nor are we agreed either as to its nomenclature, or even as to its physical character.

(3.) Some object to the presence of π, and would relegate, it by more artificialism, to a less intrusive place.

(4.) The farad as a name is lost owing to its enormous magnitude. It would have been well if we had called the present microfarad the farad. The present farad would then have been the megafarad, and brevity would have been secured.

(5.) The determination of the intrinsic value of the joule, which depends on the heat equivalent of work, and which has now reached a stage where a definite figure can be accepted as reliable, though perhaps not quite so accurate as that of the ohm.

(6.) This would lead to a definite intrinsic value of the *watt*, and therefore of the *kilowatt*, which would replace the present irregular and meaningless *horse-power* and give us an international coherent and universal unit of power.

My view is that we should at the present meeting accept the Chicago definition of the *henry*, and if a practical magnetic unit is really necessary it should be the flux = 10^8 C.G.S. lines of magnetic force. Whether this unit be called the *weber* or the *gauss*, or by any other name, is a matter of little consequence. It should have a definite name, for names are most successful in securing true conceptions of concrete ideas, in furthering exact science, and in popularising practical units. The "weber," if selected, would be as successful in familiarising the workman to the conception of *magnetic flux* as the "ampere" has that of *electric current*.—Yours, &c.,

S.s. "Monarch," August 20, 1895. W. H. PREECE.

DEAR LODGE: I should have liked much to be present at the discussion on Units in Section A this morning, but I must go home.

I should like to say a word in favour of regarding (as I believe you would) from the beginning *electric inductivity* and *magnetic inductivity* as fundamental quantities for the medium, and denoting them by k and μ respectively.

Thus if E, H be the electric and magnetic field intensities, we should have k E, μ H as the electric and magnetic inductions. (*Induction* is not a very good name for the quantities here, but I suppose it cannot be altered.)

If k_0, μ_0 be the inductivities for the standard medium, whatever it is, we should have k/k_0, μ/μ_0 for the electric and magnetic *permeabilities*. Thus the magnetic *permeability* (so say) of a piece of iron would be, as Lord Kelvin originally defined it, the ratio of the magnetic *force* in a crevasse cut at right angles to the lines of magnetisation to the magnetic *force* in a narrow cylindrical cavity along the lines of magnetisation, and would, therefore, be a mere number. Also we should have $\mu = \mu_0 (1 + 4\pi\kappa)$, where κ is a number.

A great sea of trouble would be avoided if this plan were followed consistently and from the beginning in teaching. Nothing is more bewildering to students than to have k defined, as it very often is (in Maxwell even), as a mere ratio (the ordinary K), and then when they go on to the ordinary electromagnetic system of units in which μ is taken as a mere ratio, to find that $1/k$ *has the dimensions of the square of a velocity!*

With your views generally as to L, &c., I quite agree. As to rationalisation, we have gone much too far to turn back now. And I think the inconvenience of the 4π factor in electric and magnetic work, though it is sensible, has been exaggerated.

I am sorry to trouble you with this, but I have been so strongly convinced of the desirability of the fundamental reform referred to above, that I felt compelled to write to you.—Yours, &c., A. GRAY.

121, Norwich-road, Ipswich, Sept. 18, 1895.

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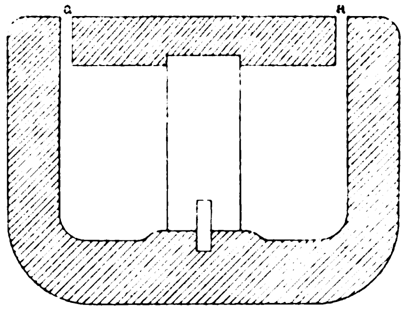
Dear Professor Lodge: Will you kindly permit me to refer to the Memorandum on "Magnetic Units" which you have drawn up for discussion in Section A? The particular point I wish to mention is the "desirability of introducing a 'gauss unit' as an aid to teaching," &c., p. 9, line 25.

Some four years ago I showed and described an instrument which may fulfil the purpose. I called it "a permanent magnetic field" (*Phil. Mag.*, 1892, I think), and gave figures showing that the value had not changed for many months. The rough sketch enclosed will give you an idea of the arrangement, and perhaps recall it to your mind, as I had the pleasure of showing it to you.



Briefly, it is a straight magnet having two pole-pieces, the upper one being a disc, the lower one a hemisphere (roughly). The space *a a* is an annular ring between the pole-pieces. I look upon the instrument as a practical unit of **N** = webers, and have found it very helpful to students. The instrument has a brass cylinder arranged to fall through the air gap. On the outer face of the cylinder is wound a coil, and the ends of this coil joined to a circuit give definite values of $Q = \frac{N}{R}$ or $\int e\, dt$. Your note makes me think it, or some modification, might be used for providing a standard gauss-fall $\omega_a - \omega_b$ as given in your equation page 3.

The permissible value of induction density in the steel magnet depends, of course, on the breadth of the air gap. My earliest instrument of this form has **B** = 5 to 6,000 C.G.S. units per square centimetre. The air gap = $\frac{1}{10}$in. in breadth. Total lines = 26,000 (about) C.G.S. (I hardly remember exact figures).

Somewhat recently, I redetermined the value of this instrument for Dr. Du Bois of Berlin, and could detect no change from the initial value.—Yours, &c., W. Hibbert.

British Association, Ipswich, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Yesterday, in the discussion on Units in Section A of the British Association, I referred to a document prepared by me for the Standards Committee some seven years ago, and published by you at the Secretary's request July 31, 1891. I am sorry that my absence from England during the recent discussion in your columns has prevented my calling attention to that document. I have just now re-read the document, and beg to apologise to Dr. Lodge for my quite incorrect assertion that my suggestions were the same as those of the Committee. What I said in the document was :—

"I would suggest that the practical unit of magnetic flux (or induction or force) be 10^8 C.G.S. units, and that it receive a name. [This is the same as Dr. Lodge's *weber*.] That the magnetic permeability of air shall no longer be assumed to be unity, but in the practical system of measurement be tabulated like the permeability of any other substance—the permeability of air will be $4\pi \times 10^{-9}$; and that in future no substance shall have unit permeability. [In Dr. Lodge's system the permeability of air is 10^{-8}.] That the unit of total magnetomotive force in a magnetic circuit be one ampere-turn. The unit of magnetomotive force gradient [magnetic potential] would be one ampere-turn per centimetre. It will follow that—

"(1.) A wire 1cm. long, moving at 1cm. per second across unit field, generates an E.M.F. of one volt.

"(2.) If a wire 1cm. long conveys one ampere, the power used (or developed) in moving it across the unit field at 1cm. per second is one watt.

"(3.) A magnetomotive gradient of one ampere-turn per centimetre produces unit induction (magnetic flux or force) per square centimetre if the permeability is one.

"(4.) Change of induction (magnetic flux or force) at the rate of one unit per second produces one volt per turn of wire."

Seven years ago I stated that I saw so many disadvantages as well as advantages in my system that I did not venture to ask for more than its discussion. The resulting system is simple, but I was frightened by the radical change involved in the permeability. Dr. Lodge yesterday said nothing about permeability, but as we must take webers per square centimetre = gaussage per centimetre × permeability, the permeability of air is 10^{-8}, instead of 1, whereas in my system the permeability of air was $4\pi \times 10^{-9}$.

For many years I have used 10^8 C.G.S. units as the practical unit of induction in such equations as $V = RC + n\,\theta\,I$, where V is in volts, R in ohms, C in amperes, n the number of turns of wire, I the total induction, and θ the symbol of differentiation with regard to time. But I have always converted ampere-turns into C.G.S. units and worked in C.G.S. when dealing with magnetic circuits—that is, when actually calculating the induction per square centimetre; and as the total induction is never needed except in the use of the above kind of equation, I always divided by 10^8 to obtain I for use with volts.

I still have the opinion that I held seven years ago, that until practical men demand units there is no great need for them. I am not in opposition to the Committee or to Dr. Lodge in their publication of the *weber* and *gauss*; if they ask me to adopt them I say, "Ay, and twenty such." Yes, faith, and I will use them, "Fridays and Saturdays and all," as Rosalind says in the play.

About the adoption of Mr. Heaviside's suggestions, and employing the whole authority of the B.A. Committee, such as it is, in an endeavour to immediately get rid of 4π from our fundamental equations; about this I have no doubt whatsoever. The change must come, and "better soon than syne."—Yours, &c.,

31, Brunswick-square, W.C., John Perry.
September 19, 1895.

SMALL WATER-POWER PLANTS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With reference to your note on the subject of small water-power plants; this is a subject to which I have devoted considerable attention. There are, in my opinion, a number of small places which could be effectively and economically electric lighted, but there are a number of causes operating to prevent its being done, and of which I will mention a few.

(1st) The native conservatism and slowness to grasp a good thing which is characteristic of this country, especially of the village element. A Londoner who is accustomed to smart business would nearly be driven crazy when dealing with the inhabitants of some small towns.

(2nd) The question of expense. This need not be a very serious obstacle. Money can be found for second-rate badly-managed gas works supplying a bad article at a high price, and why not for electric lighting? As to the question of the hydraulic works, which in most cases is a very large proportion of the whole cost of a water-power scheme, there are usually in such places either saw mills or flour mills driven by water power, and an arrangement could be made with their owners to allow the use of the power during certain hours. By this means the town would avoid the outlay of a large lump sum on works. The overlapping of the "mill" and "light" load could be provided for by a small storage, either batteries or hydraulic, the latter being the method proposed by myself in the case of a number of places during the last two years.

(3rd) The cast-iron Board of Trade. It does not seem to be realised by some people that there are many places where electric lighting could be profitably employed, but which could not be made to pay were the Board's requirements fully carried out. In such cases it is usually a case of overhead wires or none, and with various relaxations of the rules referring to hours of and constancy of service at a given pressure. If when freed from some Board of Trade restrictions the small station gives a bad service, then it will very quickly be shut down by the action of the consumers, without any necessity for anyone but the Official Receiver to interfere in the business. It should not also be necessary to spend £250 and upwards to obtain a reasonable tenure of the powers obtained by Provisional Order.

What I would propose is that the licensing system should be extended in, say, the following manner. That a "licence" be issued for seven years, and renewable on the application of the owners for a further period of seven years, subject to examination and passing as to good condition and fitness as to work (regard being of course paid to commercial considerations), so that the plant could be run for the same period as on a Provisional Order, but subject to inspection every seven years.

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Provision might be made for intermediate inspection on the application of the Local Authority, if it was reasonably believed that the plant was being allowed to get into a dangerous state. There are numerous other points which I might touch on, but I do not wish to occupy your space more than necessary.—Yours, &c., GEORGE T. PARDOE.

September 23, 1895.

STORAGE BATTERY REACTIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to your Editorial remarks in last week's issue, in the paragraph relating to Mr. Earle's Paper on Storage Batteries, you compare the strength of acid which gives maximum capacity with that yielding maximum proportion of persulphuric acid. Other remarks are made, the general tendency being to support the idea that the explanations are to be found in persulphuric acid.

I hope to deal with this and some other matters later on, having already entered into communication with Mr. Earle on the subject. Meanwhile, may I point out that on two points your remarks are not quite correct. Mr. Earle finds best results with 1·250 acid so far as *capacity* is concerned, but not with regard to *voltage*.

Again, I think you are mistaken in suggesting that as the acid rises to 1·500, the formation of persulphuric acid nearly ceases. At this density, the maximum is passed, but it is still a long way from ceasing.—Yours, &c., W. HIBBERT.

14, Goldhurst-terrace, South Hampstead, N.W.

LEGAL INTELLIGENCE.

Jaques and Sons and Thornton v. Hemming and Co. (Limited).

Applications were made to Mr. Justice Hawkins (sitting as Vacation Judge) on Tuesday last, on behalf of the holders of first and second debentures, that Mr. Thompson, who had been appointed interim receiver, might be continued as receiver and manager of the defendant Company, who carry on an electrical engineering business at Birmingham. Mr. Marten, Q.C., for the Company, submitted that the proper person to manage the business was Mr. Hemming, the present manager. His Lordship appointed Mr. Thompson as receiver and manager in both actions, with liberty to act at once, and to raise and pay the wages next week.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.—The Corporation of Eccles invite tenders for the supply and erection of Lancashire boilers, alternating-current dynamos and engines, cables, street boxes, &c., and transformers. Tenders must be sent in to Mr. Geo. Wm. Bailey, Town Hall, Eccles, by 12 o'clock noon on Monday next, the 30th inst.

——— The Electric Lighting Committee of the Harrogate Corporation require tenders for the supply and erection of the following plant:—(*a*) Lancashire boilers, economiser, feed pumps and accessories; (*b*) steam alternators, condensers, fittings, &c., steam exhaust feed and sundry pipes, valves, &c.; (c) switchboard and instruments; (*f*) transformers and accessories; (*g*) meters; (*h*) overhead travelling crane. Tenders, addressed to the Town Clerk, Municipal Offices, Harrogate, must be delivered by Monday next, the 30th inst.

——— The Building Committee of the Harrogate Corporation invite tenders for wiring the new Montpellier Baths for the electric light. Tenders, addressed to the Town Clerk, Municipal Offices, Harrogate, must be in by Monday next.

——— The Board of Control, Dublin, require tenders for the supply and erection of two direct-coupled steam engines and dynamos, a battery of accumulators, main switchboard, &c., for the lighting of the Purdysburn Asylum, Belfast. Tenders to Secretary of the Board, Custom House, Dublin, by to-morrow, Saturday.

——— The Dundalk Town Commissioners invite tenders for the erection and maintenance of the necessary plant for lighting the town by electricity from July 1, 1896. Tenders by October 7th.

——— The municipal authorities of Tongres, Belgium, invite tenders for the concession for the public and private electric lighting of the town. Tenders to the Administration Communale by October 10th.

TENDERS INVITED.—The Lancashire and Yorkshire Railway Company invite tenders for stores for the twelve months ending October 31, 1896. Included in the list of articles required are fog signals, india-rubber, iron castings (hydraulic and water pipes), iron chain, iron hinges, steel, and files, sundry tools, varnish, brake blocks, ironmongery, &c. Further particulars and forms of tender may be obtained at the Stores Department, Osborne street, Manchester, up to the 5th prox., between 10 a.m. and 4 p.m., and on Saturday between 10 a.m. and 12 noon. Tenders, addressed to the Secretary (Mr. C. W. Bayley), must be sent in not later than 10 o'clock on Monday, October 7th next. Some further information is given in our advertisement columns.

——— The Directors of the Great Western Railway Company invite tenders for telegraph instruments, india-rubber goods, copper, iron and steel wire, telegraph ironwork, tools and drysalteries, electric light carbons, telegraph poles, &c. Tenders, addressed to the Secretary, Paddington Station, W., by October 7th prox.

——— The Electric Lighting Committee of the Bedford Urban Sanitary Authority invite tenders for the supply and delivery of 200 cast-iron lamp columns, carriers and globes. Tenders must be sent in to the Clerk (Mr. T. S. Porter) by the 8th prox. Some further particulars appear in our advertisement columns.

——— The Corporation of Blackburn invite tenders for high-tension concentric cables, low-tension triple-concentric cables, cast-iron pipes, junction boxes, drawing-in and service boxes, &c. Tenders must be sent in to the Town Clerk (Mr. R. E. Fox), Town Hall, Blackburn, by October 5th.

——— The South Molton Shirt and Collar Manufacturing Company (Limited) invite tenders for supplying generating plant, and for wiring their factory buildings for the electric light. Tenders to the Secretary.

——— The Croydon Town Council invite tenders for wiring, and for supplying and fixing electrical fittings at the New Town Hall, Courts and Free Library. Tenders must be sent in to Mr. C. M. Elborough (Town Clerk), Town Hall, Croydon, by 4 p.m. on October 8th.

——— Messrs. Willans and Robinson (Limited) require tenders for about 600 tons of mild steel and 20 tons of cast iron for their new engineering works at Rugby. Tenders to the Secretary, Picton House, Thames Ditton, Surrey, by October 5th.

——— The Goole Urban District Council invite tenders for establishing telephonic communication between Goole and Rawcliffe Bridge, a distance of about three miles. Tenders to the Clerk (Mr. Geo. England) by the 30th inst.

——— The Direction Générale of French Posts and Telegraphs require tenders for the supply of a quantity of paper-insulated cable, in two lots. Tenders to the Direction Générale des Postes et des Télégraphes, 103, Rue de Grenelle, Paris, by October 10th.

——— The municipal authorities of Alexandria (Egypt) invite tenders for the concession to construct and operate a system of electric tramways in the town for a period of 50 years. Tenders by Tuesday next, October 1st.

——— Messrs. Goodbody and Co., Greenville, Dublin, invite tenders for the electric lighting of their works. Plans and specifications from Mr. W. Leake, 30, Victoria-buildings, Manchester.

TENDERS ACCEPTED.—The Sunderland Town Council have received the following tenders for the supply of plant and apparatus for their electricity works:—

High-Tension and Low-Tension Concentric Cables.

British Insulated Wire Company, Prescot (*accepted*).	Fowler-Waring Cables Company, London.
Siemens Bros. and Co., London.	Callender Company.
India-Rubber Company, „	Glover (W. T.) and Co., Salford.
W. T. Henley's Company „	

Cast-Iron Pipes and Box Frames and Wires.

Maclaren (R.) and Co., Glasgow (*accepted*).	Birtley Iron Company, Birtley.
	Mackenzie Bros., Edinburgh.
Shaw (J.) and Co., Glasgow.	Mallett and Co., London.

Stoneware Casing Boxes.

Doulton and Co., London (*accepted*).	Electric Construction Co.

Transformers.

Electric Construction Company (*accepted*).	Brush Company.
	Crompton and Co.
Johnson and Phillips.	John Fowler and Co., Leeds.
Siemens Bros. and Co.	

Meters.

British Thomson-Houston Company, London (*accepted*).	Chamberlain and Hookham, B'ham.
	Edmondson, J. A., Bradford.

——— The Oldham Corporation received 11 tenders for wiring the Central Baths, Oldham, for the electric light. The amounts varied from £32. 7s. to £53, and the lowest tender, that of Messrs. Baxendale and Co., Manchester, has been accepted.

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TENDER ACCEPTED.—The Ilford District Council have given the contract for providing an electric call system in connection with the fire brigade, and establishing telephonic communication with the police, to the Consolidated Telephone Construction and Manufacturing Company (Limited), 109, Farringdon-road, E.C. The contract is for a term of five years.

TENDERS RECEIVED.—The following tenders have been received by the Cowes District Council for supplying plant for their proposed electricity generating station :—

John Fowler and Co. (Leeds)	£8,350	0	0
Siemens Bros. and Co. (London)	8,100	0	0
Greenwood and Batley (Leeds)	7,600	0	0
Thomas Parker (Limited) (Wolverhampton)	6,970	0	0
Johnson and Phillips (London)	6,650	0	0
India-Rubber Company (London)	Informal.		
Crompton and Co. (London)	6,215	0	0
Bennett and Druce (Preston)	6,150	0	0
Bennett and Druce (Preston)	4,850	0	0
Brush Company (London)	5,930	0	0
Sharp and Kent (London)	5,333	0	0
Electric Construction Company (London)	5,154	18	0

The Water and Lighting Committee referred these tenders to Mr. N. F. Dennis, the borough engineer, who recommends that the tenders of Messrs. Crompton and Co., Sharp and Kent and the Electric Construction Company be retained for a further detailed analysis. The Committee rather favour the latter tender, and the Town Council at their last meeting decided to apply for a Provisional Order.

——— The Shoreditch Vestry received nine tenders for insulated electric mains, conduits and drawing-in boxes. The tenders have been referred to the Electric Lighting Committee for consideration and report.

SALE BY AUCTION.—Messrs. Wheatley Kirk, Price and Goulty will sell by public auction on Wednesday and Thursday next, October 2nd and 3rd, the surplus plant and machinery in and upon the works premises of Messrs. Smith, Beacock and Tannett, Victoria Foundry, Water-lane, Leeds. Included in the sale is a great variety of lathes and tools, overhead travellers, jib cranes, Lancashire boiler, vertical engines, smiths' hearths, anvils, staple vices, screw cutting, drilling, punching and shearing machines, &c. Catalogues may be obtained (price 6d.) on application to the auctioneers, Messrs. Wheatley Kirk, Price and Goulty, 49, Queen Victoria-street, London, E.C., and Albert-square, Manchester, or of Messrs. Smith, Beacock and Tannett, Victoria Foundry, Leeds.

APPOINTMENT.—Mr. J. Schneider has been appointed inspector of the aerial line system (from Buenos Ayres northward) and assistant electrician of the Central and South American Cable Company. Mr. Schneider was formerly in the India-Rubber Company's service.

APPOINTMENT VACANT.—An assistant in the physical department of the City and Guilds of London Technical College, Exhibition-road, S.W., is required. Salary £100 per annum. Applications to Prof. W. E. Ayrton.

DISSOLUTIONS OF PARTNERSHIP.—Messrs. Edwards and Barnes, hitherto carrying on business as metal founders and stampers at Broad-street, Birmingham, have dissolved partnership. Mr. H. C. Heard retires.

——— The partnership business of engineers and founders, hitherto carried on under the style of Peter Pilkington, at Accrington, has been dissolved. Debts by Mr. W. R. Pilkington, who continues.

NEW OFFICES.—Messrs. Julius Harvey and Co., engineers and contractors for electric light and other machinery, have opened offices at Mansion House-chambers, Queen Victoria-street, E.C.

REMOVAL.—Messrs. Oscar Moenich and Co. have removed their offices to Billiter House, Billiter-street, London, E.C.

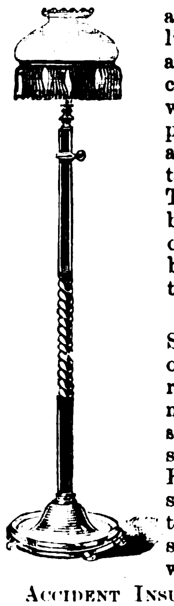
BANKRUPTCIES.—The first meeting of creditors in the bankruptcy of Dr. Joseph Whatmough, trading as an electrical engineer under the styles of D. J. Whatmough and J. and P. Dyer, and lately as W. Mason, at 39 and 41, Market-place, Oldham, will be held at the Official Receiver's office, Oldham, on October 2nd at 3 p.m. The examination of the bankrupt takes place at the County Court, Oldham, on October 18th, at 11 a.m.

——— The first meeting of creditors and contributories in the bankruptcy of Ronald A. Scott (Limited), lately carrying on business as electrical engineers at Acton, London, W., was held on Tuesday at the office of the Official Receiver for the Brentford district, Temple-chambers, E.C. As there was not a quorum at either meeting no resolutions could be passed, and the meetings were therefore adjourned for a fortnight. Afterwards the adjourned meeting of the creditors of Ronald A. Scott was held. In reply to a question as to what distinction there was between R. A. Scott and Ronald A. Scott (Limited), the Official Receiver stated that as Mr. Scott turned himself into a company in July, 1894, the creditors who had supplied goods after that date would have to prove against the Company instead of against R. A. Scott. Not that it made any difference, as in either case there was no prospect of a dividend being paid. The whole of the furniture and effects of R. A. Scott were taken over by the Company, so that he had now practically nothing ; and in the case of the Company, the whole of the assets were covered by certain debentures. In reply to questions, the debtor said he thought the Company had agreed to take over his liabilities as well as the assets. The reason he formed himself into a company was because his solicitors (Messrs. Reeves) told him it would facilitate further capital being put into the concern, and he did not form himself into a company for the purpose of giving further security to Messrs. Reeves and their clients in respect of money they had advanced. The debtor further stated that he only became aware of his insolvency in December last. In reply to a creditor, the Official Receiver stated the declaration of a dividend was not "within the range of practical politics." The debtor further stated that the Company had a lien on certain patents in connection with advertising by electricity, and if these could be sold for a reasonable sum everyone would be paid in full. This, however, is a somewhat remote possibility. The estate was left with the Official Receiver for summary administration.

LIQUIDATION.—The Official Receiver of the Worcester County Court (Mr. Luke Sharp) has issued his observations as to the liquidation of the New British Electrical Installation Contractors (Limited). The statement of accounts shows a deficiency of £4,722. 16s., plus £1,977. 12s. 2d. (added in respect of the Company's gross profits since its formation), a total of £6,700. 8s. 2d. After giving full details of the history of the concern, the secretary of the Company mainly attributed the failure to insufficiency of capital. The Official Receiver, while withholding his opinion as to the precise cause of the failure, points out that as the old Company had an authorised capital of £20,000, of which not one-twentieth part had been subscribed in cash, further information appears to be necessary as to why the new Company was ever formed. The unsecured liabilities appear to be principally for goods supplied. The Official Receiver adds that two or three of the principal creditors informed him that they were not, at the time of supplying the goods, aware that such goods were subject to the debentures immediately they reached the Company's premises. All the property is claimed by a receiver, who was appointed on behalf of the debenture-holders on July 19th last.—The first meeting of creditors takes place at 2:30 p.m. on October 1st, at the Official Receiver's office, Worcester. The contributories meeting takes place on the same day and at the same place, at 2:45 p.m.

BENNETT AND DRUCE.—This firm have recently installed the electric light at eight large sheds at the Salford Docks, at St. Joseph's Catholic Church, Preston, and at Col. Ormrod's mansion at Scorton, where a complete set of electric cooking and heating apparatus was also supplied. The firm have several smaller installations throughout the Lancashire district in hand, and have recently opened branch offices in Belfast.

BATTERY AND MOTOR COMPANY (LIMITED).—Mr. H. T. Barnett has resigned his position as joint Managing Director of this Company. Mr. Barnett will, however, continue to act as consulting electrician to the Company.



MOVABLE ELECTRIC LIGHT STANDARD.—The accompanying illustration represents a new electric light standard manufactured by Messrs Worsnop and Co., Halifax. The stand is strongly made, cheap and durable, and especially suitable for shop windows. The base is heavily weighted, so as to prevent any possibility of the lamp being overturned, and the supporting tube is of great strength and tapers from 3in. in diameter to 1in. at the top. The wire is run up the inside of the tube from the base, where it is connected by a flexible wire with one side of the window, so that the standard may be moved about at pleasure. The lamp is made in three sizes—4ft. 6in., 6ft., and 7ft. 6in.

NON-MAGNETIC WATCHES.—Messrs. S. Smith and Son, of 9, Strand, W.C., inform us that as a result of special care and attention which the firm have recently been paying to the production of non-magnetisable complicated watches, they have just succeeded in getting one of their 100-guinea split-second chronographs through the Class A tests at Kew. The tests are carried out in a special house some distance away from the observatory, so that the delicate instruments in the main building should not be affected by the very severe tests to which the watches are subjected.

ACCIDENT INSURANCE.—The Accident Insurance Company, of St. Swithin's-lane, E.C., send us a copy of their prospectus. This Company have made an important departure in insurance, as they now issue policies providing for compensation in the event of accident or disease. The Company also issue policies covering risk under the Employers' Liability Act, and act as a fidelity guarantee society.

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Agency.—Messrs. Girdlestone and Co., Davies-street, Berkeley-square, W., have been appointed sole London agents for Messrs. J. P. Hall and Co., of Oldham.

Aberdeen.—Trinity Hall, the home of the Incorporated Trades of Aberdeen, is now lighted electrically. The installation has been fitted up by Messrs. P. C. Middleton and Co., School Hill, Aberdeen, and consists of about 150 lights, varying from 8 c.p. to 50 c.p.

Asylum Lighting.—The work of installing the electric light at the Sunderland Borough Lunatic Asylum at Ryhope is now complete. About 700 incandescents are used. The generating plant consists of two direct-coupled Belliss engines and Parker dynamos, and a battery of D.P. accumulators has also been installed. The laundry machinery is driven by an electro-motor, and there are several other motors employed for ventilation and for distributing the hot air by which the various wards are heated. The electrical installation has been carried out by Messrs. Edmundsons (Limited) under the joint superintendence of Mr. G. T. Hine, the architect, and of Mr. A. A. C. Swinton, the consulting engineer. The boilers and heating apparatus were supplied by Messrs. Ashwell and Nesbit.

Bedford.—The Local Government Board have sanctioned the borrowing of a further sum of £27,000 by the Council for electric lighting purposes. At the last meeting of the Council it was stated that the demand for electric current was increasing in a highly gratifying manner, and the report of the Electric Lighting Committee, recommending extensions of the mains in various streets, was adopted.

Brighton.—The electric light continues to make very satisfactory progress in Brighton. The number of customers now on the books of the Corporation is 970, as compared with 720 in 1894, 336 in 1893, and 157 in 1892. The profit on last year's working was £9,800, or, with balance in hand, £10,100, of which £5,014 has been appropriated for the loan account. For some time past the Electric Light Committee have been busy extending their mains, erecting arc-lamp standards, &c., and when this extension work is complete Western-road, North-street, St. James's-street, Queen's-road, West-street, Preston-street, East-street, Old Steine, Marlborough-place and the London-road to New England-road, will all be lighted electrically, while the lighting of the Marine Parade will complete the line of lamps along the sea front.

Bristol.—Some material for sensational paragraphs was afforded the local papers by a slight accident at a transformer sub-station in St. James's Barton on Monday. According to Mr. Faraday Proctor's account of the matter, as told to a *Mercury* reporter, the mishap was of the most trifling description. The engineers were testing the new cables for the Stoke's Croft supply at three times their working pressure—that is to say, at 6,000 volts, before permanently joining them up. For the purpose of the test temporary wires were run across the St. James's Barton sub-station, and as it was thought possible there might be some breakdown, the covers of the chamber were left off, and a man was left to watch. Directly the pressure was applied the fuses went at the central station. At the same time a telephone message was received "that something had gone wrong," and that smoke was issuing from the manhole of the transformer chamber. Those in charge then went there and found that the temporary leads had broken down and fired some pieces of creosoted wood to which they were fastened. No damage was done to the transformers, and current was being delivered from the sub-station again by 7 p.m.

Central London Railway.—It is reported that plans of the Mansion House Subway, in connection with the Bank Station of the Central London Railway Company, will shortly be laid before the Commissioners of Sewers for their approval. Access for foot passengers will be provided from Princes-street, Mansion House-street, the Poultry, Queen Victoria-street, Walbrook, Mansion House-place, Lombard-street, Cornhill and Threadneedle-street. The Company intend to commence operations on this portion of the work, and by a special provision the Waterloo and City Railway will also have access to the subway. So far as is known at present, each train will be composed of seven cars, each capable of accommodating 56 passengers, and will be lighted throughout by electricity. The distance between the Bank Station and Shepherd's Bush will be traversed in 25 minutes. It is, however, expected that many months must elapse before the plans are finally approved.

Church Lighting.—St. George's Roman Catholic Cathedral, Southwark, will shortly be lighted electrically.——Messrs. Bennett and Druce recently installed the electric light at St. Joseph's Catholic Church, Preston.

City of London College.—The Michaelmas Term of this College (White-street, Moorfields, E.C.) commences on Monday next, the 30th inst. Classes in magnetism and electricity, mathematics, sound, light and heat, chemistry, &c., are held. Accommodation for practical work is also provided.

City of London Electric Lighting Company (Limited).—This Company announce that as it has been found that the scale set forth in their circular of January 31st last may be in contravention of clauses 19 and 20 of 45 and 46 Vic. (cap. 56) it has been cancelled, and the allowances (except the reduction in meter rentals) will not become operative.

Cork.—For some time past the Electric Lighting Committee have been considering the subject of the introduction of the electric light, but before they proceed further they wish to obtain the advice of an electrical expert. A special meeting of the Committee will be held on the 27th prox., when the notices of intention to apply for Provisional Orders given by the Cork Gas Consumers Company, the Cork Electric Light and Power Company, and the Electricity Supply Corporation of Ireland, will be discussed. At this meeting the question of the expediency of the Corporation applying for a Provisional Order will also be considered.

Denbigh.—At the last meeting of the Town Council the Mayor reported that the Manchester Edison-Swan Company had laid before him certain terms and conditions upon which they were willing to introduce the electric light into the town, and on the motion of Mr. Mellard the subject was referred to the Lighting Committee for consideration and report.

Douglas (Isle of Man).—In consequence of the enormous traffic between Douglas and Kirk Braddon, a number of influential local gentlemen have been considering the advisability of constructing a tramway between the two places. The proposers of the scheme have received a report from a firm of consulting engineers on the subject, and are assured that no difficulty stands in the way of the working of either an electric, cable, or horse tram service.

Dover.—The new school of science, art and technology, which has been erected by the Dover Corporation at a cost of £10,000, was opened on the 19th inst. The school is lighted throughout by electricity.

Dublin.—Several of the Directors and officials of the Dublin United Tramways Company have left for the United States to study the various systems of electric traction in that country with a view to introducing the best system of electric traction on the city tramways.

Edinburgh.—The Town Council have decided to extend their electric light mains to East London-street by way of Broughton-street, at a probable cost of £550. The question of introducing the electric light in Grassmarket and West Bow was remitted to the Cleansing and Lighting Committee for consideration and report.

Electric Traction in Spain.—An application has been made for a 60-year concession to construct and operate an electric tramway between Cadiz, San Fernando and Chiclana.

Electric Traction on the North Staffordshire Tramways.—A deputation of some 20 gentlemen, including the Mayors of Stoke-on-Trent and Longton, and the representatives of the Hanley and Burslem Town Councils, and other local authorities in the Potteries, is visiting Havre for the purpose of inspecting the system of electric traction adopted by the tramways in that town, with a view to the introduction of the system on the North Staffordshire Tramways, which serve the Potteries.

Enfield.—At the last meeting of the District Council a letter was read from Mr. T. Ellis, of Bycullah Park, stating that he was acting on behalf of a company which is being formed for the purpose of supplying electric current to Enfield, and requesting the Council to support their application to the Board of Trade for a Provisional Order. The Chairman said that if the Council should decide to adopt a refuse destructor scheme it might be advisable for the Council to keep the electric lighting powers in their own hands, and on his suggestion the letter was referred to the General Purposes Committee for consideration and report. In the meantime Mr. Ellis is to be asked to give details of his scheme.

Fire.—It is stated that the electricity pavilion at the Bordeaux Exhibition has been totally destroyed by fire, caused by the explosion of a gas engine.

Fire Prevention.—The United Asbestos Company, Dock House, Billiter-street, E.C., write to say that the serious results arising from such deplorable accidents as that which recently occurred on the s.s. "Iona" might be greatly minimised, or prevented, by covering the partitions and ceilings of the various compartments with asbestos "Salamander" embossed decorations, or lining them with asbestos millboard, or constructing them entirely of specially-prepared asbestos, and thus preventing the fire spreading beyond the compartment where it occurred. These suggestions also apply to buildings, and particularly to warehouses, stores, factories and workshops, where the contents render the chances of fire great.

Glenisla.—A meeting of local influential gentlemen was held at Glenisla last week for the purpose of considering the proposal to construct a light railway from Alyth to Glenisla and Braemar, to decide the gauge of the line and the motive power to be adopted. Mr. Japp said that he thought the proposal a feasible one. It had been estimated in 1881 that the line would cost about £150,000, but the chief question for them to consider was whether, in face of the great progress which electricity had made, they ought not to

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adopt it as the motive power. Mr. W. S. Barber Starkey, of Knockshandoch, read a letter from a firm of electrical engineers, who stated that there should be no difficulty in introducing the overhead conductor system on a 15-mile light railway, and by employing this system the cost of running should be materially less than by steam locomotives. Resolutions appointing a committee to make the requisite arrangements with the view of promoting the scheme, and pledging the meeting to promote the same, were adopted.

Hampstead (London, N.W.).—At the last meeting of the Vestry the Lighting Committee reported that the Vestry Clerk had taken proceedings against the London and Hampstead Battery Company for non-compliance with the London County Council's bye-laws, under the London Overhead Wires Act, with reference to the wires placed by them over and along the streets of the parish. The Company, however, undertook to comply with the bye-laws, and on this condition the summons was withdrawn. The Committee also reported that they had authorised their engineer to expend £2,343 in providing additional machinery for the electricity station. The engineer has also been empowered to order certain materials, including a number of house service boxes at 35s. each. The Vestry have hitherto paid £3. 16s. each for these boxes. The Committee further reported that they had given instructions that no pupils or improvers were to be employed at the electricity station in future, and that they had insured their entire staff against accident, the insurance covering injuries arising from electric shock. The report was approved, and instructions were given to obtain an electric motor for driving the chaff-cutting machine at the stone-yard at a cost of £24. 3s. 9d., and, on the motion of Major-Gen. Young, it was also decided to fix a Blackman electrically-propelled ventilating fan in the Board room.

Hastings.—The following letter from Mr. L. Andrews, Managing Engineer of the Hastings Electric Light Company, appears in the *Hastings Times* of the 21st inst. :—

Sir: We saw in the report of the Hastings Gas Company, published in your issue of the 7th inst., that Dr. Gray is said to have stated that for electricity to compare favourably with gas it must be reduced in price to 3d. per unit. Although we have never actually tested the light-giving properties of Hastings gas as compared with electric light, we had always understood from experiments that had been made in other towns that, with gas at 3s. per 1,000 cubic ft. and electric light at 6d. per unit, the total cost for a given amount of light would be practically the same. In order to see which of these statements was correct, we have had fitted up at the works seven Bray gas burners on one side of a room, and a 200 c.p. Ediswan electric lamp on the other side. By means of a Bunsen grease spot photometer the light was adjusted until it was equal from each source. These were left burning for two hours, from 9 p.m. to 11 p.m., and careful measurements taken of the gas and electricity consumed. It was found that 142·2 cubic ft. of gas had been used—this at 3s. per 1,000 cubic ft. is about 5d., whereas the electricity meter showed that only 0·76 units had been used. In order to bring the total cost up to the same as that of the gas it will be necessary to reckon the electricity at 6½d. per unit instead of 3d., as stated in the gas report. Dr. Gray will be interested to know that several of our customers will not pay on an average more than 6d. per unit for their current used during this half-year, whereas many, profiting by our new system of charging, are replacing gas lamps with electric lamps, for which they will not pay more than 4d. per unit for the current used. From this it is obvious that in many cases it will be necessary for the Gas Company to further reduce the price of gas to 2s. per 1,000 cubic ft. before they can compare favourably with the present price of electricity. We shall be pleased to repeat the above experiments in the presence of Dr. Gray, or any others whom they may interest.—Yours faithfully, L. Andrews.

As the *Hastings Times* remarks, "but for the cost of electric light wiring the Gas Company would soon be brought to reason."

Huddersfield.—A sub-committee has been appointed to consider the subject of letting out electric motors and heating and cooking appliances on hire, together with the prices to be charged therefor.

Hull.—Mr. Rienzi Walton will hold a Local Government Board on Thursday next, into the application of the Town Council for sanction to borrow £8,000 for electric lighting extensions.——The Electric Lighting Committee have received 57 applications for the position of borough electrical engineer. The Sub-Committee are to select 3 names for submitting to the Council, in whose hands the final appointment rests.

Killarney.—The public auditor (Mr. J. Calvert) recently held an audit of the accounts of the Town Commissioners. The decision as to the legality of the payments made by the Commissioners for gas and electric lighting was reserved for six weeks.

Leicester.—The accounts just presented to the Corporation by the Gas and Electric Lighting Committee show that the result of the last half-year's working is a loss of £951. 14s., after allowing for £588 appropriated for sinking fund purposes and £268. 3s. 1d. profit on the electric light fitting department. The total loss for the year is £1,142. 10s. 6d. At the last meeting of the Town Council a memorial from the local electric light wiring contractors against the competition of the Electric Lighting Committee in connection with electric light fitting, was presented. The memorialists urged that the competition threatened to overwhelm their business and was stifling that healthy trade competition which would otherwise exist for the benefit of the public. They further prayed that the Committee might be instructed to refrain from such competition in future. The petition was referred to the Committee for consideration and report.

Liverpool.—The Liverpool Electric Supply Company (Limited) agree to postpone the completion of the purchase of their undertaking on condition that the same is completed within six weeks from the date of the Act of Parliament authorising the purchase, and providing the Act is passed next year.

Nottingham.—On the invitation of Sir John Turney (Chairman of the Electric Lighting Committee), several members and officials of the Corporation attended at the electricity station on Friday last to hear an account of the progress made by the electric light during the first year of working. Sir John stated that their total capital expenditure to date amounted to £48,633. The complete figures for the year were not yet available, but their receipts for the first nine months amounted to £2,090. 18s. 9d. The cost of generating the current had been £1,383. 16s. 4d., leaving a gross profit of £707. 2s. 5d. £1,355 had been set aside for interest, sinking fund, &c., and thus there was an actual deficiency of £647. 17s. 7d. for the nine months, but he believed that when the figures for the last quarter of the year were forthcoming it would be found that there would have been no deficiency. He also said there had not been the slightest hitch or breakdown during the year, and that the demand for current was increasing in a most satisfactory manner; they were at present supplying electric current to an equivalent of 13,547 8 c.p. lamps, and he had no doubt that next year they would be able to show a fair profit. They had already laid 12 miles of cables, and he anticipated that they would lay down as many more during the ensuing year. The Mayor complimented Sir John Turney on the result of his labours, and presented him with a gold key as a memento of the work. In returning thanks Sir John compared the progress made in this country in electric traction and in the United States, and trusted that they would shortly have electric tramways in the town.

Oldham.—At the last meeting of the Electric Lighting Committee the borough electrical engineer (Mr. S. Wilmott Newington) stated that 261 additional lamps had been connected to the mains during the month, and that they had now practically reached the limit of the capacity of their present plant. It was also decided to reduce the meter rent to 10 per cent. on the cost of the meters.

Telegraphic Delays.—At a specially-convened meeting of the Home Affairs Committee of the Glasgow Chamber of Commerce on Monday, the question of the alleged insufficient telegraphic communication between Glasgow and London was discussed, and it was unanimously agreed to make strong representation to the Postmaster-General to provide adequate and increased telegraphic facilities. A memorial to this effect will be at once presented.

Telegraphic Extensions in Japan.—The Japanese Government has ordered 800 miles of submarine cable from the Telegraph Construction and Maintenance Company. It is understood that this is intended for effecting telegraphic communication between Japan and Formosa. The Japanese have determined to lay this cable themselves, and it will be shipped to them in sealed tanks by chartered ships. As reported recently in our columns, the Japanese Government are having a cable ship built at the shipbuilding yards of Messrs. Lobnitz and Co., of Renfrew. This ship will be fitted with the most modern cable-laying gear by Messrs. Johnson and Phillips, so that the Japanese will shortly be able to lay and repair their own cables.

Theatre and Music Hall Lighting.—The New County Theatre, Reading, is lighted throughout by electricity.——The Empire Palace Music Hall, Sheffield, at present in course of erection, will also be lighted electrically. Current will be obtained from the Sheffield Electric Light and Power Company.

Tipton.—At the last meeting of the District Council a letter was read from the Board of Trade in reply to a communication from the South Staffordshire Tramways Company as to the introduction of an improved system of traction on their lines. The Board stated that they were unable to regard as satisfactory the circumstances under which the Company's application for a further renewal of the authority to use steam on a portion of their lines was made. They had frequently sanctioned the use of steam, notwithstanding the objections of local and road authorities, in the hope and assurance that an improved system of traction would be introduced within a reasonable period. The Company had made little progress in this direction, and were unable to show that there was any definite prospect of any possible arrangements in this respect. Under these circumstances the Board doubted whether they were justified in granting any further extension, but having regard to the consensus of local opinion, that it would be detrimental to the public if the tramway ceased to work, they had decided to give a final opportunity to the Company of providing a proper system of traction. They therefore enclosed an order for authority to use steam until

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the end of the year. No application for a further extension would be considered unless the Company were able to satisfy the Board that arrangements for improved traction were actually in progress, or the local and road authorities supported the application, giving adequate reasons therefor. The subject was debated at some length by the members of the Council, and finally a motion that the Council object to the Company using steam power after the expiry of the extension allowed by the Board of Trade, was passed.

TUNBRIDGE WELLS.—Major-Gen. C. Phipps Carey held a Local Government inquiry at the Town Hall on Tuesday into the Council's application for power to borrow a further sum of £12,000 for electric light extensions. It was stated that the electric lighting scheme had proved a great success, no fewer than 3,500 lights having been applied for. Mr. Preece gave details of the proposed extensions, and there was no opposition to the loan.——The Town Hall was lighted by electricity for the first time on the 19th instant. The electricity works will be formally opened early next month by Lady Salomons.

COMPANIES' MEETINGS AND REPORTS.

Brush Electrical Engineering Company (Limited).

The sixth annual general meeting of this Company was held at the Cannon-street Hotel on Monday, under the presidency of Mr. J. B. Braithwaite, jun.

The SECRETARY (Mr. Broadhurst) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN: Before moving the adoption of the report and accounts it will be my pleasure to make a few remarks upon the balance sheet, the profit and loss account, and upon the general prospects of the Company. Taking first the balance sheet, and looking at the debit side of it, you will see that there has been no change during the year in the amount of the capital of the Company, which still remains at £450,000 of share capital and £125,000 of Debenture stock. The creditors have been reduced during the year from £72,324 to £44,888, showing a reduction of about £27,000. The loans and overdrafts from bankers have increased from £25,000 to £78,000. Provision for depreciation on property, patents and goodwill account remains as last year, and the items of profit and loss account, which follow, are fully dealt with in the report. The contingent liability in respect of uncalled capital has been reduced from £39,697 to £5,547, so practically it disappears, because the £5,547 remaining is not likely to be called up. On the credit side the item of property, patents and goodwill has been increased by additions to plant during the year by £2,487, and, after deducting the usual sum for amortisation of lease of the Borough-road premises, stands at £238,374. Stock in hand stands at £100,800, and the item of debtors stands at £141,400. Cash at call, at bankers and in hand, amounts to £3,910. Shares and debentures with other companies at cost, less amounts written off, amount to £61,236. Liquidators' balances and suspense accounts is an item standing at £1,963, and the balance of foreign and colonial branches accounts stands at £104,305. The chief item probably which will attract your attention in this balance sheet is the increase of the loan from bankers from £25,000 to £78,000. That has arisen from the two items to which I will call your attention. £27,000 of it is the result of reducing the amount due to our creditors from £72,000 to £44,888, and the remaining amount is due to the increase of our shares and debentures in other companies. It practically represents the difference between the £39,697 liability on shares we had last year and the £5,547 which we now have. Those calls have all been paid up during the year, and it is those items which account for the increase of our loans from the bankers. I will just turn to the profit and loss account for a moment, and there you will see that the gross profit for this year has been £37,853, being, as we have mentioned in the report, a decrease of close upon £20,000 from the figures of last year. That amount, as we have already mentioned in the report, is due entirely to the difficulties which have occurred in connection with our contract with the City of London Electric Lighting Company, to which I will refer more particularly later on. On the other hand, the general charges stand at £17,027, against £19,974 last year. The maintenance of buildings and plant has cost £2,708, and you will observe at the foot of the page the certificate of our engineer that the buildings and plant under his supervision have been maintained in an efficient condition during the year ended June 30, 1895. There is no other item of interest, I think, in the profit and loss account except the amount of bank interest and commission, £2,227, which will disappear on the issue of the additional amount of Debenture stock which we are now proposing to make. Now, with respect to this issue of Debenture stock, I stated last year that the loan of £25,000 from the bank was likely to be only a temporary matter, and that, therefore, it was not worth while to issue additional capital to liquidate it. All that I said last year with respect to that matter applies with equal force to the amount we now owe our bankers of £78,000, and for that reason we do not propose to make any permanent addition to the capital of the Company. I think you will see from the figures I am going to give you that it would be unwise to saddle ourselves permanently with additional capital, and we propose to issue this amount of £105,000 as Redeemable Second Debenture stock. On the other side of our balance sheet we have assets more or less liquid which might come in in the form of cash—shares £61,000, balance of debtors over creditors £96,000, and stock £100,000, making a total of £257,000. Of course, I hope we shall not see anything like the whole of that sum come in in cash, because if we did realise the whole of our stock, and the whole of the difference between our debtors and creditors, it would mean that our business had practically come to an end; but at the same time the balance of debtors over creditors is very much larger than it would be in a normal year's trading, owing to the fact I mentioned last year of the heavy retention funds which are kept in connection with some of our municipal contracts. I think it is easy to suppose, however, that the £96,000 might be reduced to £50,000, and in that way we should get in about £50,000. That, in addition to the shares and debentures which are constantly in course of realisation, would give us sufficient to redeem the whole of this £105,000 which we propose to issue. In view, therefore, of the undesirability of burdening the Company with any issue of capital which we should have no power to redeem in the future, we propose to make the new Debenture stock redeemable at 105 per cent. at any time on six months' notice. That being so, I think you will agree that it is wise to make this issue so as to pay off our bankers and give us that amount of cash in hand which a company of our standing ought to possess. At the same time it is more than probable, unless some very unexpected expansion of our business takes place, that in the course of the next two or three years the whole or a considerable portion of that Debenture stock will be redeemed. There is one other matter connected with the balance sheet to which I ought to refer—that is, the position of the Preference shareholders. You will see from the report that we are of opinion that the Preference shareholders are entitled to the whole of the profit made during the past year up to an amount sufficient to pay their full dividend. The net profits are, unfortunately, not sufficient to pay the full dividend of 6 per cent. on the Preference shares, but they are sufficient to allow of the division of a sum of a little over £2,000, and that distribution we propose to make among them at the earliest possible date. Under our Articles of Association the Preference shares are cumulative as regards the year, but not as regards subsequent years. I mean that they are a first charge over the Ordinary shares to the extent of their full dividend on the profits of the year, but they are not cumulative from one year to another year. During this year we have earned £7,541, out of which they have received £5,400, so that another sum of about £2,000 is due to the Preference shareholders, which I hope they will receive next year in addition to their ordinary 6 per cent. I do not know that there is any other item in the balance sheet or profit and loss account specially calling for notice. I will therefore turn to other matters connected with the Company, and, of course, the first question you will want to hear about is the circumstances in connection with the contract with the City of London Electric Lighting Company which have turned what would have been the best year in the Company's existence into the worst, unfortunately. That only illustrates the disadvantages in some ways of having contracts of such very great magnitude, but it may be a satisfaction to the shareholders to know that apart from the City of London Electric Lighting Company's contract, the past year has been the best in the history of the Company. We have made more profit than we ever made before apart from that one contract. It is due to the shareholders to know that, as otherwise they might consider this large drop in the profits as due to a falling-off of our business generally, or to our not being able to conduct the business at a profit. That, however, is no the case, the decrease being entirely owing to extraordinary circumstances connected with the City of London Electric Company's contract I do not know that it is for me to go into detail about it (cries of Yes). I do not think I am at liberty to go into exact details; but I think I can give you in general terms sufficient information to understand the position. The contract with the City of London Electric Lighting Company was one of considerable magnitude, amounting to something like £300,000, and under that contract the decision of all points connected with it was left absolutely to the engineer of the City of London Electric Lighting Company for the time being. That is a usual provision, and would have been satisfactory under ordinary circumstances; but we have been unfortunate enough to have no fewer than three engineers to deal with during that contract, each of whom has become practically supreme judge as to whether the contract was being carried out to his satisfaction. I need not tell you that among electrical engineers each has his particular views, so you will understand that the change of engineers, which took place in the City of London Company in December of last year, was a very unfortunate thing for us when it turned out that the new engineer had very different views of what the obligations under the contract were from those of his predecessor. We have done the very best under the difficult circumstances in which we were placed. In view of the fact that the engineer of the City of London Company is made supreme judge, there was practically no alternative for us but to accept the altered view of what were the obligations under the contract or to resort to an expensive or ruinous lawsuit. I do hope that you will give us credit for making the best arrangements we could under the circumstances, although the result has been to have a serious effect on our profits for the past year. We have tried to adjust matters with the new engineer of the City of London Company on the basis he wished, and that has been accomplished, and work under the contract is again proceeding. With respect to the general business of the Company, we are in the fortunate position of having our works fully occupied with orders for some months in advance. During the year we have carried out and opened central stations for electric lighting for the municipalities of Worcester and Leicester; and we have also opened for the County of London and Brush Provincial Company a station for the supply of Dover. All these have turned out entirely satisfactory, and we have work of a similar character in hand for St. Luke's, for Clerkenwell, and for the Wandsworth district for the County of London and Brush Provincial Company and various other stations up and down the country. As regards our electrical shops, therefore, we have plenty of work in hand; and with respect to our car shops we are also full of orders at the present time. We have been building locomotives for the Beira Railway, which is being constructed for the opening up of South Africa; and we have also in hand a large number of cars for the Rouen Tramways Company, which

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has been equipped with electricity. Then, with respect to the engine-building side of our works, we have carried out a considerable number of orders. As you will see from the report, we have already sold about 35,000 H.P. of engines, and our chief engineer, Mr. Raworth, has just introduced a new enclosed high-speed engine, from which we hope great things in the future. This is an engine which will be equally suited for electrical work and all other kinds of work to which steam engines are generally put, and we hope it will bring considerable additional orders into our engine shop, and give us an engine which we can manufacture at a very satisfactory profit. That is our chief duty to our shareholders after all—to find articles which we can manufacture, in the present severe state of competition, at a reasonable profit. We believe that will be the case in this instance. The question of electric traction is occupying our attention very much, and we must all feel—we who read the daily newspapers, and know what is going on with respect to electric traction—that that is the thing we must look to very largely in the future to keep our electrical engine shops full in this country. Up to the present time electric traction in Great Britain has been practically a dead letter. If, however, you go to the United States of America, to Canada, or many other places, you will find quite small villages have their electric tramways and railways. I suppose that in the States there are now thousands of miles of tramways worked by electricity, whereas in this country the electrical tramways now opened can be counted on the fingers of one hand. At the same time, the thin end of the wedge has been introduced in this country, and no doubt when the three or four tramway works now in course of construction are opened, and the public realise the immense convenience and acceleration of travelling which are due to the adoption of electricity for working the tramways, we shall see, I believe, a very great rush of electrical tramway business in this country. With regard to the working of railways by electricity, we have in England two systems worked entirely by electricity—the City and South London Railway, running out to Stockwell, and the Liverpool Overhead Railway, both of which are working satisfactorily. There are two other important railways in course of construction under our streets. One is the Waterloo and City line, and the other the Central London Railway, which will run from the City up to Shepherd's Bush, through Holborn and Oxford-street; therefore, even in this country, electric traction is taking hold, and when we read in the American papers the accounts of the first locomotive that has been built for handling main-line traffic, I think we must see the great possibilities there are for electric traction. The first locomotive turned out for the Baltimore and Ohio Railroad Company has drawn a freight train weighing 1,200 tons at 15 miles an hour, and on a speed test is reported the other day to have attained a speed of 61 miles an hour without any difficulty. I think we may see, therefore, that the electrical industry has an enormous future before it in the direction of electric traction. As regards electric lighting, that is not likely to retrograde; but electric traction is in this country comparatively a new field, and I look in this direction for a very large amount of business in the future. I do not think there is any other matter to which I need call attention except this—that in view of the position in which the Company is placed by these unprecedented circumstances with regard to the City of London Electric Lighting Company's contract, my colleagues and myself feel that it would be the right thing for us in the ensuing year to forego half our fees. That, I think, will indicate our desire to do our best for the Company in every way; and we therefore propose for the ensuing year to take only half the fees to which we are entitled under the Articles of Association. I shall be exceedingly happy, after the adoption of the report has been seconded, to answer any questions I rightly can, and give any information which I have failed to impart in the remarks I have already made (applause).

Mr. B. H. VAN TROMP: I have much pleasure in seconding the motion.

The CHAIRMAN: The motion is—

"That the report of the Directors and statement of accounts to June 30, 1895, now presented to the shareholders, be received, and that the same be hereby adopted."

Mr. WARD desired to know whether the Chairman and the Directors endorsed the statement in the auditors' certificate, that the shares and debentures in other companies held by this Company were "of the full value stated in the accounts." It was of considerable moment to the shareholders to know whether the shares, represented at £61,000, were of that value or anything approaching it. He regarded the present report as the most unsatisfactory that had ever been issued to the shareholders. With a trading company one naturally expected every now and then to have losses; one year they would make a large profit, but in another year they would have a loss. In their own case the loss which had been sustained had not been in ordinary trade matters, and he could not help thinking that the Directors made a considerable blunder in agreeing that in the event of any difference arising in connection with the contract with the City of London Company the matter should be referred to the engineer of that Company, for which they were doing the work. He had never heard of such an arrangement. Usually each party appointed an umpire, and in the event of any difference arising another umpire was appointed to settle it. Although one was glad to hear from the Chairman that they had entered into various other contracts, one was anxious to know whether they contained some stipulation similar to that in the contract with the City of London Company. He hoped the Directors would be very careful in the future in seeing how the contracts were drawn up and signed. He had been very glad to hear the Chairman say that the Directors would next year forego half their fees.

Mr. LAMONT asked if the Chairman could throw any light on the fact that for two or three weeks before the issue of the Directors' report the shares were going down.

Mr. McLEAN asked how it was that, while enough profit had not been made to supply the Preference shareholders with their dividend, £6,750 had been divided among the Ordinary shareholders for the first six months of the year. He wished to know if the item of £5,385 standing on the debit side of the balance sheet against provision for depreciation on property, patents and goodwill account, was for the present year, or was a standing account, or if any portion of it was for the present year.

The CHAIRMAN: With regard to the question which was put by Mr. Ward, I think, with reference to the shares and debentures we hold in other companies, that is a matter which, as he says, is a very important one naturally, to the stability of the balance sheet, and it is a matter to which we have given very great attention, as have also the auditors. Rather more than half of the amount—something like £35,000 out of the £61,000—are shares quoted on the London Stock Exchange; and with respect to those I may say that, personally, I shall be considerably disappointed if when we realise them we do not make a substantial profit of £3,000 or £4,000 on their sale. With respect to the remainder—say £25,000—they are shares and debentures mostly in connection with undertakings in which we have been interested in the past. I think I may say that in every case those undertakings are in an improving position, and in many cases we are in receipt of dividends from them. In the case of similar undertakings, which stood in our books for some time past, we have sold the shares in the past year, and realised a satisfactory profit on the transaction. Some of these shares are valuable to us apart from their actual market value, as they give us a controlling interest in companies which supply us with orders. Answering Mr. Ward's question, I think I may say that after anxious consideration about it, the Board believe that they are well worth the figure standing in the balance-sheet. With reference to the conditions in the contract with the City of London Company, I was not responsible for negotiating that contract; that was in the days before I was Chairman of the Company. At the same time, I think it very probable that I should have done the same thing had I been in the position of our then manager, as it was impossible, I think, to foresee that there would be three new engineers of the City of London Company in as many years; and the circumstances are so extraordinary and unprecedented that I do not think any reasonable amount of foresight exercised four or five years ago could have avoided the difficulties in question. At the same time, I quite agree that it is a most unsatisfactory form in which these contracts are drawn up, but it is the usual form. If we did not take the contracts on these terms our competitors would do so; and I am not sure that it would not be well if they did do so in some cases. I may, however, say, with reference to the other contracts in hand, that we have no indication at present of any difficulties arising similar to those connected with the City of London Company. Our manager tells me that we have carried out a number of similar contracts without any difficulty, but in those cases we did not have changes in the engineers. That has been the real difficulty. A gentleman remarked very properly on a fact that has given extreme annoyance to the managers and the Board, and to myself particularly, of there having been some leaking out of the purport of our report. We are investigating this matter, but so far we have been unable to trace anything. It is very annoying to those who are connected with the conduct of the Company, as it would seem that "those in the know" have been taking steps to realise at better prices than they could have done after the issue of the report. I do not think I need assure the shareholders that neither my colleagues nor myself have done anything in this direction. All that I have done has been to increase my holding on the drop which took place in the shares, which have fallen, I believe, to very much below their intrinsic value. With regard to the question of Mr. McLean, with reference to the interim dividend, the shareholders will realise from what I have said, and from the report, that at the time we paid the last interim dividend, everything was proceeding entirely satisfactorily with us. We had a most careful balance sheet and statement prepared, showing that an interim dividend both on the Preferred and the Ordinary shares had been fully earned, and under these circumstances, following the practice of previous years, we thought it right to pay it. The whole of the loss has been in the second half of the year, and has been owing entirely to the extraordinary claim put forward by the new engineer of the City of London Company. I imagine it will be the view of the shareholders in the future that we should not pay any interim dividend on the Ordinary shares, although we shall, unless you instruct us to the contrary, pay an interim dividend on the Preference shares if the circumstances warrant it. Probably as regards the Ordinary shares, it will be better to wait for the completion of the year. Unless any gentleman has any other remark to make or question to ask, I will now put the motion.

A SHAREHOLDER inquired how much longer the contract with the City of London Company had to run.

The CHAIRMAN: There is no definite period named for the completion of the contract with the City of London Company. That Company are bound to order from us their plant for the supply of the western and central districts of the City, but there is no period within which they are bound to give us those orders.

Mr. WARD: We have representatives on the Board of the City of London Company.

The CHAIRMAN: We have none at present. We had two—the late Duke of Marlborough, who was then Chairman of this Company—and myself. On the Duke's sudden death no effort was made by the City of London Company to replace him. That left me alone to represent this Company on that Board, from which I have felt it my duty to withdraw, not specially in connection with our contract, although I think we have been badly treated by them in that matter, but because I dissent from the policy their present engineer is carrying out in the interests of the City of London Company itself.

Mr. McLEAN asked what proportion of the sum set against depreciation on the debit side of the balance sheet had been set aside this year.

The CHAIRMAN: That is the same amount as stood there last year. He then put the resolution, and declared it carried *nem. con.*

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On the motion of Mr. VAN TROMP, seconded by Mr. GEORGE RICHARDSON, a shareholder, Mr. Edward Woods and Mr. A. Ayres, the retiring Directors, were re-elected to their seats at the Board; and the auditors, Messrs. Cooper Brothers, were also reappointed.

In answer to a question by Mr. LAMONT as to Mr. Raworth's high-speed engine,

The CHAIRMAN said: Under our agreements all patents taken out by our officers are offered to the Company first, and we pay nothing for them. All the payments made are by way of royalty on the sales.

Mr. FRY proposed a vote of thanks to the Chairman and Directors. They would not, he pointed out, meet in the ordinary course for another twelvemonth; but could not the Directors in some way meet them or send out a circular at the end of the half-year—next January or February—and give them some information as to the position of the Company?

The motion having been seconded and agreed to,

The CHAIRMAN said: It is not usual to hold a meeting unless you can present accounts, and in a company like ours that would mean an interruption of our factories for two or three weeks, which would be very serious if repeated more than once a year. As to sending out a circular to the shareholders when we have anything important to communicate, it is a valuable suggestion, and if we can do so at the end of the six months we will do so. We are very much obliged to you for your vote of thanks, which is greatly appreciated at a time like this.

The proceedings then terminated.

Halifax and Bermudas Cable Company (Limited).

The sixth annual general meeting of the shareholders of this Company was held on Tuesday last, at the offices of the Company, 33, Old Broad-street, London, E.C. The Directors' report and accounts for the year ended June 30, 1895, were unanimously adopted, and the retiring Directors (Messrs. Thomas Skinner and T. G. H. Glynn), as well as the auditors (Messrs. Gribbon and Holroyd), were re-elected.

The Directors' report states that the cable receipts for the past year amounted to £4,203. 7s. 10d., as compared with £3,462. 17s. 7d. for the previous year. This increase is attributed to the improvement in the general business condition of the Bermudas. As a result of the year's working there is a profit of £1,023. 9s. 8d., as compared with £328. 16s. 4d. for 1893-94, this reducing the debit to capital to £3,870. 5s. 4d.

The report also states that the Company's cable has worked with complete efficiency throughout the year, and its electrical condition continues excellent.

The Directors also report that they have obtained the assent of all the holders of the Company's debentures to such a modification of the Trust Deed as permits of the application of the sinking fund to purchases or drawings. Accordingly offers for the sale of debentures to the Trustees were invited in June last, when £11,200 of the Four and a-Half per Cent. First Mortgage Debentures were acquired and cancelled at a cost of £10,216. It is intended to apply the sinking fund half-yearly, viz., in June and December. The reduction of the capital outstanding, resulting from this operation, permits of the extinguishing of the debit to capital account of £3,870. 5s. 4d., and the writing down of the capital expenditure by £7,329. 14s. 8d.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1895, pages *304-332, &c., &c.*

CRYSTAL ELECTRIC LAMP COMPANY (LIMITED).—This Company was registered on September 17th with a capital of £15,000, in £5 shares, to enter into an agreement with James W. Rogers, electrician, of Highgate, London, N., to carry on the business of an electric light company in all or any of its branches, and to carry on business as electricians, electrical and mechanical engineers, manufacturers of and dealers in electric lamps and electrical apparatus and appliances. The subscribers, with one share each, are: James W. Rogers, F. Naylor, H. J. Gibbs, J. Wiggins, J. H. Smeed, W. W. Smith, and G. Hawkins. The first Directors are James W. Rogers, H. J. Gibbs and F. Naylor.

LANCASTER AND TONGE (LIMITED).—This Company was registered on September 17th with a capital of £30,000, in 50 £5 per cent. Preference shares of £100 each and 250 Ordinary shares of similar value, to acquire and carry on the business of an engineer, metal founder, millwright, boiler maker, &c., now carried on by R. F. C. Tonge under the style of "Lancaster and Tonge," Pendleton, Lancs.

LITHANODE ELECTRIC STORAGE COMPANY (LIMITED).—This Company was registered on September 23rd with a capital of £12,000, in £1 shares, to acquire and take over as a going concern the business carried on by the Lithanode and General Electric Lighting Company (Limited) (in liquidation), at Millbank-street, London, S.W., to enter into agreements with the said Lithanode and General Electric Lighting Company (Limited) and its liquidator, and with J. T. Niblett, and to carry on the business of electricians, mechanical and electrical engineers, electrical instrument makers, lamp manufacturers, manufacturing chemists, contractors for public and private works, and the general business of an electric, gas and other light company in all or any of its branches. The subscribers, with one share each, are: E. G. Dakin, J. H. Matthews, F. Stuttaford, R. A. Dawson, W. J. Cooling, H. W. Roach, W. R. Elston.

ROUND'S ACCUMULATOR COMPANY (LIMITED).—This Company was registered on September 17th with a capital of £10,000, in £1 shares, to enter into a proposed agreement between Benjamin Round and E. Lester, W Topham and J. Hancock, to generate, accumulate, distribute and supply electricity, compressed air or any other force or power; to construct, lay down, establish, fix and carry out all necessary accumulators, cables, wires, lines, lamps and works, and to carry on the business of electricians, electrical contractors, mechanical engineers, and manufacturers and suppliers of and dealers in electricity and compressed air. The subscribers, with one share each, are: J. Leah, engineer; W. J. Warrilow, J. K. Frost, J. Stafford, A. Woolmer, M. Round, and F. P. Burt.

CITY NOTES.

MEMORANDA.—Bank rate, 2 per cent. (Feb. 22, 1894). Price of silver, 30$\frac{3}{16}$d. per oz. (Sept. 26th). Consols (2$\frac{3}{4}$ per cent.) 107$\frac{11}{16}$—107$\frac{13}{16}$ for money, 107$\frac{3}{4}$—107$\frac{7}{8}$ for account (Sept. 26th); 2$\frac{1}{2}$ per cent. 106$\frac{1}{8}$—106$\frac{3}{8}$. Stock Exchange Settling Days: Consols, Oct. 1st; Stocks and Shares Continuation Day, Oct. 14th; Ticket Day, Oct. 15th; Pay Day, Oct. 16th; Mining Shares Carry-over Day, Oct. 12th.

BIRMINGHAM ELECTRIC SUPPLY COMPANY (LIMITED).—At the last general meeting of this Company resolutions were passed increasing the capital of the Company by £100,000, divided into 20,000 shares of £5 each. The Directors now offer 10,000 of these shares for subscription. The new capital is to be issued at a premium of 5s. a share, and will in the first instance be offered to the present shareholders in the proportion of one new share for every two existing shares.

BUDAPEST TRAMWAY COMPANY.—To meet the expenses in connection with the conversion of their horse tramways into electric tramways, for which the concession was received some time ago, the Company is about to increase their original share capital of 3½ million florins by 2 million florins (£200,000).

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended September 22nd were £831, against £835 in the corresponding week of 1894, a decrease of £4. The total receipts for half-year amount to £10,148, against £10,238 for the corresponding period of 1894, a decrease of £90.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—We are informed that Mr. Joseph Bevan Braithwaite, jun., has resigned his seat on the Board of Directors of this Company.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 22nd inst. amounted to £1,239. The amount for the corresponding week last year was £955; increase, £284.

RAND CENTRAL ORE REDUCTION COMPANY (LIMITED).—The annual meeting of this Company was held on Monday last when the directors' report and accounts were passed. The Directors' report states that during the year 357,000 tons of ore were treated, at an average cost of £3. 10s. 5d. per ton, and the actual extraction of gold was 71·6 per cent. The total expenditure for the year, including £45,224 on new works, buildings, and plant, and £1,899 for experimental work, was £90,197, while the receipts amounted to £85,722. The Company has acquired a half-interest in the Siemens and Halske patent for the precipitation of gold by electricity. The Directors express their satisfaction at the progress made with this process during the year, and state that the economy and general advantages of the process are daily making themselves felt. The Managing Director's report also speaks highly of the process, and a list of companies who have adopted or have decided to adopt the process is given. Dividends of 25 per cent. on the Ordinary and £6 per share on the Founders' shares were declared.

SOUTH AFRICAN TERRITORIES (LIMITED).—During the week this Company issued a prospectus inviting applications for £75,000 Six per Cent. First Mortgage Debentures of £50 each. The prospectus states that the Company have acquired the right to construct a railway or tramway from Lüderitz or Angra Pequena Bay to the interior of the Company's possessions, with the option of constructing branch lines, and the exclusive right for a period of 50 years to construct railways in any part of the Company's territories. The lists opened on Tuesday and closed on the same day for town, and on Wednesday for the country.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.—The traffic returns of this Company for the week ended September 20th were £606, an increase of £19, as compared with the corresponding week last year.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to allow the following securities to be quoted in the Official List: Further issue of 3,498 Seven per Cent. Cumulative Preference shares (Nos. 12,846 to 16,343) of the Electric Construction Company (Limited), and the further issue of 3,163 Ordinary shares (Nos. 1 to 601, 1,092 to 1,181 and 7,529 to 10,000) in W. T. Henley's Telegraph Works Company (Limited).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended September 20th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,972.

WILLANS AND ROBINSON (LIMITED).—The registers of transfers and members of this Company will be closed from 24th inst. to 8th prox. inclusive.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, Sept. 18.		Price Wednesday, Sept. 25.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Sept. 25. Highest	Lowest
			TELEGRAPHS					£ s. d.		Highest	Lowest
£1,012,880	Stock	11 0	Anglo-American	48	50	48	50	4 0 0	Jan., Apr., July, Oct.	4)	..
£2,993,560	Stock	22 0	Do. Preferred	89	90	89	90	5 8 0	" "	89¾	89
£2,993,560	Stock	5/0	Do. Deferred	8½	9	8½	9	..	" "	8¾	8⅝
£173,400	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 16 11	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	13¾	14¼	14	14½	4 9 8	Mar., June, Oct., Dec.	14 7/16	13 15/16
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 7 11	June and December	..	..
10,000,000	$100	1¾%	Commercial Cable Capital Stock	160	165	160	165	4 5 9	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 0 0	April and October	..	–
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10¼	9¾	10¼	4 7 7	" "	..	–
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 5 9	..	..	–
60,710	20	2/0	Direct United States Cable, 1877	9	9½	9	9½	4 4 3	Jan., Apr., July, Oct.	9¼	..
400,000	10	5/6	Eastern	17⅛	17⅜	17⅛	17⅜	3 14 10	" "	17⅜	17⅛
70,000	10	6%	Do. 6 per Cent. Preference	18	18½	18	18½	3 4 10	" "	18¼	18
£1,297,83[illegible]	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	129	132	129	132	3 1 2	May and November	130½	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	109	106	109	4 12 5	February & August	..	..
250,000	10	2/6	Eastern Extension	17⅞	18⅜	18	18½	3 16 9	Jan., Apr., July, Oct.	18¼	17 15/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	128	131	128	131	3 1 4	February & August	..	..
£54,100	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	102	106	102	106	4 15 6	January and July	..	..
£80,600	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	102	106	102	106	4 15 6	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	107	110	107	110	3 13 1	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	113%	116%	113%	116%	3 10 0	May and November	..	..
180,227	10	3/3	Globe Telegraph and Trust	10¼	10½	10⅜	10⅝	3 19 6	Jan., Apr., July, Oct.	10 7/16	10¼
180,042	10	6%	Do. 6 per Cent. Preference	17	17½	17	17½	3 9 7	" "	17 5/16	17
150,000	10	5/0	Great Northern	21¾	22¼	21¾	22¼	3 16 3	Jan., April, and July	22⅛	..
£180,000	100	5%	* Do. 5 per Cent. Debentures, 1883 issue	103	106	103	106	4 14 9	March & September	104½	..
17,000	25	37/6	Indo-European	50	53	50	53	4 14 4	May and November	52	50½
37,548	10	..	London Platino-Brazilian	..		..		..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	104	108	104	108	5 11 7	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	108	111	108	111	3 12 9	..	..	..
11,839	8	4/0	Reuter's	4	5	4	5	..	April and October	4½	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	127	132	127	132	4 12 10	" "	130½	..
15,609	10	2/0	West African Telegraph	5½	6½	5½	6½	..	January and July	..	–
£233,300	100	5%	* Do. 5 per Cent. Debentures (red.)	104	107	104	107	4 13 11	March & September	106¾	..
30,000	10	2/0	West Coast of America	1	2	1½	2	..	January and July	1¾	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	104	99	104	7 15 9	June and December	..	..
88,321	10	6d.	West India and Panama	¾	1	¾	1	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10½	10¾	10½	10¾	5 14 3	May and November	10 7/16	10¼
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	5 13 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110	113	110	113	4 9 6	June and December	..	..
64,242	15	6/0	Western and Brazilian	10	10½	10	10½	4 5 9	May and November	10 5/16	10¼
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	–	7	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4	4½	4	4½	..	..	4 5/16	..
£165,200	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	102	106	102	106	5 14 3	February & August	–	..
£206,400	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	102	106	102	106	5 14 3	" "	..	..
$1,177,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	6 1 9	May and November	..	..
£164,300	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	103	100	103	5 17 1	March & September	..	..
			TELEPHONES.								
44,000	5	2/6	Chili Telephone (fully paid)	3½	4	3½	4	..	..	3¾	3½
224,850	10/0	1½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	–
171,504	£1	8·215d.	Oriental Telephone and Electric (fully paid)	9/16	1 1/16	9/16	1 1/16	..	Yearly	–	..
484,597	5	2/6	National	6⅛	6⅜	6⅛	6⅜	3 18 5	June and December	6 5/16	6 3/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	16	18	16	18	3 6 8	" "	16½	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	" "	15⅜	15¼
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	6⅛	6⅜	6⅛	6⅜	3 18 5	–	6⅜	6¼
1,100,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	106	108	106	108	3 5 3	January and July	107½	106
58,000	5	3/0	United River Plate	2¾	3¼	2¾	3¼	..	" "	..	..
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	93	98	93	98	5 3 4	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	14	15	13½	14½	1 14 6	–	15¼	14¾
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	15	16	14½	15½	3 17 5	–	15⅜	15⅜
£100,000	Stock	5%	* Do. 5% Debenture Stock (red.)	133	137	133	137	3 13 8	June and December	135½	134½
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	–	5 11/16	–
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	..	..
8,322	£5	..	House-to-House Electric	–		–		..	–	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	–		–		..	–	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	..	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7⅞	8⅛	7⅞	8⅛	..	–	..	..
111,000	5	..	London Electric Supply	..		..		..	–	..	..
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	12¼	12¾	12	12½	2 8 0	..	12½	12 1/16
150,000	Stock	4½%	* Do. 4½% Debs.	117	119	117	119	3 16 4	June and December	..	..
6,452	£10	2/0	Notting Hill Electric	8½	9½	8½	9½	..	..	9¼	9⅛
..	..	..	Rand Electric	7/16	9/16 prem	⅜	½ prem	..	–	..	..
19,980	£5	2/0	St. James and Pall Mall	8¼	8¾	8¼	8¾	..	–	–	..
20,000	£5	7%	Do. 7 per Cent. Preference	9	10	9	10	3 10 10	–	..	..
59,900	5	2/6	Westminster Electric Supply (fully paid)	8¾	9¼	8¾	9¼	2 19 6	..	9	8¾
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	1½	1¾	1½	1¾	8 11 8	–	1¾	1⅝
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	1¾	2	1⅞	2⅛	5 12 11	–	2 1/16	1¾
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	111	114	111	114	3 19 2	March & September	112	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref	1	2	1	2	..	January and July	..	–
12,139	5	1/6	Edison and Swan United	2	2½	2	2½		..	..	–
£100,000	Stock	4½%	Do. 4% Mortgage Debenture Stock	104	107	104	107	4 5 0	..	–	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		–			..	–	..
120,000	2	..	Electric Construction	⅝	⅞	⅝	⅞	..	..	–	..
12,845	2	2/9¾	Do. 7 per Cent. Cumulative Pref.	2¼	2¾	2¼	2½	5 11 0	..	2 7/16	2½
91,195	2	10/0	Elmore's Patent Copper Depositing	¾	1	¾	1	..	..	⅞	–
20,000	5	..	Fowler-Waring Cables (fully paid)	¼	¾	¼	¾	..	..	..	..
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	19	21	19	21	4 15 3	February & August	20⅛	19⅞
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 8 5	March & September	..	–
15,995	£10	..	International Okonite Ordinary	..		..		..	–	–	..
16,000	£10	..	Do. 8 per Cent. Preference	..		–		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	⅛	⅜	⅛	⅜	..	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	43	45	43	45	4 0 0	March and July	44½	43½
£150,000	100	5%	* Do. 5 per Cent. Bonds	104	107	104	107	4 14 1	January and July	..	–
37,514	£5	–	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	–
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	–
£[illegible]00,000	10	6/0	W. T. Henley's Telegraph Works Ordinary	12¼	12¾	12½	13	..	..	12 11/16	12 9/16
£30,000	10	..	Do. 7 per Cent. Preference	15	16	15	16	4 7 6	..	15⅝	..
£[illegible]0,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock	104	107	104	107	4 4 5	..	..	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1½%	City and South London Railway	38	40	33	40	3 2 6	May and November	..	..
7,000	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 4 6	..	–	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	134	136	134	136	2 19 7	May and November	..	..
87,500	£10	2¼%	Liverpool Overhead Railway	12⅞	13⅛	11⅝	11⅞	1 7 11	–	–	–
6,295	10	5%	Do. 5% Preference	15	15½	15	15½	3 4 6	..	–	–
25,000	Stock	4%	Do. 4% Debenture	111	113	112	114	3 10 2	January and July	–	–

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 907. [No. 23. Vol. XXXV.] FRIDAY, OCTOBER 4, 1895. PRICE SIXPENCE.

NOTES.

THE half-yearly report of Willans and Robinson (Limited) should prove very pleasant reading to the shareholders of this prosperous concern. A 7 per cent. dividend is not exactly calculated to make the lucky recipients thereof over curious as to the way in which it has been balance-sheeted. In this instance, however, inquisitiveness would not end in disillusionment. The profit and loss account, it is true, shows that some 17 per cent., or over £3,600, out of a total income of £21,283 has been derived from the sale of licences to foreigners —a source of revenue not likely in the nature of things to prove perennial—but as the greater portion of this receipt has been devoted to increasing the reserve and depreciation funds no exception can be taken. Moreover, it must be remembered that the income derived from foreign royalties may be expected to grow. By this time next year some of the rival high-speed enclosed engines will, no doubt, have got to work, and we shall be interested to see whether competition will have a bracing or a depressing effect on the firm which has so ably and pluckily pioneered this type of engine.

ALTHOUGH the experiments on "The Electrolysis of Milk," which we publish in another column, do not give grounds for supposing that electrical methods of analysis will supplant those ordinarily in use at the present time, still the results are of some interest. The obtaining of a deposit of casein on the sides of the porous partitions farthest from the anode when milk was electrolysed in a vessel divided into three compartments will recall the experiments FARADAY made to prove that a metallic electrode or pole was not necessary to produce chemical decomposition. On the GROTTHUSS hypothesis electrolysis was supposed to be due to a direct attraction exerted by the poles on the opposite constituents of the decomposing compound, which varied as the square or some other power of the distance. But this was disproved by FARADAY ("Experimental Researches," Vol. I., pp. 140-145), who showed that the decomposing forces were the same at all positions between the poles, and that insoluble hydrate of magnesia was produced at the junction between a strong solution of sulphate of magnesia and pure water when a current was passed through. The effect recently observed by M. ANDREOLI is due to the same cause, and he would appear to have found this out, as we are informed that he now connects the sheets of metal in the centre compartment to the negative terminal of the dynamo, whilst the plates in the two outer divisions form the anodes. We further learn that the porous partition may be dispensed with.

WHETHER an electric car is started on the series-parallel system, the motors being placed in series during the early stages and thrown into parallel only when considerable speed has been attained, or whether the less modern rheostat method of starting is adopted, there are many items of expense largely affected by the care which is exercised in making a start. A glance at the instructive set of curves accompanying the article on "How to Start a Car," which will be found in our columns this week, enables one to see what a great difference is made between an easy and a sudden start. And although in the latter case there may be double the maximum power consumed, full speed is not attained in much less time than with a more gradual switching into steady running. Not only does this difference affect the load on the power generators, and the distribution of pressure on the system; but it also touches the question of repairs of motor machinery. A nervous or hasty motorman will sometimes cause a flare that will do more harm to the machinery than months of steady hard work. Indeed, this is one of the chief troubles while working new and unskilled hands into motormen's duties—a novice will be apt to throw the switch hard over to full speed whenever he sees a blue spark; while an old hand is often disposed carelessly to throw the switch over too quickly, rather than be bothered. There is, of course, some difference between the way a start must be made with the series-parallel arrangement, and when rheostats are used; but, in either case, bad starts arise from the same kind of carelessness in handling the switches; and the effect upon the economy of the system may be as marked in the one case as in the other.

IN this country, at any rate until quite recently, the handling of coal within the precincts of an electric supply station was neither a very scientific, methodical nor satisfactory matter. But in recent years, especially where slack and other varieties of small coal have been used, mechanical coal-handling has received greater attention. It is, however, to America that we must turn, if we seek the development of this practice to its fullest extent; for it is by no means an uncommon thing to find, in the electric light and power stations of that enlightened land, the coal being treated to an elaborate

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miniature Lord Mayor's procession, before it is finally consumed on the firebars of the boiler furnaces. To begin with, in America it is regular practice to put the coal stores at the very top storey of the building, the boilers in the basement, and the engines somewhere between the two. Bucket-and-chain elevators carry the coal skywards from the level of the street, and, at the appointed time, tall shoots convey it downwards to the place where it is to be consumed. In making this double journey, the coal frequently is carried on a very tortuous and complicated route, though we have yet to meet with an instance of its having been conveyed through the company's offices. A variant on this practice is advocated by our esteemed contemporary, the *Electrical Engineer* of New York, and is now in actual operation in the power house of the Toronto Railway Company. The coal is dropped through the bottoms of the trucks on the railway siding, where it falls on to a motor-propelled crusher. It is here crushed to small lumps, and passed into the buckets of conveyor No. 1. Thence it passes under the motor shop and up an incline to conveyor No. 2, by which it is conducted to the storage bins. From these it drops into conveyor No. 8, which lifts it above the boiler house and drops it into a number of spouts, provided with valves, which are so arranged that the coal can be dropped anywhere in the boiler house.

Doubtless our readers have seen mysteriously-worded paragraphs in the daily papers from time to time, especially during the summer, dwelling in an appropriately vague manner on the existence of gold in solution in sea water, schemes for its recovery being at the same time shadowed forth. We are now able to give details concerning at any rate one method. The apparatus is exceedingly simple. plates of iron form the anodes, while the cathodes consist of plates of copper or other suitable material, such as amalgamated zinc, and in some cases a quantity of mercury may be arranged in connection with a cathode, these plates forming, in conjunction with the sea water, an electric battery. The inventor, however, proposes to increase the effect by connecting this apparatus in series with a somewhat more certain and more powerful source of electric supply, such, for instance, as a dynamo. It is claimed that the action of the electric current will deposit upon the copper cathode, or in the mercury, the gold which is contained in the sea water, and which is supposed to be in combination with iodine. Various forms of apparatus are described; for instance, the plates may be attached to a long, narrow float, or hung to a beam trawled from a steamer or sailing vessel, or yet again, the plates may be arranged in a long tube or conduit immersed in a tideway. The chief object to which attention has to be directed is to arrange the apparatus so that the greatest possible volume of sea water is passed through it, and subjected to electrolysis. There is a seductive charm about this idea of a golden haul becoming a common bye-product of summer day's sail, and it is obvious to the meanest comprehension that in this great invention there lies the germ of an undreamt-of development of our mercantile marine. The gold trawling industry will now no longer be confined to members of the London Stock Exchange.

Happy, we are told, is the nation which has no history; and good news is surest when there is no news at all. In the light of these two truths, the shareholders and other persons interested in the Liverpool Overhead Electric Railway may justly claim congratulation. For, while hastening through Liverpool the other day, bent upon crossing to Manxland to see another and a newer electrical railway; and again, while hastening back, we took the opportunity to pay further visits to the useful overhead line and the efficient generating station. We found the cars running the even tenor of their prompt and frequent service; the popularity and usefulness of the line having been enhanced by its extension, in a northerly direction, to Seaforth sands, and in a southerly direction, beyond the furthest dock station, to a populous suburban district. Within the great machinery hall—one of the neatest and most imposing we have ever seen—things were running as smoothly and satisfactorily as were the cars themselves; and we were pleasurably disappointed, so to say, to find that the editorial desire to be told of some interesting "incident" or anxious *mauvais quart d'heure* could not be satisfied.

Tunbridge Wells.—The municipal electric lighting station will be opened in state on Wednesday next, the 9th inst.

University College, Nottingham.—The 1895-96 session commences on Monday next, the 7th inst. Further particulars are given in our advertisement columns.

Cable Interruptions and Repair:—

	Date of Interruption.	Date of Repair.
Aden-Zanzibar	Sept. 2, 1895. ...	Oct. 1, 1895.
Cadiz-Teneriffe	Sept. 25, 1895. ...	—

Long-Distance Telephone Opened.—On September 25th the Berlin-Königsberg telephone line was given over to public use. The charge for conversation of three minutes' duration is one shilling.

Accumulator Traction in Germany.—It is reported that the Hanover Tramways Company has decided to substitute accumulators for the "trolley" on 28 of its electric tramcars. The contract for the accumulators has been given to the Hagen Accumulator Company.

Isle of Man Electric Tramways.—A concession has been granted by the House of Keys for the construction and operation for a term of years of an electric tramway along the Marine Drive, which extends southward from Douglas along the picturesque Manxland coast.

Visual Fog-Signalling at Sea.—The ss. "Calais-Douvres," of the London, Chatham and Dover Railway, has been fitted with an experimental fog-signalling apparatus, consisting of a search light, arranged to throw a vertical parallel beam from forward of the foremost funnel of the vessel.

Central Technical College.—At the recent matriculation examination of the City and Guilds Central Technical College 76 candidates presented themselves, and 62 have been admitted to the College. The highest place was taken by M. Solomon, to whom the Clothworkers' Scholarship of £60 a year and free education has been awarded.

Delineation of Alternate-Current Wave Forms.—A Correction.—In the abstract of Messrs. Barr, Burnie and Rodgers' Paper on "Some New Methods for the Delineation of Alternate-Current Wave Forms," which appeared in our last issue, the authors, by a slip of the pen, on page 721, column two, at the end of line 11, wrote the word "not" in place of the word "most."

Interurban Telephone Tariffs in France.—A notice has just been issued by the French Minister of Commerce and Industry to the effect that on and after January 1st next the charge for the use of the interurban telephonic system of the country between places less than 25 kilometres distant from each other will be reduced from 5d. to 3½d., and in some cases to 2¼d. per three minutes' conversation.

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Telephone Induction Transmitters.—In connection with the adoption, by the German Post Office, of the Münch induction transmitter, which we described in our issue last week (p. 724), Mr. G. L. Addenbrooke has called our attention to a patent, No. 14,917, dated December 4, 1885, taken out by him in conjunction with Mr. Ferranti. This patent was granted for an induction transmitter in which "the magnetic circuit in the core is completed through metal, or more nearly so than when a straight core is employed." Whereas in the Münch transmitter an iron-wire core is used, in the original apparatus patented by Messrs. Addenbrooke and Ferranti laminations of sheet iron were employed.

Electric Lighting in Shanghai.—The *China Gazette*, in a recent issue, speaking of the growth of electric lighting in Shanghai, says: "A couple of years ago there were only about seven miles of streets lighted by electricity, for which 60 arc lamps were quite sufficient, and there was not a single incandescent lamp in or around Shanghai. Now the electrical department of the Municipal Council runs 140 arc lamps, lighting some 15 miles of streets, and there are about 43 miles of line wire laid, in addition to 6,100 incandescent lamps of 8 c.p. each for domestic purposes. The customers for incandescent lighting have increased from 1 to 55 in number since the Council took over charge of the department."

Toynbee Hall.—The winter session's work at Toynbee Hall was inaugurated on Saturday last by a *conversazione*, which was attended by about 1,200 students. The scientific side of the work at Toynbee was represented by an exhibition of apparatus arranged by the electrical and chemical societies. By permission of Mr. W. H. Preece, C.B., a quantity of telegraphic apparatus (including Morse ink writer, double-plate sounder, single needle, &c.) was available, and the various buildings were in telegraphic communication. The electrophone also connected Toynbee Hall with the principal theatres. On Saturday afternoon, the 5th inst., the Toynbee Electrical Society will visit the Davies-street station of the Westminster Electric Supply Company. The party will meet at the station at 3·15 p.m.

Polyphase Litigation.—We hear on good authority that the Helios Company, of Cologne, who are the owners in Germany of the Tesla patents, have brought actions at law for infringement against all the firms in Germany who are using the three-phase system of motors. In the United States, as we have already stated, the Westinghouse Company has brought suits against the General Electric Company in connection with the "monocyclic" system. And they have gone so far as to prosecute also the Stanley-Kelly Company for using the Stanley two-phase system, although in the motors of that Company the two circuits are kept separate, and not combined to make a rotatory field. Our British manufacturers will doubtless look on with feelings of gratification at the circumstance that, whoever gains or loses, the battle is being fought at the expense of their rivals.

The Amazon Cable.—Mr. Alexander Siemens, accompanied by Mr. R. E. Peake, of the firm of Clark, Forde and Taylor, consulting engineers to the Amazon Telegraph Company, arrived on the 28th ult. at Para, where they were met by Mr. R. J. Reidy, the Company's general manager out in Brazil. These gentlemen are now on their way up the River to Manaos, the western terminal station of the proposed cable, the intention being, on the return journey, to survey the route of the cable, and also to select landing places and make the necessary landing arrangements at its numerous stations (which number 16 in all), so that on the arrival of the expedition in Brazil shortly, the submersion of the cable may be commenced without delay. The cable will be laid starting from Para. The prospects as to trade and traffic would seem to be exceedingly satisfactory.

A Good Record for an Electric Car.—Car No. 210 of the Marseilles-St. Louis Electric Tramway, after having been overhauled, was put in regular service on the line on January 24th. Up to September 15th it was on the line day for day, covering a total mileage of 22,734 without any accident to the electric parts, the attendance having been reduced to the ordinary cleaning and change of motor brushes. It was taken to the car shop for four days only, in order to repair damage to the truck from collisions and for change of a brake chain. The mean mileage of the 229 days of work was 96, the maximum mileage 129·5. This record shows a very fair result, considering the heavy work of the cars on the line, which has an enormous traffic and steep gradients, and it speaks for the perfection of the electrical equipments now in use on tramways and the security of electric traction under most difficult conditions. The car is equipped with two 18 H.P. Oerlikon motors. Another car, No 205, had previously attained, on the same line, a mileage of 17,000 without any accident either to the truck or to the electric parts.

New French Cables.—According to the Paris *Figaro*, "M. Lebon, Minister of Posts and Telegraphs, has signed a contract for the laying of a submarine cable from Brest to New York, which will be connected with the French telegraphic system in the Antilles. The contract, which bears a large number of signatures, will be presented to the Chambers on the day when they reassemble." The New York shore-end of the New York-Haiti (Antilles) cable, a cable which will have a total length of some 1,500 miles, was laid on September 24th. The two cables together will cost a sum of money calculated to satisfy the most patriotic Frenchman, whilst the fact that these long and expensive lines will be heavily subsidised by the French Government emphasises once more their determination to carry out, at all hazards and at any cost, their policy of colonial expansion with independent cable communications. But how have the requisite landing rights at New York been obtained, seeing that the French Cable Company concerned holds exclusive landing rights in Venezuela, Haiti, and elsewhere?—a fact which has generally been supposed to be a bar to any such cable being landed on the shores of the United States of America.

Argon.—An examination of the gases liberated, says *Nature*, from certain of the sulphurous waters of the Pyrenees reveals, in the hands of M. Ch. Bouchard, the interesting fact that the formerly assumed nitrogen (from which the Spanish physicians have named these waters *azoades*) consists in part of free argon and helium. The collected gas was in each case, after treatment with potash and phosphoric anhydride, introduced into a Plücker tube containing magnesium wire. Under the action of the silent discharge the nitrogen rapidly disappeared by combination with magnesium, leaving a residue exhibiting the characteristic rays of both argon and helium for the gas derived from the waters of la Raillère, helium from the springs of Bois, and helium together with probably an unknown gas from the waters of lowest temperature at Bois. The use of magnesium wire and the silent discharge is due to MM. L. Troost and L. Ouvrard, who show that the magnesium vapour produced very rapidly combines with nitrogen under the conditions obtaining in the tubes. Further, the continued action of a powerful silent discharge, for some hours after the spectroscopic evidence proves the absence of nitrogen, results in a gradual diminution in intensity of the helium and argon rays. Finally a complete vacuum is produced, hence it appears that magnesium combines with argon and helium under these circumstances. Platinum appears to behave like magnesium towards argon in Plücker tubes with the silent discharge.

Military Telegraphy in the United States.—The United States army signal officers have, according to the *Electrical Engineer* of New York, equipped the service with an ingenious arrangement for distributing telegraph and telephone wires. It was found that in laying insulated or naked wire on the ground preparatory to establishing communicating stations, the weight of the reel containing the wire was considerable, and it had to be carried in a handcart. This arrangement required two men in the operation—one to push the cart, the other to wind and unwind the wire. The latest method is to carry the wire on a wheel which is fixed to a bicycle. The rider, by his propulsion of the wheel, distributes the wire in the track of the machine. An ingenious mechanism also permits him to rapidly gather up the wire from the ground, and it is reeled on a spool borne in front of the handle-bar. In front of the saddle this Signal Corps bicycle will support a case of instruments and

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tools, in addition to the usual leather pocket, in which the bicycle implements are carried. Supported over the rear wheel of the machine, and directly behind the saddle, is the case which contains the telegraphic and telephonic instruments. This can be removed, and a communicating station established anywhere along the line. This bicycle has been tried with much success in Texas, and it will be adopted generally by the signal linesmen. The lightness of the bicycle readily permits its being lifted over obstructions, such as stone walls, hedges, and fallen trees.

The Cause of the Invisibility of the Infra-red Rays.—Infra-red light is invisible to us either because the humours composing the eye are opaque to it, or because the light is incapable of exciting the retina. Cima and Janssen have adopted the former explanation, but the alternative one has been accepted by Tyndall, Engelmann and others, while Helmholtz maintained that the strong absorption suffered by infra-red rays in their passage through the eye is sufficient to account for their invisibility. That they are strongly absorbed has been found by all observers, but Herr E. Aschkinass, says *Nature*, proves, in *Wiedemann's Annalen*, that there is no sudden increase of absorption beyond the red end of the spectrum, and that the absorptive powers of the various media of the eye are practically the same as that of water. The apparatus used for this investigation contained a fluor-spar prism and a bolometer. Thin layers of the humours of an ox eye and a human eye were interposed in the path of the rays from a zircon burner, and the absorptive effects noted by means of the bolometer. It was found that at a wave-length of 0·81 μ, the limit of the visible spectrum, the absorption was 5 per cent. for the whole human eye. This increased to 10·5 per cent. at 0·872, reached 60 per cent. at 0·98, decreased to 34·5 per cent. at 1·095, and finally reached 100 per cent., or total absorption, at 1·4 μ. This shows that a large proportion of infra-red light does reach the retina through the eye, but is not capable of affecting the nerves and producing visual sensation.

The Electrolysis of Alkaline Chlorides.—At the fourteenth annual meeting of the Society of Chemical Industry, at Leeds, the president, Prof. T. E. Thorpe, in his address said with regard to the above:—

"The application of electrical energy to the decomposition of alkaline chlorides either for the production of chlorine, or of alkali, or of both products, has been made the subject of many patents. The great majority of these processes have been stillborn, and even of those which were stimulated into vitality, the existence has been but short and feeble. With a sounder knowledge of the conditions under which success is alone possible, the problem is once more attracting the attention of technologists, and the chemical world is watching with great interest the results of two or three electrolytic processes which are now being worked out on the large scale. One of these is the invention of our member, Mr. Hamilton Castner, which has been in practically continuous operation for nearly 12 months at the Aluminium Company's works at Oldbury. In Mr. Castner's process the difficulties connected with the use of diaphragms and the liability to recombination of the products to form hypochlorite are obviated, whereby the destruction of the electrodes is prevented and a much higher electrical efficiency is obtained. I am indebted to Mr. Castner for the following account of the method:—The essential feature of the process is the employment of a moving body of mercury, which completely separates the products of electrolysis, and by its movement takes the place of a diaphragm, the sodium amalgam formed being decomposed as it is formed. The cell, which is divided into three compartments, is capable of being continuously rocked or tilted, so as to cause the mercury to flow from side to side. The two outside compartments contain the alkaline chloride solution and the carbon anodes, while the middle compartment contains an iron cathode and the caustic solution. The solution of the chloride is continuously circulating through the outside compartments, wherein it is being electrolysed, and then returns to saturators, where it is re-charged with salt. The electric current traversing the salt solution liberates chlorine and forms sodium amalgam. The chlorine escapes from each cell through an aperture into a collecting main, while the sodium amalgam, by the continuous back-and-forward tilting of the cell, passes to the centre compartment, where it acts as an anode during the passage of the current, the sodium going into solution as caustic. A regulated quantity of water is admitted hourly to the centre compartment of each cell, causing the pure solution of caustic to overflow through a discharge pipe into a large collecting pipe connecting all the cells. The cells are electrically connected in series, and are capable of being cut out or put into operation at will."

Exhibition of Horseless Carriages.—Sir David Salomons has arranged for an exhibition of horseless carriages on Tuesday, October 15th, at the Tunbridge Wells Agricultural Show Ground, which has been kindly lent him for the occasion. The carriages will enter the ring at three o'clock p.m. The grand stand is reserved for those attending by invitation. In order to offer all interested in these new carriages an opportunity to attend, the ground will be thrown open to the public on payment of one shilling entrance fee. Sir David Salomons is paying the expenses of the exhibition, and intends to apply the entrance money to the purchase of prizes to be awarded at the show of the Tunbridge Wells and South-Eastern Counties Agricultural Society next year, for the best horseless carriages intended to be used for agricultural, trade and private purposes. For the convenience of those desiring to be present, Sir David Salomons has written an article giving infromation on the subject, which will be published in the leading Tunbridge Wells journal, the *Kent and Sussex Courier*, on October 4th. This article also replies to the very large correspondence which has been received and to which it has been found impossible to reply in detail. Invitation tickets for the exhibition may be secured in order of application by fellows and members of any of the following institutions sending an addressed envelope to the secretary of the Institution of Civil Engineers, 24, Great George-street; the Institution of Electrical Engineers, 28, Victoria-street; the Institution of Mechanical Engineers, 10, Victoria-chambers; the Royal College of Surgeons, Lincoln's Inn Fields; and the Royal College of Physicians, Pall Mall East. It must be understood that if applicants do not receive a reply within three days it has not been possible to send an invitation.

Current Electrical Science.—*Wiedemann's Annalen*, No. 8, contains the usual amount of learned dissertation relieved by some striking experimental work. Victor Biernacki describes a simplified form of Hertz's Reflection Experiment. He places one of Dr. Lodge's "coherers" in the focal line of the secondary mirror, and uses mirrors as small as 45 x 30cm., with a focal length of 3cm. These need only be 4in. apart. The polarisation of electric rays may be shown by reflecting them at the surface of a tiled stove. At an angle of 60deg. all reflection ceases. A piece of good ice introduced between the mirrors perceptibly rotates the plane of polarisation. A Bohemian physicist, Franz Kolácek, gives a new method of determining Small Self-Inductions by the mechanical action of variable magnetic fields upon closed circuits. A closed coil is suspended in a homogeneous periodic magnetic field, and the force necessary to prevent torsion is measured. Tesla's Experiments are treated theoretically by A. Oberbeck, who shows that the Tesla discharge invariably consists of two oscillatory discharges of different frequencies. These frequencies are not the same as those of the primary and secondary circuits by themselves. In one case, where the latter were both 10 millions per second, the frequencies of the two discharge currents were 8 and 15 millions respectively. A simple and elegant method for determining the Electric Indices of Refraction of Liquids is described by P. Drude. He uses a small Blondlot exciter, with wires no longer than the breadth of this page. The further portion of the wires is conducted through the liquid, and the wave length in the liquid found by shifting certain bridges along the wires outside and inside the liquid. G. Jaumann deals another blow at the alleged Constancy of Spark Potential, and specifies variations of force, light, degeneration and recovery of the spark gap, &c., as causes affecting the discharge. J. Elster and H. Geitel make another of their highly suggestive contributions to the subject of Photo-Electric Currents, and come to the conclusion that the effect of polarised light upon the discharge from the liquid K—Na cathode is due to the direct influence of the electric oscillations produced at the surface of the metal.——In the *American Journal of Science* for September we find a clever Paper by L. A. Bauer on the distribution of Terrestrial Magnetism. He starts from the supposition of a globe magnetised symmetrically with respect to its axis of rotation, and shows that the chief cause of distortion of this primary symmetrical field can be represented as due to a secondary polarisation approximately equatorial in direction. The equatorial system, to account for the existing anomalies of distribution, would have to be about five or six times weaker than the polar system. To the conundrum—Is the earth a magnet or an electro-magnet?—the author does not return a definite solution

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ELECTROMAGNETIC THEORY.—LXXV.*

BY OLIVER HEAVISIDE.

(*Continued from page 668.*)

§ **292.** When the impressed force is intermediate, say at the point $x = y$, the treatment is quite similar, so that very little detail need be given. We have the operational solutions (35), (36), § 259, in which put y for a. Now circularise the functions by putting $q = si$. Remember in doing so that this is not really a complex transformation, because the operators are rational functions of p already, and therefore of s^2. This fact makes the transformation easy, by the cancelling of terms that occurs. The result is that

$$V_1 = \frac{(R\cos - Z_0 s\sin)sy\,.\,(Z_1 s\cos + R\sin)s(l-x)}{\cos sl(R^2 - Z_0Z_1s^2)\left(\tan sl + \dfrac{Rs(Z_0+Z_1)}{R^2 - Z_0Z_1s^2}\right)} e \qquad (71)$$

expresses the potential due to e at a point x on the right side of y, where e is situated. To obtain the corresponding expression for V_2, where x is on the left side of y, refer again to (35), (36), § 259, and observe that V_2 is got from V_1 by interchanging α and β, x and $l-x$, y and $l-y$, and then negativing the result. So, doing the same to (71), we get

$$V_2 = -\frac{(R\cos - Z_1 s\sin)s(l-y)\,.\,(Z_0 s\cos + R\sin)sx}{\text{same denominator}} e. \qquad (72)$$

Now apply the expansion theorem. The outside terms for the steady state may be perhaps most easily got by elementary considerations—by Ohm's law and the condenser law, that is to say. When the steady terminal resistances (effective) are finite, say R_0 and R_1, we shall have

$$V_1 = \frac{R(l-x)+R_1}{Rl+R_0+R_1}, \quad V_2 = -\frac{R_0+Rx}{Rl+R_0+R_1}, \qquad (73)$$

by Ohm's law. But when R_0 and R_1 are both infinite, and there are terminal condensers concerned, we must go further, and apply the condenser law, say as in § 291, equation (64), which is a special case of the present. In general, however, should the terminal arrangements include several condensers, it is the effective steady permittances of the combinations that are to be regarded as S_0 and S_1 in the place referred to. Or, we may get the steady states directly out of (71) and (72) by seeking their limiting values where $s = 0$. However the work be done, denoting the steady states by v_1 and v_2, and applying the expansion theorem to (71), we obtain at once

$$V_1 = v_1 + \Sigma \frac{(R\cos - Z_0 s\sin)sy\,.\,(Z_1 s\cos + R\sin)s(l-x)}{\frac{1}{2} sl\cos sl(R^2 - Z_0Z_1s^2)\left(\sec^2 sl + \dfrac{d}{d(sl)}\dfrac{Rs(Z_0+Z_1)}{R^2 - Z_0Z_1s^2}\right)}\epsilon^{pt}, \qquad (74)$$

by introducing the summation sign, the time factor, and changing the denominator by the operation $\frac{1}{2}sl(d/d(sl))$.

As regards V_2, we may get its formula by making the interchanges already indicated, in getting (72) from (71). But this is quite unnecessary. For, by inspection of the original operational formulæ (35), (36), § 259, we may see that when the denominator vanishes V_1 and V_2 become identical in those equations. That is, identical for all the values of p given by the determinantal equation, though not in the case of $p = 0$, which finds the steady states on the two sides of e. So the V_2 formula is to be got from (74) by changing V_1 to V_2 and v_1 to v_2. The expansional part is the same, in virtue of the special values of sl. Of course, we may use the alternative formula if we like, making the interchanges before described. And when the Z's are explicitly given, simplifications of form may be readily carried out. This is not a matter of indifference, if numerical calculation is wanted, because, of two equivalent forms, one may be much more manageable than the other.

§ **293.** The determinantal equation is (66) or (67). Say,

$$\tan sl = \phi(sl) = -\frac{Rl(Z_0+Z_1)sl}{(Rl)^2 - Z_0Z_1(sl)^2}. \qquad (75)$$

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Here $\phi(sl)$ is a rational function of sl. Draw the curves

$$y_1 = \tan sl, \qquad y_2 = \phi(sl); \qquad (76)$$

the abscissæ being sl, and the ordinates y_1 or y_2. The intersection of these curves indicates the admissible values of sl. It is sufficient to draw them very roughly, just to find the general situation and rough values of the roots. Only a few at the beginning are wanted, except for very small values of the time. I mentioned before that when the Z's are mere resistances, tangent tables readily find the roots. Use the graphically-obtained values as a first approximation. Say it is the first root, which is the most important in general. The tables may show that the rough value is several degrees wrong. Estimate the correction by rule of three. Apply the revised value to the tables. It will be nearly right, and a second revision may bring it right to a minute, and a third to a second.

Another easy case is that of terminal condensers. Also the case of condensers and resistances does not trouble much. And it may be remarked here that when the terminal arrangements involve only electric energy, without magnetic, the roots are always real, so that the above described process can be followed. But it is not so easy when magnetic energy is involved. There may then be complex roots as well. This occurs even when a single coil is concerned at either terminal, if the inductance be of a suitable value. Of course, in slow cable working, the inclusion of the effect of the self-induction of the coils is not an important matter, and the coils may be treated as resistances. The trouble with complex roots sets a limit to the desirability of elaborating formulæ beyond the point of ready systematic calculation. The formulæ, nevertheless, have an interest of a scientific kind, as showing what may be done if the necessary trouble be taken.

The determinantal equation may be written

$$\tan sl + \tan\left(\tan^{-1}\frac{sZ_0}{R} + \tan^{-1}\frac{sZ_1}{R}\right) = 0, \qquad (77)$$

which makes

$$n\pi = sl + \tan^{-1}\frac{Z_0 sl}{Rl} + \tan^{-1}\frac{Z_1 sl}{Rl}. \qquad (78)$$

This form shows how the difference between sl and the standard value $n\pi$, n being a positive integer, depends upon the terminal operators. Equation (78) may be readily converted to a power series, perhaps with occasional advantage. Special formulæ may also be constructed exhibiting the roots explicitly to any desired degree of accuracy, but it is questionable whether they repay the labour of obtaining them, when tables of circular functions are so useful. General principles may become smothered by overmuch detail.

The original form of the determinantal equation, as it shows itself in the operational solutions (35), (36), § 259, and (65), (66), § 253, may be written

$$\epsilon^{2ql} = \alpha\beta, \quad \text{or} \quad \alpha\epsilon^{-ql}\beta\epsilon^{-ql} = 1. \qquad (79)$$

If the left-hand operator be applied to a wave originated at a point, say at $x = 0$, the resultant would represent what it became after a journey to $x = l$, reflection there, according to β, followed by a journey to $x = 0$, and reflection there according to α. The right-hand member would show that the effect of the cycle of operations was to restore the disturbance to its original state. This is impossible, of course. But it is apparently done on a normal solution. Thus

$$\alpha\beta\epsilon^{-2ql}\epsilon^{Pt} = \epsilon^{Pt}, \qquad (80)$$

if the constant P is chosen to be any one of the values given by the determinantal equation. This equation does not imply any use of $p^{\frac{1}{2}}$, but only abbreviates a rational equation. Clear it of fractions, and we get

$$\left\{\left(1+\frac{qZ_0}{R}\right)\left(1+\frac{qZ_1}{R}\right)\epsilon^{ql} - \left(1-\frac{qZ_0}{R}\right)\left(1-\frac{qZ_1}{R}\right)\epsilon^{-ql}\right\}\epsilon^{Pt} = 0, \qquad (80\text{A})$$

when the operator is an even function of q, and is therefore rational.

In the above equation (74) we have not only solved the question of the establishment of a certain state by an impressed force, but also the connected question of the

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subsidence of that state to equilibrium when the force is removed. For, if we write (74) and its companion thus,

$$V = v - \Sigma u\epsilon^{pt}, \qquad (81)$$

where v has to be v_1 or v_2 as the case may be, we have, initially,

$$v = \Sigma u. \qquad (82)$$

That is, the state of potential v is expanded in the special Fourier series concerned. If, then, v is left to itself, unsupported by impressed force, the state at time t later will be given by

$$v_1 = \Sigma u\epsilon^{pt}, \qquad (83)$$

where v_1 is what v then becomes.

There is this remark to be made about (82). It cannot be called without limitation *the* expansion of the function v in a Fourier series, subject to the terminal differential conditions, for it may be only one of many expansions expressing the same functions v, and subject to the same differential conditions. This is quite clear in the physics of the matter. For consider what the impressed force does in the act of setting up the state v. It energises the terminal arrangements as well, electrically and magnetically, except when only mere resistances are concerned. Now the same state of potential v in the cable may be accompanied by various states of energy terminally, and all due to the same impressed force. So when we take off the impressed force we not only let the charge redistribute itself, but also let the terminal energy act on the cable, and in various manners according to circumstances. Equation (83) exhibits the potential at time due to the initial state u in the cable, *and* to the accompanying initial states of the terminal arrangements. This is true even when the Z's are only given by formulæ, and we do not analyse them to see what particular arrangements are really represented thereby, and what the terminal energies are.

It will be seen that the expansion theorem is a labour-saving agent of a remarkable character. For it is not from formulæ representing the expansion of an arbitrary initial state that we can most readily learn the general course of events in the physical problems concerned. We should rather prefer to examine the result of some special initial state, or the result of a disturbance initiated at a single spot, as an impulsive or a continued source. Now it is just in these cases that the expansion theorem shows to best advantage. We obtain our formulæ in a very ready manner, without the circumbendibus connected with arbitrary initial states and the conjugate property of the normal functions. We shall see presently how to apply the expansion theorem to arbitrary initial states. In connection therewith, it may be noted here that an integration applied to (74) and its companion enables us to express the effect due to an arbitrary distribution of impressed force along the line, all starting at the same moment in the simplest case. Put $e\,dy$ for e, and let e be a function of y. Then integrate with respect to y from 0 to l, using one or other formula, according as x is to right or left of the elementary impressed force concerned. But this is a mathematical development which is useless for our present purpose.

§ **294.** The expansion of an arbitrary function of x between the limits 0 and l naturally rests upon the expression of the function for a single point. That is, we require to find how a charge Q, initially all at the point y, diffuses itself when controlled by given terminal conditions. As was before pointed out, the construction of the operational solution for a point charge is like that for an impulsive impressed voltage, with a difference. The latter produces a jump in the potential, the former in the current, at the place of application. A continued impressed force e at a point has its analogue in a continued source of current, led in by an auxiliary wire. The operational solutions to right and left of the source are given by (65), (66), § 263, in which h is the current introduced, to be given as a function of the time. Taking $h = pQ$ makes the source impulsive, and the case is then that of an initial charge Q. So, by (65), § 263, the potential V_1 at x, on the right side of the point y, where Q is impulsively introduced, is given by

$$V_1 = \frac{\epsilon^{qy} + \alpha\epsilon^{-qy}}{\epsilon^{ql} - \alpha\beta\epsilon^{-ql}}\left\{\epsilon^{q(l-x)} + \beta\epsilon^{-q(l-x)}\right\}\frac{qQ}{2S}. \qquad (84)$$

On the left side of y the potential V_2 is to be got by simply interchanging x and y in the last formula.

Converting (84) to circular functions, by means of $q = si$, makes the equivalent formula

$$V_1 = -\frac{(Z_0 s\cos + R\sin)sy\,.\,(Z_1 s\cos + R\sin)s(l-x)}{\cos sl(R^2 - Z_0Z_1s^2)\left(\tan sl + \dfrac{Rs(Z_0+Z_1)}{R^2 - Z_0Z_1s^2}\right)}\frac{sQ}{S}. \qquad (85)$$

The final state must be either zero or constant. It must be zero if there is conductive connection with earth at either terminal—that is, when at least one of R_0 and R_1 is not infinite; and it must be finite when both are infinite, so that the charge Q cannot be got rid of. In the former case, the last equation shows the result at once, on account of the s which occurs as a factor. In the latter case, it is the permittance that controls matters. The charge Q is finally either uniformly distributed along the cable, if there is no terminal permittance, or is divided between the cable and the terminal condensers. Thus, the potential of the cable is

$$v = \frac{Q}{Sl + S_0 + S_1}, \qquad (86)$$

if S_0 and S_1 are the effective permittances of the terminal combinations. This result may be dug out of (85), but is sufficiently clear without doing that, which is, however, a useful test.

Applying the expansion theorem to (85), we obtain

$$V = v - \Sigma\frac{(Z_0 s\cos + R\sin)sy\,.\,(Z_1 s\cos + R\sin)s(l-x)}{\cos sl(R^2 - Z_0Z_1s^2)(\sec^2 sl - \phi'(sl))}\frac{2Q}{Sl}\epsilon^{pt}, \qquad (87)$$

where $\phi(sl)$ is as in (75) and $\phi'(sl)$ in its derivative. We have the same form of determinantal equation. This formula applies on both sides of the point y, both as regards the steady v and the summation. For the steady state is constant, and the original operational solutions (65), (66), § 263, become the same when the denominator vanishes. We may, however, exchange x and y in (87), and make other changes controlled by the determinantal equation.

Put $Q/S = 1$ and $t = 0$. Let u be the result. Then

$$u = u_0 + \frac{2}{l}\Sigma\frac{(Z_0 s\cos + R\sin)s(l-y)\,.\,(Z_1 s\cos + R\sin)sx}{\cos sl(Z_0Z_1s^2 - R^2)(\sec^2 sl - \phi'(sl))} \qquad (88)$$

where u_0 is the value of v with $Q/S = 1$. Here u represents the initial state. Therefore u is the expansion of the unit impulsive function of x concentrated at the point y. It represents a great deal more than that, outside the limits 0 and l, for there are periodic repetitions, though not periodic in the usual sense, except in the elementary cases of total reflection at the terminals, when we have the usual Fourier series with regularly spaced roots.

Given, then, a function $f(x)$ representing an initial state, its expansion is

$$f(x) = \int_0^l f(y)u\,dy, \qquad (89)$$

using the previous expression for u; and, by introducing the time factor in the summation, we find what the potential $f(x)$ becomes at time t. The ultimate result is a state of uniform potential—viz., the total initial charge divided by the total permittance, including the effective terminal permittances.

As regards the meaning of the expansion for V outside the limits for x, viz., 0 and l, which are imposed in the physical problem, we get some knowledge from the determinantal equation. If V is the potential at x at time t in the cable, free from impressed force, its general characteristic is $(\Delta^2 - q^2)V = 0$, where Δ is the space differentiator and q^2 is RS × the time differentiator. Also, when the terminal reflection coefficients α and β are introduced, we make V satisfy

$$\left\{\left(1+\frac{\Delta Z_0}{R}\right)\left(1+\frac{\Delta Z_1}{R}\right)\epsilon^{l\Delta} - \left(1-\frac{\Delta Z_0}{R}\right)\left(1+\frac{\Delta Z_1}{R}\right)\epsilon^{-l\Delta}\right\}V = 0, \qquad (90)$$

where in the operator on V we write Δ for q. Compare with (80A). It is to be understood that in the two Z's the same change is made, or Δ^2/RS substituted for p. So, if V is $f(x)$, we have, by Taylor's theorem, § 276,

$$\left(1+\frac{Z_0\Delta}{R}\right)\left(1+\frac{Z_1\Delta}{R}\right)f(x+l) = \left(1-\frac{Z_0\Delta}{R}\right)\left(1-\frac{Z_1\Delta}{R}\right)f(x-l). \qquad (91)$$

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This is the equation showing the functional connection between the values at points distant $2l$ from one another. When the Z's are zero, it reduces to $f(x+l)=f(x-l)$, showing the primary kind of periodicity. Further examination of (91) to see how this is modified by the terminal operators, would lead us too far away from the proper subject.

§ **295.** The expansion (89), subject to (88), has some right to be termed *the* expansion of $f(x)$ in the Fourier series in question, because it is the one that depends only upon the initial state of the cable. It gives the potential at any later time on the understanding that the terminal arrangements are initially unenergised. Unless, therefore, the Z's are mere resistances, the Fourier series (89), (88), may not be the proper one to use in the physical problem. It will still represent the initial state, but will fail later, should the terminal arrangements be initially energised. So there are, independently of the above expansion, others which represent zero initially, and which only come into operation when t is finite. The number of such auxiliaries is determined by the number of independent ways in which the terminal arrangements may be energised. It may, therefore, be finite or infinite. If, for example, there is a coil at A and a condenser at B, there are just two auxiliary expansions. For the full specification of the initial state must include not merely the state of charge in the cable, but also the charge of the condenser and the current in the coil. After the first moment, they are all connected. Initially, they are independent.

A case in which there is an infinite number of auxiliaries is got by letting the terminal arrangement at either end be a second cable, of finite length. Another one is got by putting a piece of metal inside a coil. Without the metal the coil would introduce one auxiliary. The metal, however, which will produce a quite determinate rational terminal operator, will introduce an infinite number of auxiliaries, because the initial state will require a specification of the magnetic force in all parts of the metal, and this initial state may be arbitrary. This case may seem fearfully complicated, but can be worked out (in the case of a round core), without great difficulty, by the operational method.

To show the action of a single auxiliary, let there be a terminal condenser. Say that $Z_0=(S_0p)^{-1}$ and $Z_1=0$. Then the cable is earthed direct at B, and through a condenser of permittance S_0 at A. So, by (85) above,

$$V_1=\frac{\left(\frac{S}{sS_0}\cos-\sin\right)sy\,.\,\sin s(l-x)}{\cos sl\left(\tan sl-\frac{S}{S_0 s}\right)}\frac{sQ}{S} \qquad (92)$$

represents the potential at x on the right side of y, due to the impulsive introduction of Q at y. And this expands to

$$V=\Sigma\frac{\left(\frac{S}{S_0}\cos-s\sin\right)sy\,.\,\sin s(l-x)}{\frac{1}{2}sl\cos sl\left(\sec^2 sl+\frac{Sl}{S_0 s^2 l^2}\right)}\frac{Q}{S}\epsilon^{pt}, \qquad (93)$$

which is valid on both sides of y. There is no outside term The determinantal equation is

$$\tan sl=S/S_0 s, \qquad (94)$$

and an integration according to (89) constructs the potential due to an arbitrarily given state in the cable, with no initial charge in the condenser.

Now as regards the condenser, put $y=0$ in (92). Then

$$V_1=\frac{\sin s(l-x)}{\cos sl(\tan sl-S/S_0 s)}\frac{Q}{S_0} \qquad (95)$$

represents V_1 in the cable due to Q at its beginning. That is, to an initial charge Q of the condenser. Or, if V_0 is its initial potential we may substitute it for Q/S_0. So

$$V=V_0\Sigma\frac{\sin s(l-x)\epsilon^{pt}}{\frac{1}{2}sl\cos sl\,(\sec^2 sl+Sl/S_0 s^2 l^2)} \qquad (96)$$

represents the potential V at time t in the cable due to V_0 alone. Initially we have

$$0=V_0\Sigma\frac{\sin s(l-x)}{\text{same denominator}}, \qquad (97)$$

for any finite x in the cable. This exhibits the auxiliary expansion, V_0 being any constant. The complete expansion, showing V due to the initial V_0 on the condenser and $V=f(x)$ in the cable, is therefore

$$V=\Sigma\sin s(l-x)\epsilon^{pt}\frac{V_0+\int_0^l f(y)\left(\frac{S}{S_0}\cos-s\sin\right)sy\,dy}{\frac{1}{2}sl\cos sl(\sec^2 sl+Sl/S_0 s^2 l^2)}. \qquad (98)$$

This case is peculiar, inasmuch as the same operational solution serves for the elementary charge in the cable and for the terminal charge. The distinction is that Q is finite in one case and infinitesimal in the other. It is true that in (92) Q may be finite, but when we pass to an initial finite distribution of potential, it is replaced by Q dy, the charge on the element dy, which is therefore infinitesimal. On the other hand, the Q for the condenser is finite.

§ **296**. Another consideration presents itself here. It is a common error that only finite functions can be expanded in Fourier series. That this is wrong may be seen by the above investigation. Go back to (88). Let there be initially Q_1/S at y_1, Q_2/S at y_2, and so on up to Q_n/S at y_n, these points being separate. Then

$$v=\Sigma\frac{Q_n}{S}u_n\epsilon^{pt} \qquad (99)$$

will, by (88), represent the potential at time t due to the n point charges. Initially, v is zero except at the n points, but there it is infinite, with finite space totals, however. Combine with (98). If $f(x)$ is finite and continuous, $V+v$ is initially finite and continuous, except at the n points, where finite charges exist.

Nor need these condensations be themselves finite. The Q's may be infinite. It is, indeed, true that an infinite charge suddenly introduced at a point y would in an infinitely short time raise the potential of the whole cable infinitely. In this respect the solution would be of a useless nature. But we may combine the infinities so as to have finite results. The simplest case is first to have two finite point charges Q and − Q at distance z apart. Then bring them closer, increasing Q in the same ratio, so that Qz is finite. In the limit we have a point source involving a double infinity in Q, and a corresponding expansion of the potential in a F. series. Similarly as regards poles of higher multiplicity.

Nor does the matter end here. If the self-induction of the line be included, the initial state must include a specification of the initial current, as well as of V. Fourier series are involved, and such a series has to express the initial potential, whilst a connected series expresses the initial current. There may be points of initial infinite condensation in both series.

Another common error is that the expansion of a function in a series of sines and cosines of $n\pi x/l$, n being integral, is uniquely determined by Fourier's theorem. There are other expansions. To show this (in one way), let $Z_1=-Z_0$ in (85). Then $\tan sl=0$, or $sl=n\pi$, as in Fourier's theorem. But now $R^2-Z_0Z_1s^2=0$ also, or $R^2=Z_0^2q^2$, determines a distinct set of extra normal systems, of the type ϵ^{hx}, where h is constant. So we can expand a given function in terms of the usual $\sin sx$ and $\cos sx$, and the extra functions. The result is, therefore, to represent another function of x expanded in terms of the usual sines and cosines, with equally-spaced roots. But it is not the expansion got by Fourier's theorem, though it is equally true. I will give one or two examples in illustration of this.

(To be continued.)

MOLECULAR ELECTRICITY.

BY J. H. POYNTING, SC.D., F.R.S.

(Concluded from page 712.)

Now let us take a conducting dielectric such as water. As guiding us to an account of what goes on we have the facts (1) that, however small the E.M.F., conduction and presumably electrolysis take place, and no finite difference of potential can be maintained between the electrodes unless we continually supply fresh energy, and (2) that a solute such as sulphuric acid, which appears to combine with the solvent in some way,

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enormously increases the conductivity. From (1) we gather that some of the molecules must be just ready for change of partners, and from (2) we may at least guess that molecular groups are formed much more complex than the atomic pairs we have hitherto dealt with. We can see how such molecular groups might arise by the straying out and coalescence of induction tubes of neighbouring molecules, and the consequent formation of new connections. Thus, if two pairs come together, as in Fig. 17 (*a*), we may have them connected into a single group, such as (*b*), and any number of molecules may be brought into circuit in the same way, so that we may have a parallel

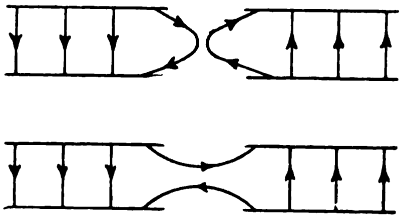

FIG. 17.

arrangement as in Fig. 18. Or if the coalescence occurs by the approach of two or more groups, such as Fig. 17 (*b*), we may have a series arrangement as in Fig. 19, the kind which we shall suppose to be effective in conduction. We must further suppose that small quantities of acids or salts in solution enormously increase the number of complex molecules. Some of these groups would appear to be more energetic than the initial pairs. Probably on that account they are continually breaking up and re-forming, the energy of translation being no doubt converted at each collision and reformation into energy of electrical separation. There are no doubt all

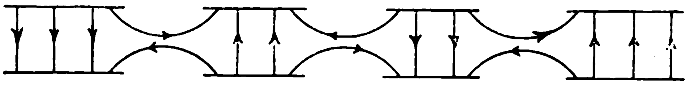

FIG. 18.

degrees of connection from those of Fig. 17 (*b*) and Fig. 19, where the result may be obtained practically by adding one closed ring tube of induction to a series of pair-molecules to the case where the tubes from each atom go half one way and half the other. But I imagine that at any given instant only a small fraction of the molecules are thus connected into groups or circuits.

If a tube of induction running from above downwards moves sideways into such a group as that in Fig. 19 or Fig. 20 (*a*), it finds the right side made ready for it, and we may possibly

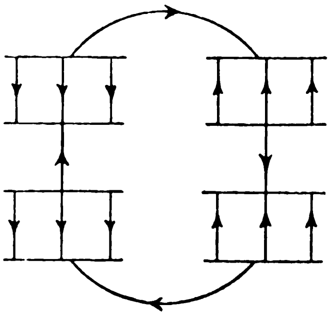

FIG. 19.

have in succession Fig. 20 (*a*) (*b*) and (*c*), where we suppose that the left-hand side splits up into pairs, while the right-hand remains threaded on the incoming line. When a liquid contains many such groups, some of the chains of molecules are almost ready made, and the chains are very easily completed from plate to plate, since the entering tubes have only to furnish a link, as it were, here and there. The "electric elasticity" $1/K$ will be a sort of average of the elasticities or of the difficulties of forming chains in all the various kinds of molecules present. To give a numerical illustration, let us have two condenser plates in a liquid in which we suppose that in the simply paired molecules, such as those on the left in Fig. 20 (*c*), the value of K is 1·77. Let us suppose also that these occupy 99 per cent. of the paths from plate to plate, while the other 1 per cent. is occupied by very much connected molecules with K equal to 7,500. Then if the capacity of the condenser in air were C, it would be with this arrangement of molecular paths

$$\frac{99 \times 1{\cdot}77\,C + 7{,}500\,C}{100} = 76{\cdot}76\,C,$$

or the resultant specific inductive capacity is 76·76.

But this is only true in the mass. If we have very minute electromagnetic waves going through the liquid they will for 99 per cent. of the molecules use $K = 1{\cdot}77$. For a very large fraction of the remaining 1 per cent. they will probably also use this K, for they are not concerned with the group as a whole, but only with the individual members to which they add or from which they subtract small quantities of induction; and as long as the points representing these members of groups are on the straight part of the characteristic their K for waves is still 1·77. We may therefore expect the value for small waves generally to be very little more than 1·77.

This appears to indicate a possible explanation of the high inductive capacity of such substances as water and alcohol. Accompanying this high value there is generally conductivity

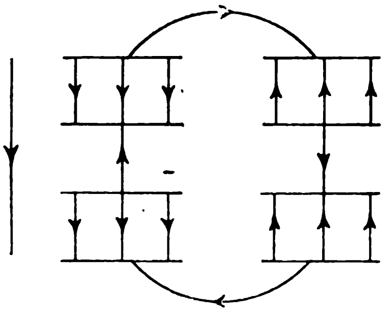

FIG 2 *a*.

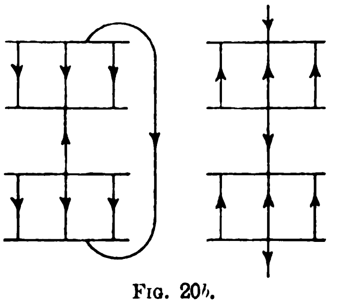

FIG. 20*b*.

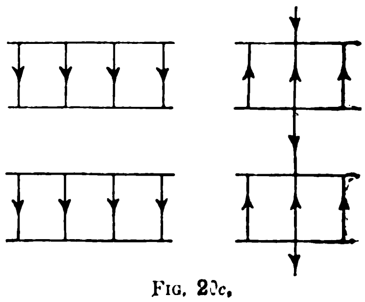

FIG. 20*c*.

and no doubt electrolysis. If we suppose that some of the groups are already so far towards decomposition that half the tubes from each atom run one way and half the other, tubes entering the substance will concentrate on such groups, for a further addition of induction will yield energy instead of requiring it, and the point of instability being passed electrolysis will occur. Perhaps even before the tubes are thus evenly divided, tubes entering the substance may prefer to pass through the groups rather than through the simply paired molecules, for while more energy may be stored in the one half of such a group as that represented in Fig. 20, when a new tube enters in it, less may be required in the discarded half, and so on the whole energy may be given up. But it does not seem possible to give any satisfactory account of the process in our ignorance of the real constitution of the complex molecules. All we can say is that some such process probably occurs, inasmuch as conduction does occur even with the smallest external E.M.F.

We may perhaps suppose that in metallic conduction we have a similar process. If the metallic molecular structure is very complicated, with many groups having unstable, or nearly unstable, construction then tubes of induction entering a metal

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will select such groups in preference to the more simple stable molecules and electrolyse them. To account for the absence of transfer of atoms along the line of current we must, I think, introduce the supposition of change of charge as already explained on p. 671, and to account for the continuance of conduction we must suppose that there is a continuous formation of new groups as the old ones are broken up. Perhaps we have here some key to the rise of resistance with rise of temperature. As the molecules become more energetic we may expect that the groups will be more broken up by the motions of vibration and translation, and that the number of unstable groups is diminished and their rate of formation is decreased. Hence the entering tubes will find fewer groups ready for them, and if the external E.M.F. remains constant, the rate at which the tubes are dissipated will be decreased. The difficulty of such explanation consists in understanding its inapplicability to electrolytes. Perhaps, too, we have here a hint as to the superior conductivity for heat of metals. If a metal consists largely of many-atomed groups entangled together, and continually breaking up and re-forming, energy supplied to one molecule will, we may imagine, be more readily transferred to its neighbours than if each molecule is self-contained and permanent. This will certainly be the case if energy given to an atom in a molecule is more rapidly transferred to its fellows in the same molecule than to atoms at the same distance in the surrounding molecules. To use an illustration which may put the suggestion in a clearer way, news will be transmitted through a population dwelling in villages and towns much more rapidly than through an agricultural population of the same average density scattered over a country in isolated homesteads.

The theory which I have been trying to set forth may be regarded as a theory of the conservation of induction tubes, and of their beginning and ending on atoms. That the atoms always have charges on them, and therefore have tubes proceeding to or from them, appears to be generally held as necessary if we accept the electromagnetic theory of light. If the molecules give rise to waves of electric induction they must necessarily be electric systems, and their parts must almost certainly be bound together by electric forces. Whether it is possible for an induction tube to exist without atoms is merely a matter at present of speculation. At present we know of no such thing. If such a tube do exist, it can only be as a closed ring, like a closed ring tube of magnetic induction round a current, for an unclosed tube would have opposite charges at its ends in free space, and charges not on matter are so entirely outside experience that we cannot accept their existence. The weight of evidence appears to me rather against the view of matter-free induction, and though at first we might be inclined to think that the passage of light waves across interstellar space implied such induction, yet even in this case we have possibly quite enough matter to supply atomic ends for the tubes to attach themselves to. If we accept the electric discharge theory of comets' tails we apparently assume the existence of enough matter to carry electric induction from a cometic nucleus outwards. I suppose that the theory implies that the nucleus is charged in one way, say positively, and that it has become separated from the matter bearing the negative, which remains far out in space. The sun is itself to be regarded as charged with the same sign as the nucleus, while the corresponding solar negative is also somewhere in space. When the induction of the comet is added to that of the sun the strain is sufficient to break down the feeble insulation of interplanetary space, and a discharge results straight out, or nearly straight out from the nucleus, and this discharge is through the interplanetary matter. But though this appears to be the only reasonable account of the discharge theory, after all it is bringing little more than a speculation to bolster up another speculation, viz., the existence of matter sufficient to carry waves of induction in the interatomic form wherever light waves travel.

At first sight this theory of molecular electricity appears to be very different from the chemical dissociation theory now generally held; but if the dissociated atoms of that theory have charges, they have also tubes of induction proceeding from the charges. When the tubes are taken into account they must, I believe, lead to some such hypothesis as that of which I have attempted an inadequate and imperfect explanation. I am only too deeply conscious of the difficulties unsurmounted. But in working at the subject I have felt all through that, since so much is nearly but not quite explained, there must be hope of progress on these or similar lines if we can only supply some as yet unrecognised idea. Perhaps the very imperfections of my account may stimulate some reader to take up the subject afresh from some better point of view, and, with new ideas, achieve success.

THE ELECTRIC ARC.

BY HERTHA AYRTON.

(Continued from page 639.)

In their Paper published in the American *Electrical Engineer* for August 2, 1893, of which I have already given an abstract (pp. 638, 639, *The Electrician*, September 13th), Messrs. Duncan, Rowland and Todd, after quoting—not quite correctly—the equations employed by various experimenters to connect the P.D. between the carbons with the current flowing and the length of the arc, said: "In fact, almost any results may be obtained by modifying the size and composition of the carbons." I shall show, however, from the results of the very experimenters whose equations they quoted that this is not the case, and that the *form* of the true equation connecting these variables is the same whatever the size of the carbons may be, and whatever their composition, as long as the carbons are solid. The values of the constants in the equation will, however, doubtless depend on the hardness of the carbons, and perhaps on their size.

It will be found, also, that although in certain cases my equation does not support the conclusions arrived at by previous experimenters, it is really more in accordance with the results of their own experiments than were the conclusions they themselves deduced from them.

If we take equation (4) in the form

$$W = 38{\cdot}88\,A + 11{\cdot}66 + (2{\cdot}074\,A + 10{\cdot}54)\,l. \quad (5)$$

and put $A = -\dfrac{10{\cdot}54}{2{\cdot}074}$ in it,

we have $W = 38{\cdot}88 \times \left(-\dfrac{10{\cdot}54}{2{\cdot}074}\right) + 11{\cdot}66,$

that is, we have two values for A and W which are independent of the value of l, showing that all the lines connecting A and W for the various constant lengths of arc must pass through one point, the co-ordinates of which are

$$A = -\frac{10{\cdot}54}{2{\cdot}074}$$

and $W = -38{\cdot}88 \times \left(-\dfrac{10{\cdot}54}{2{\cdot}074}\right) + 11{\cdot}66;$

or, $A = -5{\cdot}08$

and $W = -185{\cdot}92.$

Similarly, by putting $l = -\dfrac{38{\cdot}88}{2{\cdot}074}$, the coefficient of A disappears in the same equation, and we find that all the lines connecting W and l for the various constant currents must pass through a point, the co-ordinates of which are

$$l = -18{\cdot}7,$$
$$W = -185{\cdot}92.$$

Hence the laws upon which equation (4) is founded, and upon which it depends absolutely, may be put in the following form:—

1. The curves representing the connection between power and length of arc for various constant currents are straight lines.

2. The curves representing the connection between power and current for various constant lengths of arc are straight lines.

3. The straight lines representing the connection between power and length of arc for constant currents all meet at a point, both co-ordinates of which are negative.

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4. The straight lines representing the connection between power and current for constant lengths of arc all meet at a point, both co-ordinates of which are negative.

I shall now proceed to show that these laws are true, not only for the results of my own experiments, but also for the results of all the other experiments made with solid carbons that I have been able to find, of which detailed information has been published regarding the numbers.

Edlund gave only the ratios of the currents he used, so that it would not be possible to construct a complete equation, including all three variables from his results; but the equation he discovered, $r=a+b\,l$ for constant currents, is really another form of the first law I used, for if we multiply this equation throughout by the constant A^2 we obtain an equation of the form

$$W=\alpha+\beta\,l,$$

a linear equation connecting W and l for constant currents.

The resistance form of my equation (4) is

$$r=\frac{38{\cdot}88+2{\cdot}074\,l}{A}+\frac{11{\cdot}66+10{\cdot}54\,l}{A^2}, \quad . \quad . \quad (6)$$

and making A constant in this, we get an equation of the form

$$r=a+b\,l,$$

where $$a=\frac{38{\cdot}88}{A}+\frac{11{\cdot}66}{A^2}$$

and $$b=\frac{2{\cdot}074}{A}+\frac{10{\cdot}54}{A^2}.$$

Now Edlund concluded from the results of his experiments that a and b both diminished as the current increased (p. 636, *The Electrician*, September 13th), and this is borne out by the above values for a and b; but he also thought that a varied inversely as the current, which was not exactly correct, but only nearly so for all but small currents, for unless A were very small in the above value for a, the term $\frac{11{\cdot}66}{A^2}$ would be small compared with $\frac{38{\cdot}88}{A}$.

Further, that the values which Edlund found for $a\,A$ were not constant, as they would be if a varied inversely as A, but in every instance but one showed a decrease as the current increased, is very easily seen from the following table, which gives the results Edlund obtained from his experiments with arcs with carbon electrodes:—

Table XI.—*Results obtained by Edlund.*

Numbers proportional to A.	Numbers proportional to a A.	Series of experiments.
1·2387	0·3239	1
1·0176	8·3416	„
0·6661	0·3336	„
1·1139	6·69	2
0·9435	6·877	„
0·9618	6·34	3
0·7738	6·48	„
1·3270	4 45	4
0·9827	5·21	„

The experiments of one series must not be compared with those of another, for each was carried out under different circumstances. But a comparison of those in each series will show that, except for one in the first series, the product $a\,A$ increases as the current A diminishes, which is exactly what would follow from my value of $a\,A$, viz.:—

$$a\,A=38{\cdot}88+\frac{11{\cdot}66}{A}.$$

Hence deviations which Edlund mistook for errors of observation were evidently caused by the presence of the term corresponding with $\frac{11{\cdot}66}{A}$ in the value of $a\,A$, and what Edlund did not notice was that with one exception all his errors were *in the same direction.* Thus the conclusion to be drawn from my equation (4) with regard to $a\,A$, which Edlund called the back E.M.F. of the arc, is more in harmony with the results of his experiments than his own conclusion was.

It is hardly necessary to enter into Edlund's theoretical reasons for supposing the term $a\,A$ to be independent of the current, since his own results really proved that it was not so.

To show the fallacy of his theory that, with a generator of constant E.M.F., the total power expended in the arc was proportional to the current, I need only point out that, if it were so, A V would be equal to $k\,A$, where k is a constant, or V would be a constant for all currents.

In the experiments used by Frölich there was naturally no sort of order (p. 636, *The Electrician*, September 13th). Only in two cases were more than two currents employed with the same length of arc, and in no case was the same current used with more than two lengths of arc; thus it is impossible to construct a complete equation from them. Fortunately, however, several currents were used with an arc of 2mm., and by calculating the power expended from the numbers given for currents and P.Ds., I was able to plot the curve connecting watts and amperes for length of arc 2mm., and found it to be a straight line, as it should be according to the second law upon which my equation was founded.

The equation to this straight line obtained from the experiments used by Frölich was

$$W=40{\cdot}25\,A+68{\cdot}25,$$

from which we get the P.D. in volts,

$$V=40{\cdot}25+\frac{68{\cdot}25}{A}.$$

Table XII. shows the value of the P.D. for each current quoted by Frölich for the 2mm. arc, and the value calculated from the preceding equation.

Table XII.—*Results used by Frölich.*

Current in amperes.	From experiment.	From equation.
27·4	42·7	42·75
11·6	46·3	46·13
8·39	50·1	48·38
7·67	47·1	49·15
6·92	50·1	50·11

The general agreement of the values for V obtained by experiment and calculation is striking, considering that different pairs of carbons were used by different people in obtaining the experimental results, and this agreement renders it quite certain that V and A are connected by an equation of the form I have given.

Frölich's statement, therefore, that the P.D. between the carbons was independent of the current, and that the true equation was

$$V=m+n\,l,$$

where m and n were constant *for all currents*, was indeed astonishing, and still more so was the fact of his having given values for m and n—viz., 39 and 1·8, and having asserted that the equation

$$V=39+1{\cdot}8\,l$$

was true for all currents up to 100 amperes. For, to take only the numbers given in Table XII., which are for length of arc 2mm., his formula would give

$$V=42{\cdot}6 \text{ volts}$$

for all the currents, whereas 42·7 volts is the smallest P.D. for the largest current, and the P.D. for the smallest current is 50 volts, or 7½ volts greater than the P.D. as calculated by Frölich. Such discrepancies as these, however, he dismissed as errors of observation, and he, like Edlund, did not notice that all or nearly all these apparent errors of observation *were in the same direction.*

Since Frölich's equation for P.D. did not really express the results of the experiments upon which he founded it, it is unnecessary to dwell upon his equations for apparent resistance and power, which he deduced from that for P.D., and which, equally with it, were entirely at variance with the experimental results. Indeed, the only suggestion made by

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Frölich in his Paper that appears likely to prove true was that the cross-section of the arc was directly proportional to the current.

The first systematic attempt to find the P.Ds. that would send a given constant current through many lengths of arc was made by Peukert (p. 637, *The Electrician*, September 13th), who first, after Edlund, saw the value of eliminating one of the three variables, P.D., current and length of arc.

Having measured the P.Ds. corresponding with his various currents and lengths of arc, Peukert plotted curves connecting apparent resistance and length of arc, and found them to be straight lines. He gave the equations to these lines, and from them I have constructed the following equations connecting *power* and length of arc for each of the currents he used, by

From Peukert's Experiments.

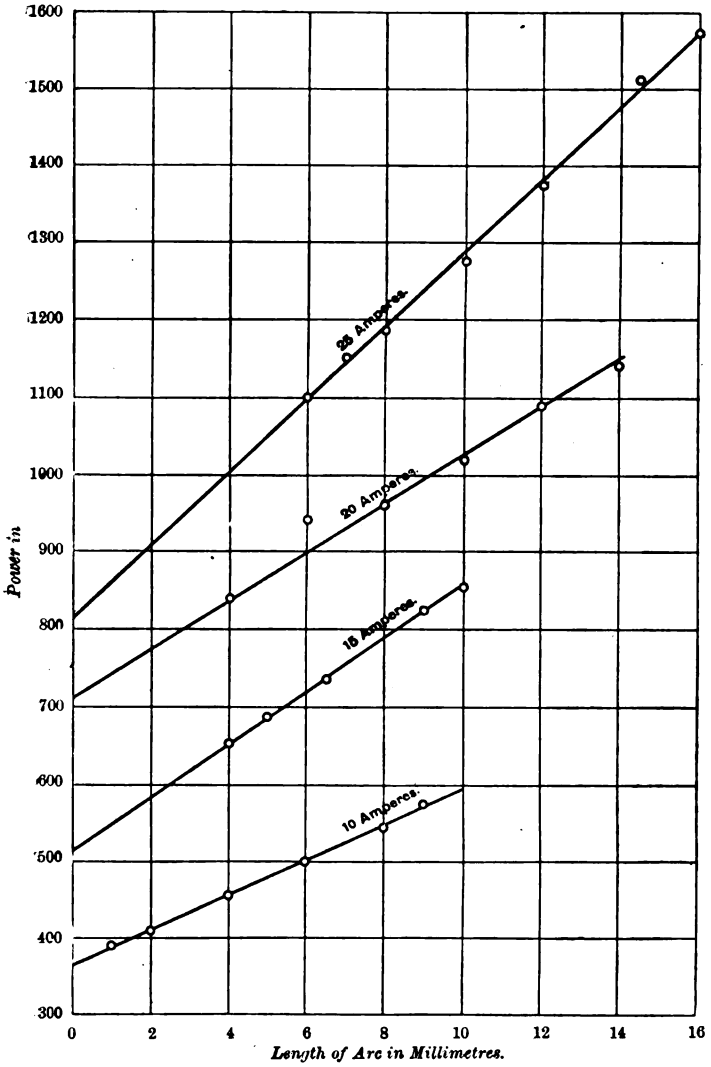

Fig. 42.—Watts and Length of Arc for Different Constant Currents.

multiplying each equation through by the square of the current which corresponded with it :—

For $A = 10$ amperes, $W = 366 + 23\,l$.
„ $A = 15$ „ $W = 517 + 33{\cdot}75\,l$.
„ $A = 20$ „ $W = 720 + 32\,l$.
„ $A = 25$ „ $W = 812{\cdot}3 + 46{\cdot}87\,l$.

These, when plotted, give the four straight lines seen in Fig. 42, and it is clear that the line for 20 amperes is wrong, as it does not make a large enough angle with the axis of l. Hence the coefficient of l, which determines the slope of the line, must be too small in the power equation for 20 amperes. And that that is the case is seen from an examination of these four power equations, for while the coefficients of l for 10, 15 and 25 amperes increase as the current increases, that for 20 amperes—viz., 32—is less than 33·75, the coefficient for 15 amperes.

Consequently the coefficient of l in Peukert's own resistance equation for 20 amperes—viz., 0·08—must also be too small. But this he was not able to detect, since it lay between 0·15 and 0·075, the coefficients of l for 15 and 25 amperes respectively. The above power equations which I have calculated from his resistance equations make us sure, however, that there was something wrong, either in Peukert's apparatus or with his observations for the current of 20 amperes.

If from the four lines connecting power and length of arc for each current we take the number of watts corresponding with length of arc 10mm., and plot them with their respective currents, and also the number of watts corresponding with length of arc 0mm., and plot them with their respective currents, we find, as was to be expected from what has gone before, that the values follow the second of the four laws I have formulated, and that the curves are straight lines (Fig. 43).

The equations to these lines are

$$W_{10} = 46{\cdot}22\,A + 129{\cdot}42,$$
$$W_0 = 30\,A + 66.$$

Substituting these values for W_{10} and W_0 in the equation

$$\frac{W - W_0}{l} = \frac{W_{10} - W_0}{10},$$

which is the equation to any one of the lines in Fig. 42 connecting power with length of arc for a constant current, we find the equation

$$W = 30\,A + 66 + (1{\cdot}622\,A + 6{\cdot}342)\,l,$$

representing the connection between watts, length of arc and current, when all three may vary.

Dividing throughout by A, we have—

$$V = 30 + 1{\cdot}622\,l + \frac{66 + 6{\cdot}342\,l}{A},$$

which is the general equation which Peukert might have obtained to express the results of his own experiments had he seen the importance of obtaining and employing the power equations.

In order to test how nearly the equation given above really expresses Peukert's results, we may divide by A, and obtain the equation for the apparent resistance of the arc :—

$$r = \frac{30 + 1{\cdot}622\,l}{A} + \frac{66 + 6{\cdot}342\,l}{A^2}.$$

If we now give A the values respectively of 10, 15, 20 and 25 amperes in this resistance equation, we find the equations on the right-hand side of Table XIII. :—

Table XIII.—*From Peukert's Results.*

Current in amperes.	Peukert's equations.	From the above general equation.
10	$r = 3{\cdot}66 + 0{\cdot}23\,l$	$r = 3{\cdot}66 + 0{\cdot}23\,l$
15	$r = 2{\cdot}3 + 0{\cdot}15\,l$	$r = 2{\cdot}29 + 0{\cdot}14\,l$
20	$r = 1{\cdot}3 + 0{\cdot}08\,l$	$r = 1{\cdot}67 + 0{\cdot}096\,l$
25	$r = 1{\cdot}3 + 0{\cdot}075\,l$	$r = 1{\cdot}31 + 0{\cdot}075\,l$

Comparing the two sets of equations, we find a striking agreement in the case of the first, second and fourth equations, while the third, which differs from that given by Peukert, expresses the result which Peukert would have obtained if he had not, as already explained, made an error when testing with 20 amperes.

Since the above equation expressing the results of Peukert's experiments is of exactly the same form as my equation (4), one would expect that his results would not only follow the two first laws upon which equation (4) was founded, but that they would follow the whole four of those laws, and such is, in fact, the case.

For, if we put $A = -\dfrac{6{\cdot}342}{1{\cdot}622}$ in the power equation for Peukert's results, the coefficient of l disappears, and we have

$$W = 66 - 30 \times \frac{6{\cdot}342}{1{\cdot}622}.$$

Hence $A = -3{\cdot}91$
and $W = -51{\cdot}3$

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are the co-ordinates of the point where all the lines connecting power and current for the various constant lengths of arc meet.

Similarly putting $l = -\frac{30}{1\cdot622}$, the coefficient of A disappears, and we get

$$l = -18\cdot5$$

and $$W = -51\cdot3$$

as the co-ordinates of the point at which all the lines connecting power and length of arc for the various constant currents meet.

Thus the *results* of Peukert's experiments completely fulfil all the four laws upon which my equation (4) is founded and are, therefore, completely in harmony with my *results.* I shall now show that where the *conclusions* he drew differ from mine, his own experiments prove him to be mistaken.

The resistance form of the general equation which I have deduced from Peukert's results may be put in the form

$$r = a + b\,l,$$

where $$a = \frac{30}{A} + \frac{66}{A^2}$$

and $$b = \frac{1\cdot622}{A} + \frac{6\cdot342}{A^2}.$$

The second term in the value for a is never very big compared with the first term with the currents Peukert used, for the numerator of the second term is only about twice as great as the numerator of the first, whereas the denominator of the second is at least ten times as great as the denominator of the first. Hence it is not very surprising that Peukert followed Edlund in asserting that a varied inversely as the current. Yet his own results show that this is not the case, for if it were, a A would be a constant, whereas multiplying the first term in each of Peukert's own equations by the corresponding current, the resulting numbers are 36·6, 34·5, 36, and 32·5, which go in descending order as the current increases, as my equation indicates that they should. The only exception is in the equation for 20 amperes, which I have already shown to be wrong. He saw, however, that b diminished more rapidly than the current, and this he was able to do because, on examining the expression I have given above for b, we see that the coefficient of the second term is four times as great as that of the first term. Hence even with fairly large currents the second term is not negligible compared with the first, and consequently Peukert was able to find an approximate law for the value of b, for which the last equation gives the full and exact law.

From the experimental observations published by Messrs. Cross and Shepard (p. 637, *The Electrician*, September 13th) I have plotted curves connecting the apparent resistance and length of the silent arc for each current they used, and have found an equation to each of these lines which fits their results rather more closely than those which they themselves gave. From these slightly more accurate equations I constructed the following equations connecting *power* and length of arc, by multiplying each equation by the square of the corresponding current, just as I had done with Peukert's equations, and found :—

For $A = 5\cdot04$ amperes, $W = 201\cdot3 + 13\cdot34\,l$
„ $A = 7\cdot0$ „ $W = 273\cdot0 + 13\cdot6\,l$
„ $A = 7\cdot92$ „ $W = 310\cdot0 + 16\cdot24\,l$
„ $A = 10\cdot04$ „ $W = 380\cdot0 + 18\cdot94\,l$

These, when plotted, give the straight lines in Fig. 44, and, like Peukert's curves, they show that one line—the line for 7 amperes—has the wrong slope, as may also be seen from the power equations. For evidently the coefficient of l for 7 amperes is too near in value to the coefficient for 5·04 amperes, and not near enough to that for 7·92 amperes.

Taking the number of watts corresponding with length of arc 10 from each of the four lines in Fig. 44, and plotting them with their respective currents, we obtain the upper line in Fig. 45, and plotting the watts for length of arc 0 with their corresponding currents, we get the lower line.

That these are straight lines is very evident, although one point of each is off the line, and it is thus evident that Cross and Shepard's results, as well as Peukert's, follow the second of my four laws. Fig. 44 shows that they also follow the first.

The equations to the two lines in Fig. 45 are

$$W_{10} = 48\,A + 93\cdot6,$$
$$W_0 = 37\,A + 14\cdot8.$$

Substituting these values for W_{10} and W_0 in the equation

$$\frac{W - W_0}{l} = \frac{W_{10} - W_0}{10},$$

which is the equation to any one of the lines in Fig. 44, we have

$$W = 37\,A + 14\cdot8 + (1\cdot1\,A + 7\cdot88)\,l$$

as the general equation connecting the power, current and length of arc, when any of the three may vary, for Cross and Shepard's results.

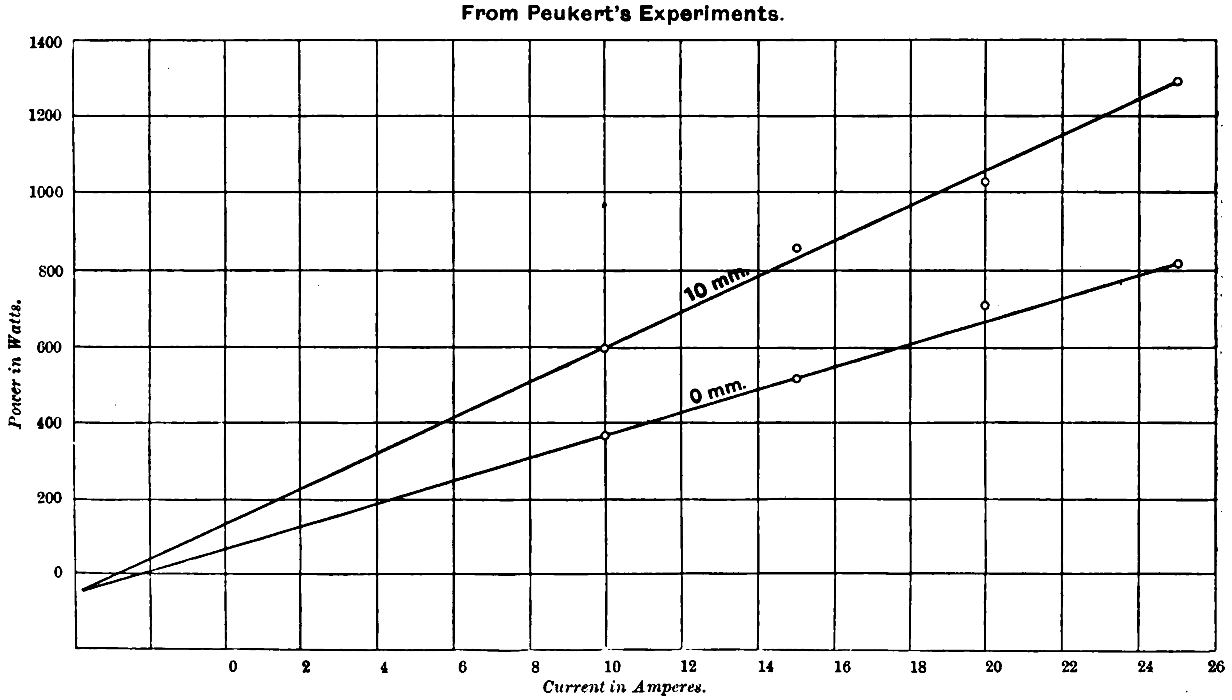

FIG. 43.—Watts and Current for Arcs of 10mm. and 0mm.

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Dividing by A we have

$$V = 37 + 1{\cdot}1\,l + \frac{14{\cdot}8 + 7{\cdot}88\,l}{A},$$

as the general equation connecting P.D., length of arc and current for the Cross and Shepard results.

If now we divide this last equation throughout by A we get

$$r = \frac{37}{A} + \frac{14{\cdot}8}{A^2} + \left(\frac{1{\cdot}1}{A} + \frac{7{\cdot}88}{A^2}\right) l$$

for the resistance equation, and giving A the values of the currents they used, we get the equations on the right-hand side of the following table:—

Table XIV.—*From Cross and Shepard's Results.*

Current in amperes.	From experiments.	From general equation.
5·04	$r = 7{\cdot}925 + 0{\cdot}525\,l$	$r = 7{\cdot}923 + 0{\cdot}528\,l$
7·0	$r = 5{\cdot}57 + 0{\cdot}277\,l$	$r = 5{\cdot}59 + 0{\cdot}317\,l$
7·92	$r = 4{\cdot}94 + 0{\cdot}259\,l$	$r = 4{\cdot}91 + 0{\cdot}264\,l$
10·04	$r = 3{\cdot}77 + 0{\cdot}188\,l$	$r = 3{\cdot}83 + 0{\cdot}187\,l$

The two sets of equations do not agree as well as those obtained from Peukert's results, because the range of current

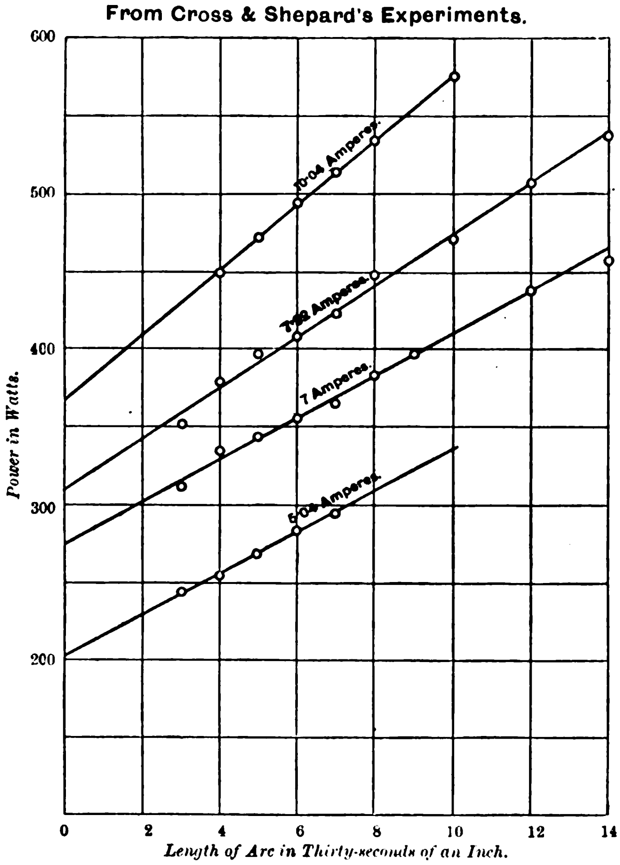

FIG. 44.—Watts and Length of Arc for Different Constant Currents.

was so much smaller, and the exact course of the lines was, therefore, much more difficult to obtain, but they agree quite closely enough to show that my general equation does really give the connection between the three variables, even if the straightness of the lines in Figs. 44 and 45 had not already shown it.

The co-ordinates of the point at which the lines in Fig. 44 meet may be found in the same way as similar co-ordinates have been found previously. They are—

$$A = -7{\cdot}16$$

and $$W = -250{\cdot}12.$$

Similarly, the co-ordinates of the point at which the lines in Fig. 45 meet are

$$l = -33{\cdot}64$$

and $$W = -250{\cdot}12.$$

. Thus, Messrs. Cross and Shepard's results also follow the four laws upon which my equation is founded.

Besides calculating the values of the constants a and b in the resistance equation $r = a + b\,l$, Messrs. Cross and Shepard gave the value of the product a A for each of the currents used. As already mentioned, Edlund, Frölich and Peukert had considered that this product was on the whole a constant, and this constancy Edlund regarded as proving the existence of a constant back E.M.F. in the arc. Messrs. Cross and Shepard, however, showed that the product diminished as the current increased; they did not give the actual law of variation, which, in my remarks on Peukert's equations, I have pointed out is

$$a\,A = \text{constant} + \frac{\text{constant}}{A};$$

but to them is due the credit of first noticing that as a increased a A diminished, and also of pointing out that Peukert's equations, when correctly interpreted, led to the same conclusion.

The formula given by Prof. Silvanus Thompson in 1892 (p. 638, *The Electrician*, September 13th),

$$V = m + n\frac{l}{A},$$

where m might vary from 35 to 39 volts, and n might have values from 8 to 18, was the first real attempt to find an equation connecting the P.D., current and length of the arc when all three varied.

Multiplying his equation throughout by A, we have the equation for the power

$$W = m\,A + n\,l,$$

which gives straight lines for power and length of arc with constant currents, and straight lines for power and current with constant lengths of arc.

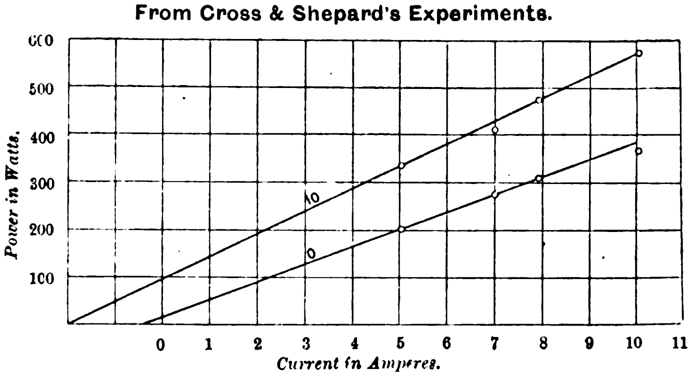

FIG. 45.—Watts and Current for Arcs of 10 thirty-seconds of an inch and 0 thirty-seconds of an inch.

Thus far, then, Prof. Thompson's formula agrees with mine, and when we consider that it was only put forward as an approximate formula founded on no special experiments, we must see that it needed great insight into the true nature of the connection between the variables to unravel that connection so far.

If, however, we compare the above equation more in detail with mine, we find that there are radical differences between them.

For my power equation (5)

$$W = 11{\cdot}66 + 38{\cdot}88\,A + 10{\cdot}54\,l + 2{\cdot}074\,A\,l$$

contains a term independent of both A and l, and a term containing the product of A and l, whereas Prof. Thompson's power equation,

$$W = m\,A + n\,l,$$

contains neither of these.

The term 11·66, which is independent of both current and length of arc, in my power equation shows that there must be a certain minimum power expended in the arc, whatever its length and the current flowing through it; for however small A and l may be, W can never be less than 11·66. This minimum power is not indicated in Prof. Thompson's equation. Its physical meaning I have not yet fathomed, but it appears to be the part of the power that varies most with different sorts

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of carbons, for in the equation from Peukert's experiments the term which is independent of A and l is 66, or more than five times as great as in my equation, and in Cross and Shepard's it is 14 8, whereas all the other three constants have very much more nearly the same value in the three equations.

The difference introduced by the presence of the term involving the product $A\,l$ is best seen by considering the equations for the P.D. Prof. Thompson's equation may be written

$$(V-m)\,A = n\,l.$$

Mine, when put into the same form, becomes

$$\{V-(38{\cdot}88+2{\cdot}074\,l)\}\,A = 11{\cdot}66+10{\cdot}54\,l.$$

Prof. Thompson stated at the meeting of the British Association in Ipswich last month that his equation was founded on experiments made by different students at different times, with different carbons, and with different currents produced by different generators, and that the variations of m and n appeared to depend upon some of these differences, but he could not quite tell which.

Under these circumstances it is difficult to know whether his n is to be regarded as constant for a fixed length of arc or not. Supposing that it is, however, then his equation agrees with mine in representing a family of rectangular hyperbolas having one asymptote in common—viz., the axis along which P.D. is measured. The other asymptote, which is parallel to the axis of current, is distant from that axis by a length equal to m in Prof. Thompson's equation, and to $38{\cdot}88+2{\cdot}074\,l$ in mine, where the unit of length is that which has been arbitrarily taken to represent a volt. m is stated in Dr. Thompson's equation to vary between 35 and 39 volts; hence, whatever the length of the arc, the horizontal asymptotes must all be between these limits, or practically the rectangular hyperbolas in Fig. 33, page 419, *The Electrician*, July 26th, ought, according to his equation, all to have nearly the same horizontal asymptote. This is clearly not the case, and my equation above shows that with the carbons I used the distance of this asymptote from the axis of current varies between 38·88 volts for l equal to 0mm, and 59·62 volts for l equal to 10mm.

Hence the m in Prof. Thompson's equation, instead of having a nearly constant value of 35 to 39 volts, varies in reality between wide limits as the length of the arc is varied.

Another result of the absence of the two terms we have been discussing in Prof. Thompson's equation is that neither of the two sets of lines represented by his power equations meet at a point, for there is no way of obtaining an equation between W and A which shall be independent of l, or an equation between W and l which shall be independent of A, except by making n in the first case and m in the second case equal to 0. But neither m nor n can equal 0, for we know the limits of their values, therefore neither of the sets of lines can meet at a point.

The Paper of Messrs. Duncan, Rowland and Todd's, from which I have already quoted, begins with a list of the equations used by other experimenters, among them

$$V = m + b\,A\,l,$$

attributed to Edlund, and

$$V = a\,A + b\,A\,l,$$

attributed to Cross and Shepard.

What Edlund, and also Cross and Shepard, really proved, however, was that for any particular value of the current the equation connecting the apparent resistance of the arc with the length was

$$r = a + b\,l,$$

where a and b were constants for the particular current. But when the current was increased they showed that a and b both diminished; therefore, while it is perfectly correct to add together $a_1\,A_1$ and $b_1\,A_1\,l_1$, in order to find V_1, the P.D. between the carbons for a length l_1 and for a current A_1, for which the values of a and b are a_1 and b_1, it is entirely wrong to attribute to Edlund, or to Cross and Shepard, as Messrs. Duncan, Rowland and Todd have done, the general equation

$$V = a\,A + b\,A\,l,$$

where a and b appear to be constant for all values of A and of l.

It seems to me desirable to draw attention to this correction, because the version of Edlund's and of Cross and Shepard's equations given by Messrs. Duncan, Rowland and Todd have been subsequently quoted as correct by others, who have, I presume, not referred to the original publications.

Messrs. Duncan, Rowland and Todd gave the values of the P.D. and current obtained experimentally for one length of arc ⅛in. long obtained with cored carbons. On calculating from these the values of the power, I find that the curve connecting power and current is very nearly a straight line, and therefore very nearly fulfils my second law; but whether it would, but for errors of observation, have completely fulfilled it, it is impossible say. I have before mentioned that for *cored* carbons the curve connecting power and current was only *almost* a straight line; it will require further experiment to prove whether it should be quite straight or not.

The equation to the straight line obtained from Duncan, Rowland and Todd's experiments is

$$W = 40{\cdot}6\,A + 84{\cdot}17;$$

therefore for the P.D. we have

$$V = 40{\cdot}6 + \frac{84{\cdot}17}{A}.$$

In Table XV. is given a comparison of the values of the P.D. obtained experimentally by Messrs. Duncan, Rowland and Todd, and the values calculated from the preceding equation.

Table XV.—*From Duncan, Rowland and Todd's Results.*

Current in amperes.	P.D. in volts.	
	From experiment.	From the equation.
3·1	65·0	67·8
4·6	58·5	58·9
6·15	54·8	54·3
7·7	52·5	51·5
8·0	52·0	51·1
9·82	49·2	49·2
11·26	47·5	48·1
12·75	46·5	47·2

With the exception of the first P.D., which is on the steepest part of the curve connecting P.D. with current, where a very small error in the current would make a considerable difference in the P.D., none of the P.Ds. calculated from the equation differ by more than one volt from those obtained by experiment, and only one differs by as much as that. Thus it seems highly probable that even for cored carbons a linear law does really connect power and current for a constant length of arc.

It is, of course, impossible to tell from the table given whether the first law connecting power and length of arc for constant currents is borne out by Duncan, Rowland and Todd's results, for they only gave the results for one length of arc. In any case, however, it was amply proved by the experiments of Prof. Ayrton's students with cored carbons, which I have published in *The Electrician*, that the curve representing the connection between power and length of arc for constant current is *not* a straight line for cored carbons.

Messrs. Duncan, Rowland and Todd gave as the equation connecting V, l and A,

$$V = m + f(l)\,f(A) + n\,f'(l)\,f'(A),$$

but, as the form of the functions was not stated, it is, of course, impossible to make a comparison between that equation and the one at which I have arrived.

To sum up then, it appears that wherever experimenters have given numbers which allow of their being tested by an equation of the form

$$V = a + b\,l + \frac{c + d\,l}{A}$$

they are found to satisfy such an equation with remarkable accuracy. Hence, so far from the different experimenters on the arc having all obtained different results, as has hitherto been supposed, their results present a striking unanimity when viewed by the light of the wider generalisations in which I have been able to present them.

(*To be continued.*)

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THE COLLINSON AMPERE-HOUR METER.

The problem of a cheap yet efficient ampere-hour meter, for use in electric supply systems, has been attacked by Mr. P. Collinson, for some years the chief engineer at the Morecambe electric supply station. The accompanying illustrations depict the instrument which is the outcome of his researches. Mr. Collinson has adopted a principle of action in his meter with which many before him have tried and failed, and it will be a highly creditable result, if he succeeds in making the instrument a commercial success. That a cheap meter is a

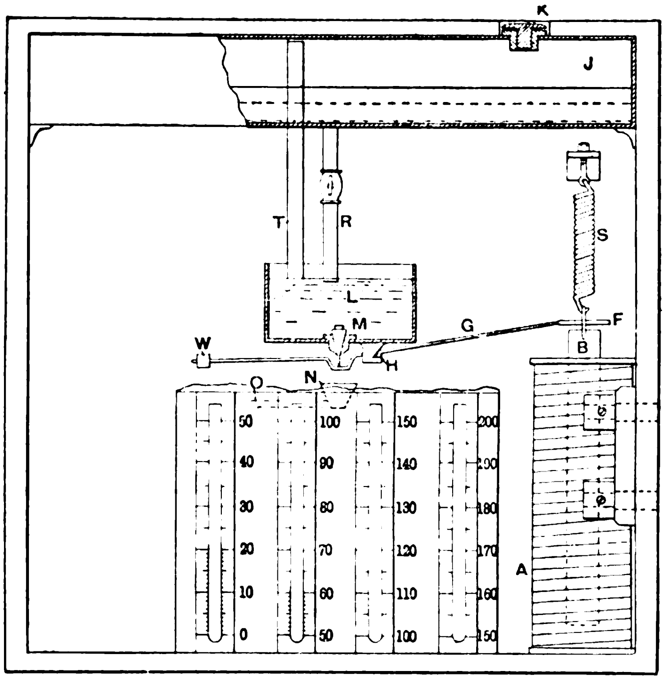

Fig. 1.—Collinson Ampere-Hour Meter: Vertical Section.

great desideratum it goes without saying; and we understand that Mr. Collinson intends to supply his for less than £3. The principle to which we have just referred, is the measurement of electric quantity in terms of the weight or volume of a liquid permitted to pass through a throttled passage, the amount of constriction depending upon the electric current.

Fig. 1 represents a vertical section of a small meter, designed for a range of current of from 0·3 to 5·0 amperes, at an electric pressure of 115 volts. Fig. 2 shows a plan of the liquid

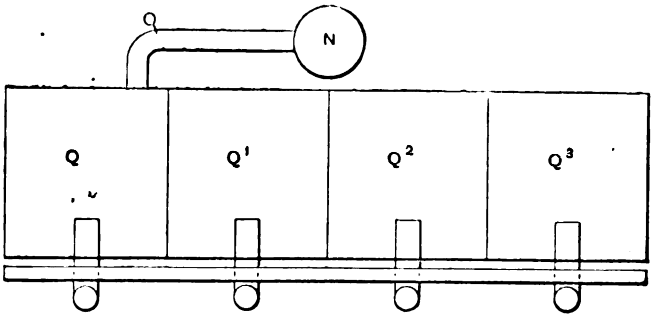

Fig. 2.—Collinson Ampere-Hour Meter: Plan of Liquid Storing Tank.

storing tanks. A solenoid, A (Fig. 1), in the circuit of the current to be measured, has within it a soft-iron core, B, suspended by a link from the coil spring S. In the link, and free to move vertically, is the soft-iron armature F, attached to the end of the lever G, which is suspended at the fulcrum H. Normal equilibrium is obtained by the counterpoise W. There is an air-tight storage tank, J, with a filling hole and screwed cap at K. The open cistern, L, is fitted at the bottom with an outlet valve at M, below which there is a funnel, N, connected by a pipe, O, to the first of a series of tanks, Q (shown in plan in Fig. 2), for collecting and storing the liquid. The reservoir tank, J, is provided with two tubes, R and T, for maintaining a constant level of liquid in the cistern L.

The action of the minimum current (0·3 ampere), though not sufficient to cause movement of the core B, yet magnetises it, and causes the armature F to be drawn down, thus slightly depressing the lever G, and opening to a small extent the orifice, by which a slight discharge of liquid takes place. An increase of current causes the core B to be drawn into the solenoid, and thereby opens the valve M wider, allowing a greater escape of liquid in proportion to the current. The series of storing tanks are arranged that each will overflow into the next; and the level of the liquid in each is indicated on a gauge. The scales behind the gauges are graduated to read in Board of Trade units. The particular meter shown is designed to register at the rate of 600 watts. Meters ranging to 50 amperes are contained in wooden cases measuring 12in. × 12in. × 6in.; and it is claimed they will run for six months without attention.

THE ELECTROLYSIS OF MILK.

In a somewhat lengthy Paper recently sent us by Mr. C. E. S. Phillips, the author, after referring to some of the tests adopted for ascertaining the purity of milk, proceeds to describe experiments undertaken to discover whether electrolysis would offer a more expeditious and reliable method than those in use. On electrolysing a sample of milk between platinum electrodes, the anode became coated with a white, spongy-looking material which increased until so thick upon the plate that it ultimately became disengaged and floated to the surface of the milk; it was observed on making experiments in this way that the white deposit consisted principally of a mixture of caseine and fat, that the milk gave off a characteristic odour during the electrolysis, and it was found to be slightly alkaline after the operation. The liberated caseine floating upon the milk seemed to show that owing to alkalinity of the solution it had become insoluble; it was, however, evidently due to the lifting power of the gas bubbles clinging to it. By continuing the electrolysis further it was possible to extract practically all the solids from the milk used (30 cubic cm.), leaving a transparent solution behind; at the same time no appreciable deposit of any kind took place at the negative electrode. Tests made with litmus paper during electrolysis showed that the action was extremely local; it was, however, noticed that the froth on the negative electrode produced by a too rapid electrolysis was strongly alkaline. The formation of caseine on the positive electrode was then studied in a miniature cell under the microscope. On making the circuit bubbles of gas appeared upon each electrode, more of course at the negative one, but at the anode a yellowish deposit grew and spread uniformly out towards the opposite electrode. A dark ridge was built up about equidistant all along the electrode, and became more definite till the band widened out on either side, and concentrated at a point immediately opposite the cathode. Very peculiar movements could be made to take place in this band by making and breaking the circuit rapidly. Photographs showing these changes are given by the author. A drop of litmus used to stain the milk showed that an acid and an alkali were formed at the anode and cathode respectively, evidently accounting for the deposition of caseine at the former. The action would appear to be similar to that which takes place when milk is exposed to air for some days; lactic acid is formed, which throws down the caseine. By electrolysis, however, the action can be started and stopped as desired, so that any portion or all of the caseine can be removed from the milk. Next a small vessel was divided into three compartments by means of two porous partitions, and the effects recently described by M. Andréoli were tried. About 10 cubic cm. of milk were poured into the centre division, while the anode and cathode compartments contained a solution of sodium chloride. On the passage of the current a deposit was formed in the centre compartment on the side of the partition separating it from the anode. When all three compartments contained milk, the deposit occurred on the sides of both partitions furthest from the anode. Under these circumstances it seems that an action takes place in the milk in the centre compartment. No deposit took place upon metallic plates immersed in the milk in either case. Some experiments upon the preservation of milk by means of this electrical withdrawal of a portion of its caseine were made, but with no success so far. Mr. Swinburne mentions, however, that milk can be sterilised electrolytically (*The Electrician*, Vol. XXIX., p. 391). In conclusion, the author states that platinum is the most suitable material to use for electrodes in the electrolysis of milk, as the lactic acid formed attacks most other metals. Aluminium can, however, be used in certain cases for the positive electrode, but it is eventually dissolved, and consequently of little use for quantitative work.

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The Electrician.

The Oldest Electrical Journal (1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher, "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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PROGRESS OF THE POSTAL TELEGRAPH SERVICE.

Last week we had to comment upon a feature of the POSTMASTER-GENERAL'S Annual Report as unpleasing as it was novel. Another, equally novel, but far more interesting, portion of that Report calls for further observations to-day. We refer to the "Historical Outline of the Telegraph Service since 1870" contained on page 33, and reproduced at length in our present issue. This memoir appears as a fitting landmark in the progress of telegraphy under Post Office management for the past quarter of a century; and its compilation, at once lucid and compact, is in most respects worthy the occasion. The historical survey is taken up principally with what may be called the traffic returns of the period, and the engineering department; a very natural preponderance of attention being given to these items, which reflect the greatest credit on the management. On the financial side of the subject comparatively little is said, but quite sufficient to indicate that more—very much more—remains unexplained. Regarded as a public servant the Telegraphs is all that could be desired, and its achievements are set forth with evident confidence and pride. Not so regarded as a financial undertaking; and the perfect frankness, not to say complacence, with which its failure in this respect is announced, suggests the reflection that while success in one direction is a subject of general congratulation, failure in the other direction is a matter of indifference. The account is supposed to emanate from the head of the Post Office; we cannot help wondering whether the same philosophical tone would have characterised the financial part of it had it been written by the head of the Telegraph Department.

As to the splendid career of the Telegraphs, apart from its shortcomings as a revenue-earning concern, there can be no question. The enormous outlay on wires and plant during the first few years after 1870, although considered extravagant at the

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time, proved to be none too great for the overwhelming growth of business with the increased facilities which these extensions afforded. In a very short time the traffic had doubled, and just prior to the reduction of the tariff to 6d. in 1885 the number of telegrams had risen from 7,000,000, at which it stood at the time of the transfer, to no less than 33,000,000. The outlay, having been on a far-seeing and liberal scale in the first instance, had not increased in nearly the same ratio, the additional work being disposed of easily by means of improvements in electrical methods and appliances. Without these improvements, it may be confidently said that no reduction of rates, with its consequent burden of messages, would have been possible. The effect of lowering the initial charge from 1s. to 6d. was to swell the number of messages from 33,000,000 to almost double in less than four years; and the growth has gone on increasing until now, when the annual total stands at about 72,000,000 per annum, or ten times what it was when the State took over the work. No other country in Europe makes such extensive use of the telegraph, and we have yet to learn that these magnificent figures are exceeded in the United States. If the efficiency of the Telegraphs may be measured by the use that is made of it, nowhere is it so trustworthy as in the British Isles.

But this does not by any means represent the aggregate amount of telegraphing crowded on to the wires in this country, where the Press tariff is so low as to attract no fewer than 650,000,000 words annually. The aggregate for all other messages is only 970,000,000, so that the Press alone appropriates two-fifths of the whole traffic, and as the average length of each Press message is 120 words, whilst that of an ordinary message is less than 15, it will be seen that the nominal total number of telegrams is no criterion of the actual work performed. Taking this fact into account, the business of the Telegraphs has increased since 1870, not ten-fold, as is claimed, but more probably fifteen-fold. The number of offices has increased rather more than three-fold, and the mileage of wire less than four-fold. Instruments now number 26,000, against 4,000 at the beginning of the period, but this increase may be set down largely to a vast augmentation in the number of small offices and minor circuits, not wholly to increase of work.

These last-named figures bring us to the most striking feature of the case—namely, the comparatively small expenditure on material and appliances for such a rapid and enormous growth of business. The official mind appears to be fully alive to this fact, giving ungrudging praise to the Technical Department of the Telegraph Service for its enlightened policy in accepting inventions and new ideas from outside sources, and for its zeal and ingenuity in effecting improvements on its own account. But for the spirit prevailing in this Department, differing, by all accounts, from every other State department, the Service must either have utterly broken down, or a vast outlay have been incurred in the multiplication of wires and apparatus. Instead of this, by accepting the best devices forthcoming from America, and by adapting them to the climatic conditions of this country, by unremitting labour in perfecting the fast-speed instruments of English origin, and by supplementing them with repeaters of original design, circuits which formerly were worked at the rate of 50 words a minute can now dispose of 500; and each wire which normally only carries one message at a time can now at pleasure be made to convey four and even six at the same time. Making every allowance for the costliness of the appliances needed for these operations, it is hardly an exaggeration to say that every increase of traffic is met, not by fresh demands on the exchequer, but by the extended application of electrical devices under the guidance of the technical officers of the Department.

It is perhaps necessary to emphasise this statement, because a little further on the results are ascribed—probably by a slip of the pen – to the "officers of the Post Office." One might, with just as little truth, ascribe the failure of the Telegraphs financially to the engineering staff. In reality the two departments appear to be now as widely apart as ever they were, the officers in one section being all telegraphists by profession, whilst in the other they are all post-office officials. For the efficient working of the Telegraph Service the former are primarily responsible, and they have reason to be proud of their achievements. For the financial failure of the Service the responsibility, such as it is, must always rest with the Post Office. We have spoken of the head of the Telegraph Service; but there is no such head, or, at all events, none that is at once responsible for and solicitous of the reputation of the Telegraphs as distinct from that of the Post Office. If such an officer existed he would not admit that the Telegraphs cannot pay; he would probably deny that it does not pay. More than one Postmaster-General has declared that it is impossible to separate the accounts of the two services on anything approaching equitable lines; and so long as the Telegraph Service is without any representative on the postal staff, who have the sole control of its finances, so long will the public be dissatisfied with the excuses put forward for the financial deficits proclaimed year after year in the Telegraphs balance sheet. It may be that the figures represent the real facts; but it would be more satisfactory if someone with an interest in the Telegraph Service had a hand in preparing them. In any case, supposing them to be fair and true, the responsibility must, as we have said, rest with the Post Office. Nobody but the Post Office would have so long endured the imposition of such absurdly generous Press rates, or of railway free messages, or the drain upon telegraph revenue due to private telephonic enterprise. A great public department may have its own reasons for pliability in such important particulars, but that is only an argument for assimilating the two services in reality as well as in name. So long as they are kept separate so long will the Post Office proper be tempted to swell its reputation for liberal concessions to the public at the expense of a service in which it has no personal or historic interests to preserve or safeguard against unreasonable and unprofitable concessions.

REVIEWS.

Motive Powers and their Practical Selection. By REGINALD BOLTON. (London: Longmans, Green and Co. 1895.)

This little book consists mainly of a heterogeneous compilation of engineering data and details of practice, the professed purpose being to assist an ordinary or non-technical person in the selection of motive power for any class of work he may wish to accomplish. All the various sources of power, and the engines in which they are usefully developed, are considered; and about each one a quantity of more or less reliable and accurate information has been compiled. Nevertheless, we cannot consider that Mr. Bolton's book has successfully hit the mark at which he aimed. To the non-technical reader, it will be a composite mass of figures and statements; difficult to comprehend, and not infrequently misleading or absolutely incorrect. To the engineer it supplies no information which is not far better and more reliably given in the standard treatises with which he ought to be familiar. To that intermediate and unsatisfactory individual, the man whose little knowledge has reached the danger mark, such works as this may prove of some assis-

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tance in the perpetration of *dilettante* and amateurish engineering; and it is often such people as those who belong to this class, who first of all do a job badly, and afterwards have to call in a professional engineer to help them out of their troubles and put things right. Let us seek to justify these criticisms by more direct reference to some of the contents of Mr. Bolton's book. Here is a quotation from an early chapter:—

"The conduction of the current over a wire involves a certain loss by friction, which must be allowed for, and of which tables are given, rendering elaborate calculation unnecessary."

Or again, describing secondary batteries, he writes:—

"They are boxes containing alternate frames or plates of various compositions, chiefly based on lead, which being immersed in dilute sulphuric acid, one set are decomposed by the action of the electric current and deposited upon the other."

It is a comfort to be told that "electricity is incapable of explosion of any kind"; but what does the statement mean? Or, what guide to the selection of motive power is disguised beneath the statement that "an electric motor is practically a dynamo reversed," which is all the description of these motors which we can find; unless, we are to couple this statement to the assertion that "a dynamo is extremely simple to manage." The voltages which do not give dangerous shocks are "110, 105, 100, 85, 65, 60 and 50," which to know may be useful in its way.

We find, however, a considerable amount of accurate information in this book; much of which might be gleaned and sifted out by a student possessing sufficient experience to enable him to distinguish between wheat and tares. The chapters on steam plant are particularly replete with such information, either in the form of tables or of general statements.

The Practical Telephone Handbook and Guide to the Telephonic Exchange. By Joseph Poole, A.I.E.E. Second Edition. (London: Whittaker and Co. 1895).

An admirable idea of the equipment and operation of a telephone system, whether for but one or two subscribers or for a large multiple exchange, is to be derived from a perusal of this well-arranged and well-written little treatise. We can heartily recommend Mr. Poole's book to all who desire to receive an intelligent general instruction in the subject, and who wish not to be too much burdened with technical matters. A subscriber, for example, curious to learn something of the ins-and-outs of telephone work; a telephone employé, anxious to gain an elementary knowledge of the principles and working of the industry with which he is connected; or the student, or the amateur telephone maker; might with undoubted advantage peruse the pages of the volume before us. We are glad to find that very little space has been devoted to the ancient history of the subject; the chapter devoted to this being short, and happily destitute of many of the fossils which it is too often the custom to trot out in small manuals and elementary textbooks. No one but an antiquarian feels very keen interest in model ears made of pig's bladder and timber. The chapters describing the various transmitters and receivers now in common use are very well written; the material having been well chosen with a view to practical utility, and showing evidence of an acquaintance with practice in other countries than our own. By developing gradually the subject of switches and exchanges, and starting with the simplest arrangements of telephone circuits, the author brings his descriptions even of the complications of elaborate exchanges within the comprehension of a non-technical reader; and his descriptions are supplemented by a number of well-drawn illustrations, mostly of details drawn to scale. When the author tells us that "punning is very important, and should on no account be scamped," he is not referring to the vicious misuse of words, but is describing how an important operation in "outdoor construction" should be carried out; and the chapter which he devotes to this branch of his theme is full of practical advice and information. A short chapter is devoted to "Long-Distance Working," and contains some account of the induction trouble and its remedies. The author appears to put entire faith in the much-debated K.R. law. Since the issue of the first edition of this book, the practice of metallic-circuit working has been developed very extensively, and a chapter on this important extension of practice deals with the subject in a brief but clear and useful manner. The author expresses the view that "as electric lighting and electric traction are getting so general, it is becoming absolutely necessary to discard the earth return."

A First Book of Electricity and Magnetism. By W. Perren Maycock. Second Edition. Thoroughly revised, corrected, and greatly enlarged. (London: Whittaker and Co.)

The author has written this little book "for the use of elementary science and engineering students, and general readers," and it may be safely recommended to those for whom it is intended. We have no desire to make captious criticisms of a little manual which is so generally excellent, but we would suggest to the author that the Ewing molecular theory of magnetism and the researches of J. J. Thomson and others on the electrolysis of gases warrant a more exact explanation of the supposed cause of magnetic retentivity, and a more qualified statement as to the invariability of the sign of the atomic charge. Beginners, we have frequently observed, have a particular liking for complicated mnemonic rules, giving the direction of the current in a wire when the deflection of a compass needle is known, and so on; and the author has amply satisfied their wants in this direction. Indeed, the whole book bears evidence that its writer has had considerable experience in the teaching of elementary students.

Electricity in Our Homes and Workshops. Third Edition. By S. F. Walker. (London: Whittaker and Co. 1895.)

In this short treatise the author has sought "to explain in simple terms the ordinary everyday working of some forms of electrical apparatus that are in use by outsiders, and not under the constant supervision of trained electrical engineers." Commencing with a glossary, in which a number of popularly expressed explanations of electrical terms have been collected together, the author passes on to consider, in successive order, the properties of the electric circuit, the simplest phenomena of magnetism, and galvanic batteries. Thus is the first half of the book arranged; the remaining half being devoted to the elements of practice connected with electric bells, electric mining signals, and telephonic apparatus. The descriptions are free from difficult technical details, and are such as might readily be comprehended by non-technical readers. And to this class of readers this little book may be recommended. The work is copiously and, in general, usefully illustrated.

GAS ENGINE ELECTRIC SUPPLY STATIONS.—III.*

Morecambe.

The first gas-engine station for the generation of electric energy for public supply in the United Kingdom was that which was erected at Morecambe, in Lancashire, in 1892. And this station possesses a further interest, from the fact that it was almost from the first driven by engines supplied with Dowson producer gas. Only for a short time at the start, was town gas used in this station; and we understand that the Dowson producers have been continuously used from the time of their introduction.

The station itself was somewhat of a tentative and temporary venture, it having been intended to make the experiment with the rather inadequate accommodation afforded by these quarters, and subsequently to transfer the generating plant to a more substantial and more conveniently situated house. The necessity for this removal to other quarters has, unfortunately, been emphasised by the fact that complaints have been made by the occupants of houses around the present station, that the waste gases from the generators and engines have created a nuisance. The transfer of the plant to a stone building not in a residential district is being contemplated; and the change would probably be found to be advantageous.

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At the present time the equipment of the station comprises the following details:—There are three Dowson gas generators, two of 75 H.P. and one of 150 H.P. capacity. These are connected to a gas tank, having a maximum capacity of 1,500 cubic ft. Steam for the gas generators is raised in one or the other of two small vertical boilers. The engine plant comprises one Crossley gas engine, of about 100 H.P., and three "Stockport" gas engines, each of 25 H.P. The dynamo plant includes two small two-pole continuous-current generators, one large machine of similar pattern, and one six-pole machine, which is partially used as an alternator and partially as a continuous-current generator. Each of these machines is belt-coupled to a separate gas engine, the 100 H.P. engine driving the six-pole machine. There is a small storage battery, comprising 72 E.P.S. cells of the K type.

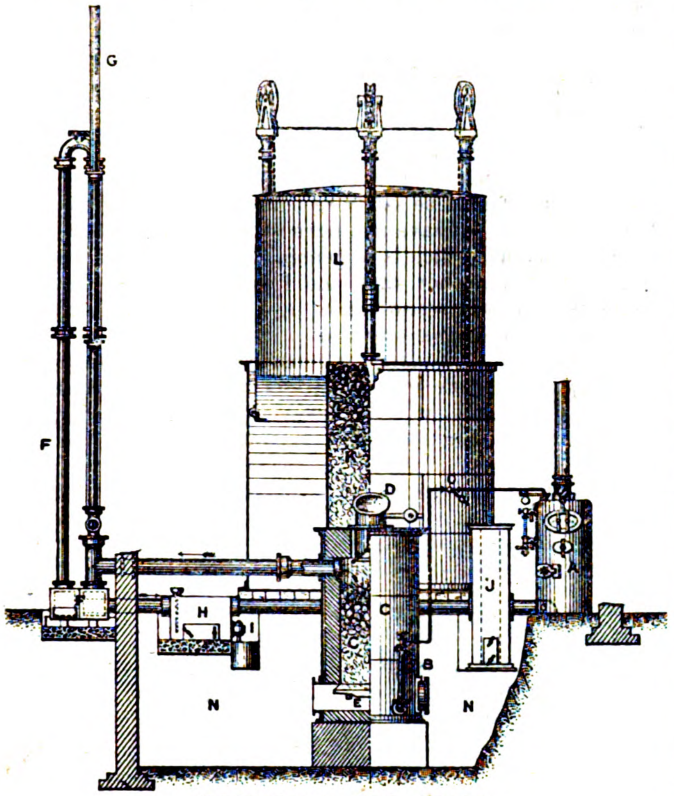

FIG. 1.—Dowson Gas Generating Plant.

As the chief interest in this station arises from its gas-engine equipment, we will devote our chief attention to the details of this, reserving for the conclusion a few remarks upon some of the electrical features.

Fig. 1 shews an elevation and vertical section of one of the units of Dowson gas generating plant, together with the gas tank and connecting pipes, &c. The generator or producer itself is shown at C, and it consists of a brick-lined furnace, wherein anthracite, supplied through the door D, is fed with a blast of admixed steam and air. The steam is generated in the boiler A, and is usually superheated on its passage from the boiler to the steam range or pipe O. Through the imperfect combustion of the incandescent carbon or anthracite, and the dissociation of the steam, a diluted fuel, known as Dowson water-gas, is generated in the furnace C. These admixed fuel gases, comprising hydrogen, carbon monoxide, carbon dioxide and nitrogen, in very varying proportions, according to the conditions of generation at the moment, are passed from C through the gas pipe to the coolers F. These coolers consist of a stack of vertical cast-iron pipes, giving sufficient radiating surface to reduce the temperature of the gas to ordinary limits. From the coolers the gas passes through the hydraulic box or water trap to the sawdust scrubber J, and thence to the coke scrubber, which in Fig. 1 is shown to be inside of the gas-holder, at K. Passing up through the coke scrubber the gas will collect in the small gas tank or holder L, from which it is drawn off as required for use in the engines. More commonly, and in the actual plant at Morecambe, the coke scrubber is separate from the gasholder. A view of the Morecambe gas-house is shown in Fig. 2.

The steam in the boiler is generated at a normal pressure of 60lb. per square inch; and it is not found to be economical to reduce this pressure very considerably on light loads. The quality of the gas very much depends on the boiler pressure, or rather, on the pressure of the steam blast. Too great a reduction of pressure generates poor gas. Normally, about 120lb. of coke per hour is burned in the working boiler.

The sawdust scrubber is re-charged every three weeks, and the coke scrubber once only every six months. We have found

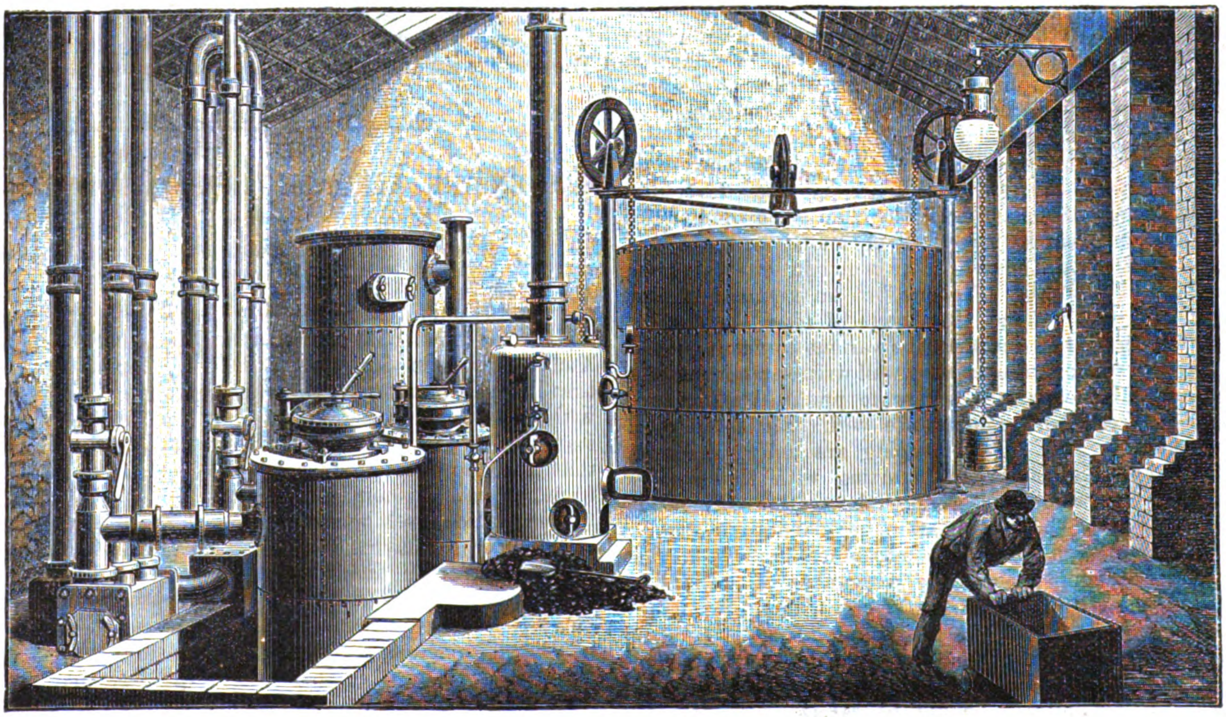

FIG. 2.—Morecambe Electric Supply Station. Gas Generator House.

in other places that a more frequent change in the charges, especially of the sawdust, is advantageous.

The gasholder is of 1,500 cubic ft. capacity; it is thus only large enough to serve as an equaliser of the pressure, for full load on the station will empty it in ten minutes if a gas producer is not working. We should like to see the experiment of a much larger holder for Dowson gas tried, as under those conditions the gas could be generated more regularly and in better quality. As it is, the changes in the load on the engines are also thrown upon the gas producers, which are intrinsically ill-fitted to stand severe changes of load.

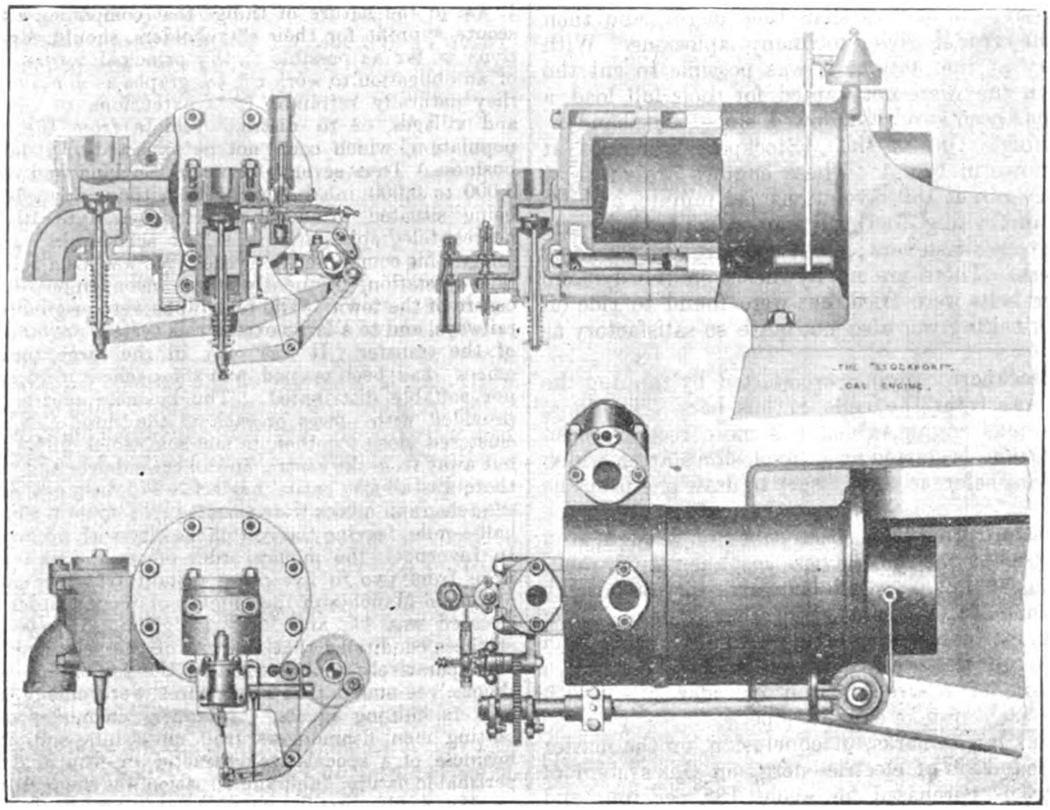

Fig. 3.—Valves and Valve Gear of the "Stockport" Gas Engine.

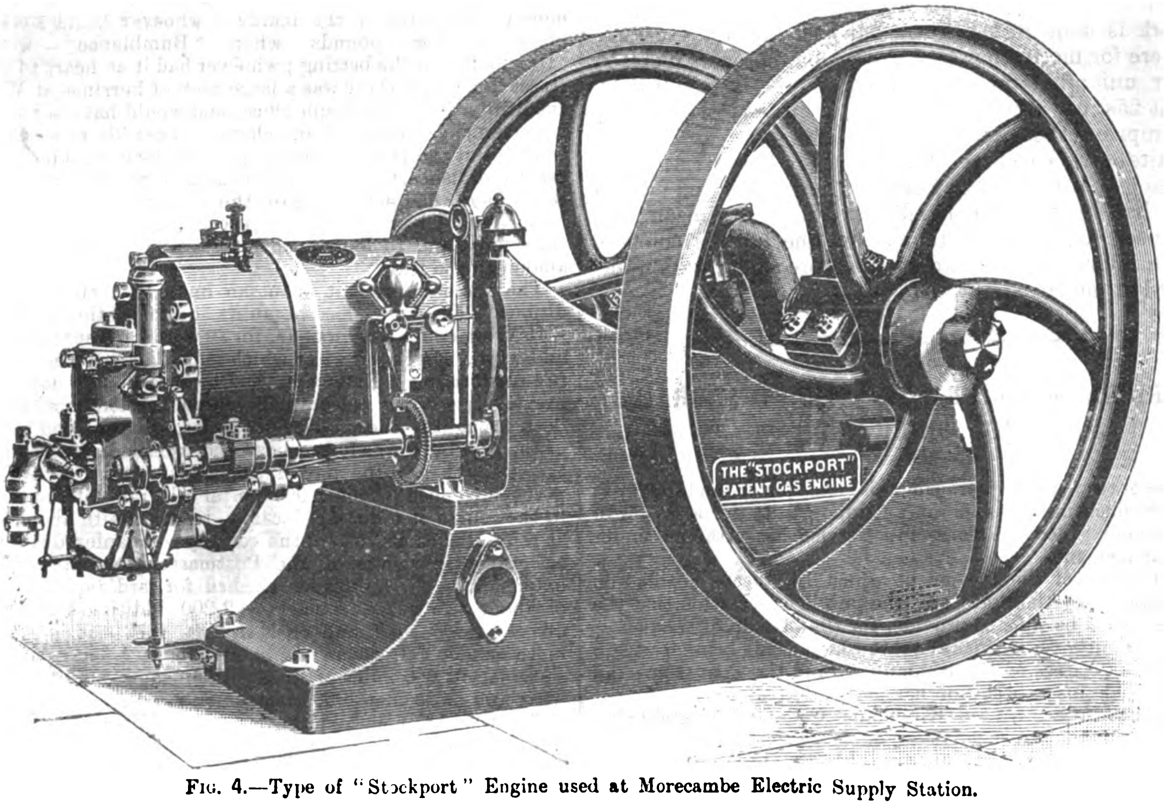

Fig. 4.—Type of "Stockport" Engine used at Morecambe Electric Supply Station.

Fig. 3 shows the usual arrangement of the "Stockport" gas-engine valves, valve gear, &c.; but it is interesting to note that this has been considerably modified in the Morecambe plant. Neither the governor shown in the illustration nor the graded-charge governor is used; for, on these engines all governing has been abandoned, except to prevent the engines from excessive racing, and the engines are left to develop full

load during all the time they are running. It had been found that with close miss fire governing there was not sufficient steadiness in the light, owing to the vice which the engines developed of missing more fires than they ought, and then making up for the error by giving too many explosions. With a storage battery at the station, it was possible to cut the engines out when they were not wanted for their full load, a practice which has been steadily followed since the abandonment of governing. One of the "Stockport" engines at Morecambe is shown in Fig. 4. These engines are rated at 25 H.P. each, they run at 180 revolutions per minute, and are coupled by cotton belting to the dynamos. The belts are fastened by Lagrelle's fasteners; and they have run for three years with success. There are no flywheels on the dynamo shafts. Leather belts were tried, but were found to ride off the pulleys; link belting was also not quite so satisfactory as the cotton kind.

The three "Stockport" engines are started by running the dynamos as motors from the cells or 'bus bars. The large 100 H.P. Crossley gas engine, which has more recently been erected in the station, is started by an explosion starter, which gives six explosions before it is necessary to draw gas from the mains.

All the engines are fired by ignition tubes of wrought-iron steam pipe, plugged at one end. These cost about 1·5d. each, and last for about 50 hours; which compares very favourably with the magnitude of this item at some other stations. Each engine has a separate exhaust up-take, passing vertically from the engine through the well-ventilated roof. There is a silencer, consisting of a wrought-iron cylinder filled with shingle, capping each up-take exhaust pipe.

We may make a few remarks, in conclusion, on the matter of the cost of production of electric energy on this system of generation. Coal is purchased for about 18s. per ton, and at that rate the average cost of fuel per unit metered out of the station, during three months of working, was about 0·5d. per unit. On short runs Mr. Collinson has succeeded in bringing the cost down to 0·3d. per unit. The normal load on the station, in lamps wired, is 3,000 lamps, including the equivalent of some 40 small arc lamps. A small trade in motor work is done in the town, but there is not excessive demand here for motive power. Power for motors is metered at 7d. per unit; but for all lighting, power is supplied by contract at 25s. per annum per 16 c.p. lamp, and the equivalent for lamps of other power.

The entire work has been carried out by Messrs. Andrews and Preece; and the management of the station and system of supply has been in the hands of Mr. P. Collinson, the chief engineer, to whom our thanks are due for the courtesy with which information regarding the Morecambe station has been placed at our disposal.

HISTORICAL OUTLINE OF THE TELEGRAPH SERVICE SINCE 1870.*

The lapse of twenty-five years since the transfer of the telegraphs to the Post Office in 1870, affords an opportunity for a review of the development which the Telegraph Service has attained under national management.

The mainspring of the movement which led to the acquisition of the telegraphs by the State, was the public expectation that the Post Office would be able to provide, for the benefit of the nation as a whole, an improved service at a rate which would bring it within the reach of all classes of the community, and the Post Office can justly claim that this expectation has been fulfilled.

The attempt of the "United Kingdom" Company to establish a uniform rate of 1s., irrespective of distance, had failed, and in 1869 the tariff charged by that Company, as well as by its older rivals, the Electric and International, and the British and Irish Magnetic, stood at 1s. for a message of 20 words for distances up to 100 miles, 1s. 6d. up to 200 miles, and 2s. beyond 200 miles in Great Britain. For messages between Great Britain and Ireland the charges ranged from 3s. to 6s. In many instances these rates, high as they were, did not cover the whole transmission of a telegram. They only applied to the wires of a single company, and where a message had to be transmitted over the systems of two or more companies, an additional charge, frequently of considerable amount, was levied.† Not only were the charges high, but the systems were incomplete. It was in the nature of things that companies whose aim was to secure a profit for their shareholders, should restrict their operations as far as possible to the principal towns. In the absence of an obligation to work the telegraphs as a national undertaking, they naturally refrained from extensions to the smaller towns and villages, or to districts remote from the chief centres of population, which could not be expected to yield a remunerative business. Thus several towns in England and Wales with from 3,000 to 6,000 inhabitants were without any telegraph facilities, being situated at distances of from 5 to 10 miles from the nearest telegraph station. Where such towns were provided with telegraphic communication, the office was, as a rule, situated at the railway station, frequently at an inconvenient distance from the centre of the town. The telegraphs were originally confined to the railways, and to a large extent this system prevailed up to the time of the transfer. It was only in the large towns that "town offices" had been opened, and these offices were neither numerous nor suitably distributed. The business centre of the town was provided with offices of each of the three competing companies clustered close together, in fact sometimes only a few yards apart; but away from the centre, and in the suburbs and outlying districts, there was almost entire neglect. For instance, in Edinburgh all the telegraph offices were situated in a circle with a radius of about half-a-mile, leaving the rest of the city with no provision whatever. In Liverpool, the money order offices for six suburban districts were from two to five miles distant from the nearest telegraph office; in Manchester the number of money order offices similarly situated was 11, and in Birmingham. It was a natural result of these conditions that the use of the telegraph was confined to a comparatively small section of the population. The companies themselves stated that their wires were chiefly used by "stock-brokers, mining agents, shipbrokers, colonial brokers, racing and betting men, fishmongers, fruit merchants, and others engaged in business of a speculative character, or who deal in articles of a perishable nature," and the situation was thus graphically described by Mr. Scudamore in one of his reports: "By maintaining high charges as long as they could; by reducing those charges inch by inch, as it were, and only under pressure; by the confinement of their operations to important towns, and by planting their offices mainly in the business centres of those towns, the telegraph companies had brought speculative men, and speculative men only, to a free use of the telegraph. Whoever could make money on a turn of the market; whoever could advantageously place a few pounds when 'Bumblebee' went below 'Dulcibella' in the betting; whoever had it at heart to let Thames-street know that there was a large take of herrings at Wick, rushed cheerfully to the telegraph office, and would have submitted to any inconvenience, and paid any charge, to get his message through in time. But the general public, puzzled by a variable and complex tariff and disheartened by the distance of the telegraph offices from their doors, had got to regard the telegraph as a medium of communication which they might use in times of sore necessity, and then only, and to look upon a telegraph message with a feeling amounting to fear."

The transfer brought about an immediate change in these conditions. The Post Office began its administration of the telegraphs with the moderate tariff of 1s. for 20 words, irrespective of distance, and with a system of wires which it had already been instrumental in transforming. Extensions had been made to a number of places previously without telegraphic communication, and the wires had been brought to the suburbs of the larger towns and to the centres of the smaller towns formerly served from the railway stations, with the result that on the day of the transfer the Post Office was in a position to open about 1,000 postal telegraph offices, situated each in the centre of a distinct locality, together with about 1,900 offices at railway stations, where the railway companies dealt with public telegrams as agents of the Postmaster-General. The work of extension on these lines was pushed forward rapidly. In a period of about two years, as many as 2,200 additional postal telegraph offices were opened, and on March 31, 1872, the system comprised more than 5,000 offices (including about 1,900 offices at railway stations), 22,000 miles of line, with an aggregate of 83,000 miles of wire, and more than 6,000 instruments.

The year 1872 marked the first stage in the development of the postal telegraphs. In that year, the third of the administration by the nation, the extensions undertaken with the view of providing a fully-equipped telegraph system had practically been completed, and the result was seen in a large expansion of business. In the first year after the transfer, the number of telegrams of all

* From the Postmaster-General's Annual Report.

† Besides the companies here mentioned, there were the London and Provincial, the Universal Private, and a few other small companies. There was nominally a "local" rate of 6d. in London and some other large towns, but its scope was so restricted that it only applied to about 2 per cent. of the total number of telegrams.

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descriptions was about 10,000,000, in the second about 12,000,000, and in the third (the financial year ended March 31, 1873) over 15,000,000, or more than double the number in 1869, which was less than 7,000,000. The period from 1872 up to the adoption of the sixpenny tariff in 1885 was one of steady progress. The addition of new offices was not large, the total of 5,000 offices in 1872 having only increased to 6,000 in 1885. But great improvements were made in the means of communication between places already connected, and the increasing appreciation of the telegraph service by the public was shown in the fact that in 1885 the number of telegrams had again been more than doubled, having risen to 33,000,000.

The reduction of the tariff in 1885 opened a new era. A comparison of the old tariff of 1s. for 20 words with 3d. for each additional group of five words, and the new tariff of 6d. for 12 words with ½d. for each additional word is complicated by the fact that the free addresses allowed under the former tariff were abolished under the latter. But the point that can be clearly seen is that, whereas it had been impossible to send a telegram, however short, at a less charge than 1s., a telegram of 12 words could now be sent for 6d. The fact that addresses were now charged for, did not prevent the senders of telegrams from so reducing the number of chargeable words as to obtain the full benefit of the lower tariff. The actual length of the telegrams was largely curtailed, especially in the addresses; and economy was effected through the operation of certain new rules, one of which prescribed that figures, formerly chargeable each as a single word, should be counted at the rate of five figures to a word. In the result a large proportion of the total number of telegrams was brought within the minimum charge of 6d., while the average charge, which had been 1s. 1d. in 1885, was reduced to about 8d. in 1886, and has since fallen below 7¾d. Under the reduced tariff, telegraph business again received a powerful stimulus. The charge was so low as to popularise the telegraph service still further, and to render it available for purposes for which it had not hitherto been used. In particular, it became adapted to the requirements of local traffic; and in London the local telegrams were more than doubled in about two years, having risen from about 1,800,000 in 1884-85 to 3,800,000 in 1886-87.

The Post Office has had to contend with an increasing competition on the part of the telephone companies, who have chiefly competed in that class of business, the local traffic, which afforded, under the new tariff, the greatest promise of growth. It is stated by the National Telephone Company that the volume of their business is equivalent to 280,000,000 messages of an average length of 100 words. A certain proportion of this vast business would undoubtedly, in the absence of the telephone, have been transacted by telegraph; but, notwithstanding the loss to the telegraph service in this respect, a development exceeding that between 1870 and 1885 has actually occurred. The number of telegrams of all descriptions, which had reached 33,000,000 in 1884-85, rose to 50,000,000 in 1886-87 and 62,000,000 in 1889-90, while in the financial year just expired a total of 71,589,000 has been attained. With the possible exception of the United States, for which complete statistics are not available, no other country in the world makes so extensive a use of the telegraph. In France the number of public telegrams is about 42,000,000, in Germany 33,000,000, in Austria and Hungary 18,000,000, in Russia 13,000,000, and in Italy 10,000,000. In the United Kingdom about 184 telegrams are sent for every 100 persons, as compared with 108 for the same number of persons in France, 66 in Germany, 42 in Austria-Hungary, 31 in Italy, and 10 in Russia. The nearest approach to the United Kingdom in this view is Switzerland, where the number of telegrams per 100 persons is about 127; even Belgium does not produce more than 87 per 100 persons. An adequate idea of the volume of telegraph business in the United Kingdom cannot, however, be gathered from these figures alone. The tariff for Press telegrams in this country, working out, as it does, on the average, at about 4½d. per 100 words, is the lowest in the world, and the amount of work performed for the Press is without a parallel in any other country. Although the Press telegrams, 5,400,000 in number, are included in the total of 71,589,000, no allowance is made for their exceptional length. Being of an average length of about 120 words, they contain an aggregate of about 650,000,000 words, as compared with an aggregate of about 970,000,000 in all other telegrams. Under the arrangements for news telegraphy this number of words does not, it is true, entail on the Post Office a corresponding amount of work; but it is a striking fact that the words dealt with for the Press form no less than two-fifths of the total number of words.

The growth of the whole business since 1870 (from less than seven to more than seventy-one millions) has been more than ten-fold. The number of offices has increased from 3,000 to nearly 10,000. The system, including submarine cables, now consists of about 35,000 miles of line, as compared with 15,000 in 1870, and about 215,000 miles of wire as compared with 60,000, while the number of instruments has increased from about 4,000 to over 26,000.

But for the improvements which have been effected in telegraphy since 1870, the increase in the mileage of wire and the number of instruments must necessarily have been much greater. It was urged at the time of the transfer that the possession, by the Government, of a monopoly in telegraphs would tend to discourage invention. To this contention the progress achieved in the technical department of the telegraph service is a sufficient answer. Partly through the adoption of outside inventions (with due recognition of the rights of the inventors) and partly through improvements devised by its own staff, the Post Office has succeeded in largely increasing the working capacity of the wires. The improvements are too numerous to be set forth in detail, but it may be well to mention some of the more striking. In 1870, each wire only afforded a single channel for communication. At the present time a single wire can be used for the simultaneous transmission of two messages under the duplex system (which may be said to be the normal method of working between busy offices), four under the quadruplex system, and six under the multiplex system. These inventions were obtained by the Post Office from outside (the duplex from Mr. Stearns, the quadruplex from Mr. Edison, and the multiplex from Mr. Delany), but their value for practical purposes is largely due to the efforts of the officers of the Post Office to develop and improve them. No less important than this increase in the number of available channels of communication is the improvement in the speed of working. In 1870 a speed of from 60 to 80 words per minute was the highest which could be attained in the working of the Wheatstone automatic apparatus. At the present time a speed of 600 words per minute has become possible, and a working speed of 400 words is the fixed standard for certain circuits. The duplex system has been successfully applied to the automatic apparatus, with the result that many circuits are working at a speed of 250 words per minute in two directions. Two copper wires between London and Dublin are working on the duplex system at even 300 words per minute, whereas under the conditions of 1870 they would only have given about 40 words in one direction as a maximum. The "repeaters" used for strengthening the current on long circuits have also been greatly improved. In the absence of repeaters it would be impossible to obtain a higher speed than 40 words per minute between London and Aberdeen, whereas with repeaters at Leeds and Edinburgh a speed of 350 words is attained.

The financial side of the telegraphs unfortunately does not present so favourable an aspect. It is undoubtedly a matter for concern that during the year ended March 31st last the expenditure exceeded the revenue by about £154,000, to which must be added the interest (£298,000) on the capital expenditure incurred at the transfer, making the total loss for the year about £452,000. In the period of 25 years since 1870 the receipts show a balance of about £1,795,000 in excess of the expenditure, but they fall far short of meeting the interest on capital, the aggregate deficiency in this respect being £5,859,000. The large price paid as purchase-money on the terms authorised by Parliament is one of the factors which have contributed to the unfavourable financial results of the working of the telegraphs. The expenditure on capital account amounted to about £10,130,000. Of this amount about £2,130,000 was expended on extensions, and the remainder, £8,000,000, in the purchase of the undertakings of the telegraph companies and the interest of the railway companies in public telegraphs. It is generally held that the companies were liberally treated, and in certain cases a price which must be regarded as excessive had to be paid. The right, accorded to the railway companies at the time of the transfer, of sending postal telegrams free of charge, has proved another burden. The number of the railway free telegrams, at first insignificant, increased out of all proportion to the growth in ordinary public telegrams, until in 1891 it reached a total of about 1,600,000 telegrams, representing, at 1s. 0½d. per telegram (the average length being 25 words), a value of over £80,000 per annum. It is, however, a matter for satisfaction that arrangements have recently been made under which this burden is materially lessened, while a barrier is imposed against future growth. A still more serious burden is caused by the loss on Press telegrams. The charge specified in the Telegraph Act of 1868 for Press telegrams is 1s. for 75 words during the day, or for 100 words at night. But a proviso was added that for copies the charge was to be only 2d. per 75 or 100 words, and no condition was laid down as to the copy being for the same town as the original. The newspapers accordingly combined to receive, from the news associations, messages in identical terms, and by dividing the cost they are enabled to get the benefit of a rate which comes nearer 2d. than 1s., the average charge being, in fact, about 4½d. per 100 words. Notwithstanding the economical arrangements which have been made for the transmission of the telegrams (5,400,000 in number, containing 650,000,000 words), the loss incurred by the Post Office in dealing with them is estimated to amount to £300,000 per annum.

These unfavourable conditions have permanently affected the telegraphs. They must in any case have diminished the possibility

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of profit, and in the actual circumstances their effect has been to augment the loss. Moreover, new influences inimical (temporarily if not permanently) to financial success have come into play, namely, the reduction of the tariff in 1885, the increase in the pay of the staff, and the competition of the telephone companies for local traffic.

The results of the alteration of the tariff in 1885 have been described in an earlier paragraph. While the average amount received for a telegram was reduced from 1s. 1d. to 7¾d., a large addition was made to the main element of cost, namely, the pay of the staff. The proportion of the amount expended on salaries and wages to the total telegraph expenditure, which in 1881, before the revision carried out by Mr. Fawcett, stood at about 55 per cent., has since risen, as the result of that revision and the revision effected by Mr. Raikes in 1890, to about 65 per cent. At the same time the competition of the telephone companies deprived the Post Office of a large portion of what was at once the most promising and the most remunerative part of its business. There has, it is true, been a development of local telegraph traffic since 1885, but in recent years the increase has been materially checked. In certain cases the traffic conducted by the Post Office in the large towns, or between large towns situated at a short distance from each other and connected by the trunk wires of the National Telephone Company (as, for example, between Glasgow and Greenock, and between Liverpool and Manchester), has suffered an actual diminution.

Against the loss of money incurred on the telegraphs must be set the benefits which the system confers on the community. That an expeditious service, extending into every part of the United Kingdom, is provided at a charge of less than 8d. per telegram, is an advantage for the whole nation which may be regarded as at least commensurate with the sacrifice entailed by the financial loss. The amount provided by the taxpayers to meet the deficit is not lost; it is virtually repaid in services for which a higher charge would otherwise have had to be levied, and the main object of the acquisition of the telegraphs by the State may be said to have been realised in the attainment of a development to which no other country affords a parallel. The Post Office has to admit a deficit on the working of the telegraphs, but its 71,000,000 telegrams bear testimony to the value of the service which it renders to the public.

THE STRUGGLE BETWEEN TELEGRAPH AND TELEPHONE.*

BY PATRICK B. DELANY.

I have been much interested in the attention you have been giving to the telegraph and telephone situation of late, and although in general touch with both subjects, I was startled by your graphic presentation of the power and proportions gained by the telephone during the few years of its existence. It is easy to understand that if the telegraph and telephone continue their growth in the future in the same ratio as in the past, it will not be long before the telephone is greater than the telegraph in property and earning capacity. Indeed, judging from the great disproportion in the development of the two systems, and the constantly increasing gains of the telephone relatively, the decline of the telegraph, if conducted on the present plans, may be reasonably expected. There is no escape from the self-evident fact that the telephone has been managed with energy and enterprise, while the telegraph has been guardedly confined to the old conservative grooves, blind to the march of events, and deaf to the demands of development. Before the telephone was born the telegraph might have, to a large extent, occupied its field and earned a large revenue from telegraphic *conversations*. The demand for such facilities was *forced* upon the notice of the telegraph companies constantly, but the idea was frowned down, and only in rare cases, and as a great favour, were privileges of this kind granted. It is my firm belief that even at this late day type-written conferences by telegraph would be popular and profitable if the telegraph companies would take the trouble to bring people to the ends of the wire as the telephone companies are doing.

Viewing the whole subject of communication and correspondence broadly, one cannot fail to be impressed with the fact that after all the telegraph and telephone combined do but a small proportion of the work. There are about three billion sealed letters carried by the Post Office during the year, or about 40 letters to one telegram, and this difference in number is owing mainly to the difference in cost.

It might as well be admitted at once that the telephone holds the field for local communication, mainly because of the subscriber system, the lump-sum yearly charge, regardless of the number of messages, and its ever-ready facilities. The local telegraph, as everyone knows, is slower than the long-distance lines. It takes less time on an average to send a telegram from New York to Chicago than from Madison-square to Wall-street. Nor is the telephone service to occasional or outside users much better in this respect, as everybody that has wrestled with a local pay station outfit, its "Hello's," "Number's," "Busy now's," &c., &c., can testify. With subscribers it is different. The facilities are so much more convenient and the service so much quicker, that in these days no telephone subscriber would think of sending a telegram to his correspondent in the same town.

Leaving local communication to the mails and the telephone, the more important question of communication between distant points is the one to be dealt with, and it is to this domain that the struggle for supremacy between the telegraph and the telephone will be confined. I cannot believe that telephony at nine dollars for five minutes' use between New York and Chicago and proportionate charges all over the country will ever become popular to any great degree, even though it should yield the 150 words per minute with which you credit it, a speed, however, which I think is more than double its capacity in the hands of the average user. There are but few public speakers that will average 150 words per minute in delivering an address. That such a rate can be wrung out of a telephone with all the interruptions, repetitions, and miscellaneous skirmishing in getting down to work, seems highly improbable. It seems to me that a word a second, 60 words per minute, or 300 clearly understandable words in five minutes, would be a very liberal rate for telephony, and this without any record, unless one employs a stenographer to take it down, thereby adding to the trouble and expense, and introducing another fertile element of doubt and distraction. When it is remembered that this rate of 60 words per minute involves the use of *two* wires, the capacity of the telephone for correspondence is not as great as that of the telegraph, even with its present slow method of hand working; for a quadruplex will carry 60 words per minute over one wire. Reckoning the eight operators engaged in the telegraph work as a partial offset against the second wire of the telephone, matters will still be in favour of the telegraph with the additional advantage that in the case of the telegraph the 60 words per minute may be type-written, whereas the telephone message is in the user's head, not always a reliable reference. The cost of 300 words type-written by telegraph at regular rates would be $9.10, or 10 cents more than the telephone charge, assuming 300 words to be a fair clean-up product of five minutes' conversation.

Thus it would seem that as at present organised for work the telegraph and the telephone are about on a level. But the telephone has insuperable advantages in its subscriber system and the facilities afforded for *completing* a conference or transaction on the spot. So long as a business man in New York can, without leaving his office chair, confer with another business man a thousand miles away, and get his reply on the moment, he will pay the price *whenever the occasion warrants*, but he will not write telegrams, send them to the telegraph office and wait from one to four hours for the answer, *at the same cost*.

It is plain, however, that at the present rates the telegraph and telephone combined cannot get more than 4 or 5 per cent. of the number of messages carried by the Post Office. They will continue to be used in cases of urgent necessity represented by this percentage and no more.

In the battle for supremacy, the telegraph is infinitely more resourceful than the telephone. With the present system of operation, but 5 per cent. of the carrying capacity of the present telegraph wires is utilised, and with larger copper wires speeds may be enormously increased. Not so with the telephone; the speed of which must, under most favourable conditions, be limited to the rate of human articulation. When telegraphy is broadened to its proper function, the mails will be carried by it over all important routes, and the railway time for a letter from New York to Chicago will be practically eliminated, or reduced from about 25 hours to the telegraph speed of a few seconds—and with a rate of 15 cents for 50 words, or 90 cents for 300 type-written words against nine dollars for the same message over the telephone, using two wires, the degree of urgency requiring the use of the telephone would be of great rarity, while at the same time, the incentive to save so much time over the regular mails would result in an enormous traffic for the letter telegraph. No telegraph engineer will now deny that it is practicable to send 1,000 words per minute over an 850 pound per mile copper wire from New York to Chicago, producing a record from which type-written translation can be made at the rate of 50 words per minute, or that 1,000 words can be prepared for transmission as quickly and as cheaply as it can be telegraphed by hand. Therefore it would be difficult to avoid the conclusion that automatic or machine telegraphy, with chemical recording, will carry the bulk of the correspondence too urgent for the regular railway transportation and not urgent enough for the telephone and its great expense. Letter telegraphy is only a question of copper, construction, and chemical automatic working. The telegraph with a differentiated

* From the *Electrical Engineer* of New York.

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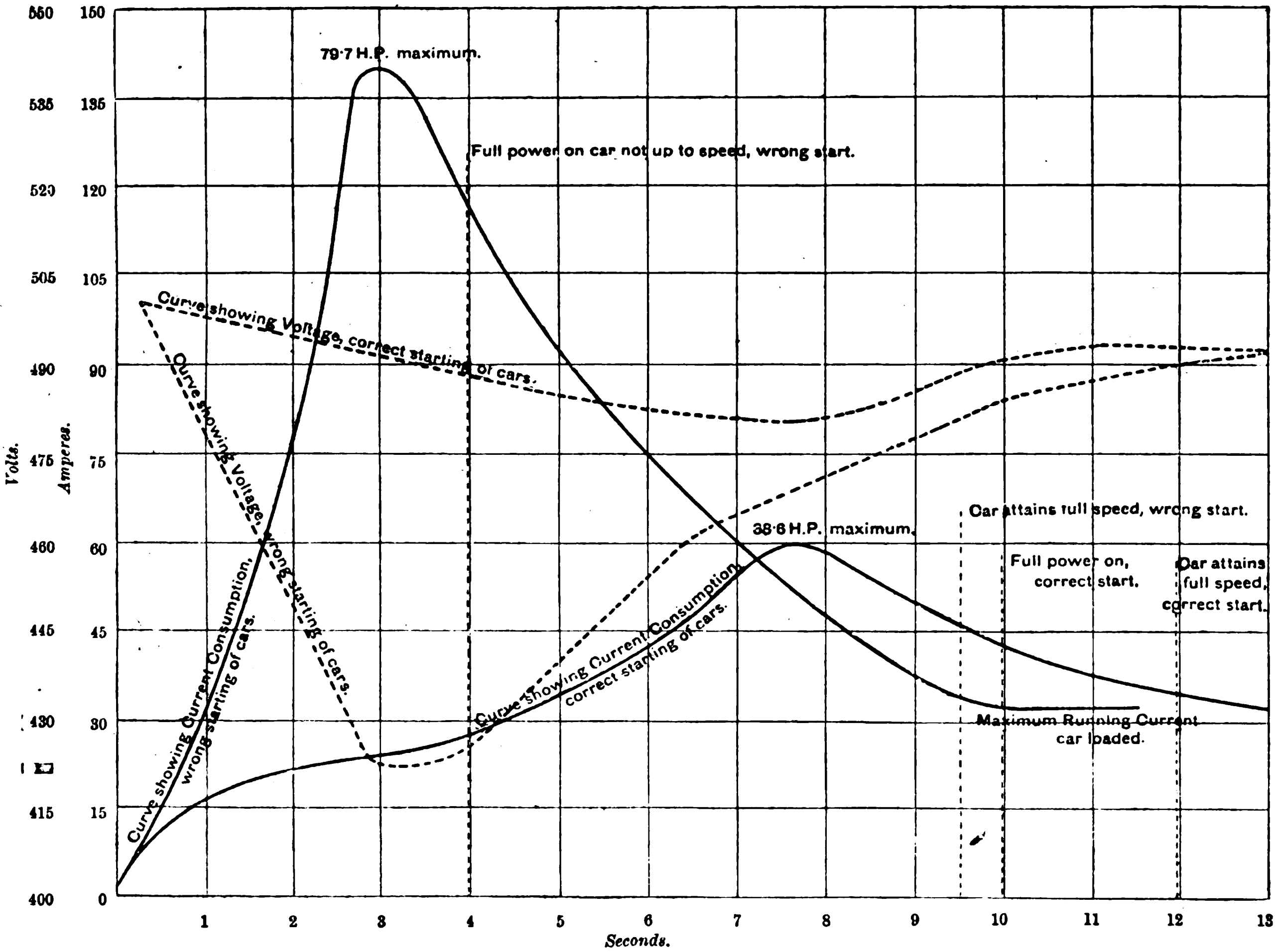
service, amplified to meet the various grades of exigency, and with rates made possible by machinery which will bring into use the 95 per cent. of efficiency now wasted, should stand in no great dread of the telephone.

HOW TO START A CAR.*

The abuse of motors by too rapid handling of the controller has been harped on ever since electric roads were first started, and every competent superintendent realises the importance of educating motormen not to turn on current too fast. At the same time acceleration with the motors in series. The somewhat startling results shown by the upper curve in the diagram are caused mainly by throwing in multiple too quick.

One of the most interesting and encouraging things about the diagram is the small gain in time which is made by the wrong start. There has been a constant tendency of late years toward quick starts in order to make a fast schedule. A heavy starting current has been considered as something which could not be avoided in this connection. Mr. Knox's investigations show, however, that if the controller is handled rightly there is very little time lost by the correct as compared with the incorrect start, while there is an enormous saving in current and consequent strain on the motors.

The facts brought out by the tests have, of course, been known in a general way by electrical engineers for some time, but they



Curve Plottings of actual tests made on the road, showing power consumption of motor cars in correct and wrong starting. Plottings show an average of a series of tests.

	Wrong starting of cars.		Correct starting of cars.
Time in which full power is turned on	4 seconds	....	10 seconds
„ „ „ speed is attained	9·5 seconds	....	12 seconds
Distance car has travelled when full power is on	13·5 feet	....	110 feet
„ „ „ „ speed is attained	85 feet	....	150 feet

	Wrong starting of cars.		Correct starting of cars.
Maximum current consumption in making start	140 amperes	....	60 amperes
Volts drop in making start	80 volts	....	20 volts
Watt-seconds consumed in making start	307178·4	....	221676·0
Average H.P. used in starting	43·3	....	24 7
Average loss in H.P used in. starting per car	15·6	....	

nearly every superintendent laments the difficulty of getting men to observe at all times the rules about slow starting.

It is seldom that the difference between a correct and a too quick start is illustrated as graphically and unmistakably as in the accompanying diagram, which represents the results of a series of tests made on the Chicago City Railway by Mr. G. W. Knox. Blue prints of this diagram are posted at all the car barns for the benefit of motormen. By insisting on the observance of the lesson which this diagram teaches, and by suspending for a few days those who refuse to learn, the current output per car at the power station has been reduced by a large percent. This, of course, also means a saving in repairs.

A series-parallel controller requires a very different handling from the old style of rheostat, and in some cases motormen and those who educate them do not seem to recognise the peculiarity of this method of control. While the initial starting current is not very high with this kind of controller there is a sudden rise when the change is made from series to multiple, and particular care needs to be taken not to throw in multiple until the car has attained its full

* From the *Street Railway Review* of Chicago.

are not often put in such definite shape as here, and consequently they are not as fully realised and acted upon by all concerned as they ought to be.

THE OVERHEAD WORK IN THE BELT LINE TUNNEL, BALTIMORE.

The following particulars with regard to the overhead work and form of trolley adopted for the purpose of electric traction in the belt line tunnel at Baltimore, which have appeared in the American papers, will be read with interest. It should be pointed out that in this case electric traction had to be adapted to the traffic instead of the traffic being adapted to electric traction. The tunnel is only a link in a through line, and long trains of the ordinary kind have to be hauled through, locomotives and all, just as they are. The locomotives weigh some 96 tons, and take currents of from 500 to 3,000 amperes.

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The conductor selected is a trough formed by two 3in. Z-shaped iron bars in which slides a shuttle-shaped brass trolley shoe. These Z-shaped bars (*see* Fig. 1) are ⅜in. thick riveted to a cover plate ¼in. thick and 11½in. wide. The feeder wires are attached by cleats to the transverse frame supporting the "up" and "down" conductor troughs and midway between them. The trough is made in 30ft. sections, weighing 90lb. to the yard. Outside the tunnel the method of suspension consists of lattice steel poles on either side

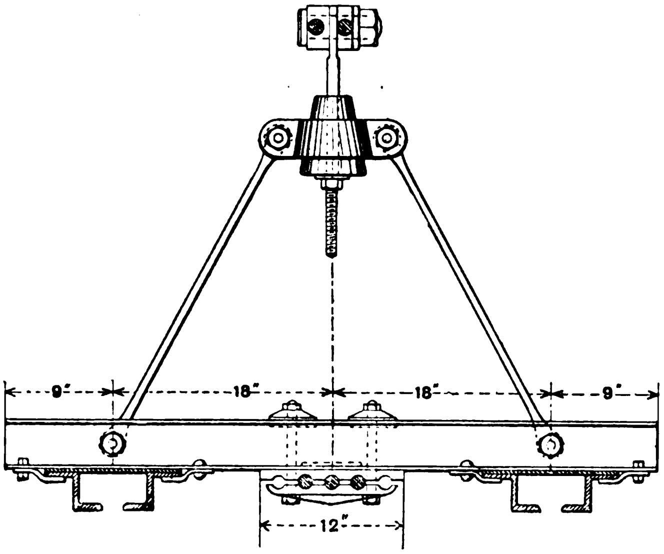

FIG. 1.—Section through Overhead Work.

of the track, carrying between them transverse trusses. From these trusses, which are 50 yards apart, are stretched chains of iron rods, from which vertical rods are dropped down at intervals of 15ft. to support the current-carrying trough. In the tunnel the conductor is supported every 15ft. from transverse frames hung from the arch. Inside the tunnel the conductor is 17½ft. above the track, outside it is 22ft. In Fig. 2 is shown the form of trolley adopted.

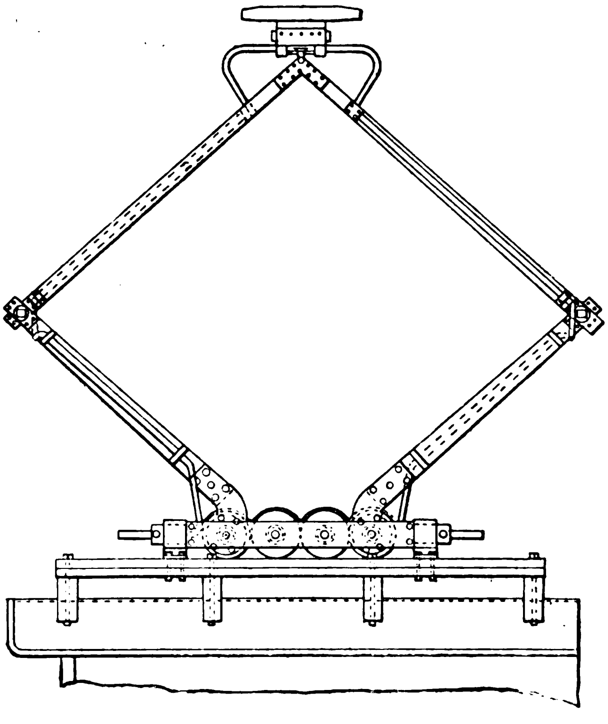

FIG. 2.—Trolley.

During the trial trips some difficulty was experienced from the fact that in the tunnel the moisture had acted to form a coating of high resistance inside the trough, consequently when a heavy current was taken off the trolley shoe became red hot and almost welded itself to the trough. This impromptu welding trouble has, however, now been overcome by a thorough cleaning out of the trough, which will in future be kept clear by the constant traffic through the tunnel.

THE HERMITE PROCESS OF DEODORISING SEWAGE.*

BY J. NAPIER, F.C.S., F.I.C.

The treatment of sewage for the purpose of preventing putrefaction is a subject which has occupied the minds of chemical and sanitary engineers for many years, and numerous methods of dealing with it have been devised and brought before this and other societies, each claiming to perform its work in a more perfect manner than its predecessor. Those methods, with only one or two exceptions, treat the sewage at a point between the last inlet into the main sewer and the outfall, usually at the outfall, and as far away from the town as it is possible to put it. Those systems of dealing with sewage at the outfall do not give the town from whence it came any sanitary benefit. They do not prevent sewer gas accumulating in the sewers and escaping into the air from manholes or ventilating shafts and becoming an annoyance and nuisance to the inhabitants. The objects of those systems of treating sewage, then, is to purify the sewage sufficiently to prevent the pollution of a waterway or river, and without in any way being of the slightest benefit to the health of the town.

With the Hermite process the sewage is treated at the other end of the sewers—*i.e.*, at the beginning—deodorised there, so that flowing through a town the sewers give off no offensive smells, and the putrefactive changes which take place in sewage have been arrested. With this system, then, there is no need for ventilating shafts, and if the manholes are perforated there is no offensive smell given off; on the contrary, there is a faint chlorous or bleach smell, which is much more acceptable to the nose than sewer gas. The principle of this process is passing a current of electricity through sea-water, or, if sea-water is not handy, a solution of magnesium and sodium chlorides; a portion of these chlorides is converted into hypochlorite, a substance which disinfects, deodorises, and bleaches, and is similar to the active ingredient of bleaching powder—calcium hypochlorite. The change from chloride to hypochlorite takes place almost entirely with the magnesium salt-yielding magnesium hypochlorite ($MgCl_2O_2$). It is found, however, that in the electrolysers and tanks a white deposit takes place, consisting of magnesium oxide combined with water—viz., magnesium hydrate—showing that the magnesium hypochlorite has decomposed, forming magnesic hydrate, which precipitates, leaving hypochlorous acid in solution. The action may take place as follows: $MgCl_2O_2 + 2H_2O = MgH_2O_2 + 2HClO$. This is called the Hermite solution. The amount of oxidising power is expressed by the quantity of available chlorine in grammes per litre—the usual working strengths being from five to one gramme per litre of solution. When sewage is mixed with about 5 per cent. of the solution, the offensive smell is instantaneously destroyed and the decomposition arrested for about six days, long enough under ordinary circumstances for the sewage to be well out to sea.

This electrolysed, or Hermite, solution has been subjected to many experiments, and numerous criticisms have been made upon it as to its power of rendering sewage sterile. Sir Henry Roscoe found that a 0·8 gramme solution practically sterilised the liquid portion of sewage, when used in sufficient quantity, and that the solid matters were unaffected. Well, a solution which will thus practically sterilise liquid sewage must, I think, be of great value, and when used in effective quantity tend to benefit any locality by preventing those contagious diseases which are usually developed from sewer gases. Although chemical and sanitary engineers have had this aim—*i.e.*, to completely sterilise sewage—in view, this point has not been attained on the large scale by any of the at present known systems. Hermite solution, however, does the next best thing, for in larger proportions it sterilises the liquid portion, and even in small quantities completely deodorises. This is confirmed by Sir Henry Roscoe's eleventh conclusion—viz., "the Hermite fluid even of 0·25 strength acts as an excellent deodoriser."

This is the point taken up by the Ipswich Corporation. They say, if we can have the sewage deodorised and its decomposition arrested for from three to six days the sewage will be well out to sea, and the nuisances of offensive smells in the town will be entirely done away with. Sir Henry also made experiments as to the stability of the electrolysed solution, and he found that a 0·5 gramme solution lost 90 per cent. of its strength in 24 hours, a 0·75 gramme solution being more stable, losing 34 per cent., and a 1 gramme solution 10 per cent. in the same time. This is very interesting and important, but as regards the working of the system in Ipswich, it is not necessary to take this into consideration, because the moment the electrolysed solution is made it is carried direct into the sewer within two minutes after its production. We have in Ipswich been electrolysing sea-water for three months and treating the sewage. The Sewage Committee directed me to report on its working, so I made daily tests and inspections for about two

* Abstract of a Paper read before the British Association at Ipswich Section G.

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months. The strength of solution varied from half a gramme to one gramme, according to the flow of sea-water through the electrolysers, the quantity of available chlorine made being fairly constant, and the average being 1·04 gramme per ampere-hour. As to the effects of this solution on the sewage I have no figures to give you, but can give a general idea of its deodorising powers. The difficulties in the way of sewering and treating sewage in Ipswich may be explained in the borough surveyor's own words: "To dispose of the sewage of Ipswich, either by irrigation or by intermittent filtration, would be attended with considerable expense. The town is divided by the River Orwell, and, as is frequently the case with towns so situated, the longitudinal falls are very slight, while the lateral falls are very great. The fall from the one end of the sewer to the other is only 8ft., so the flow is not very rapid, whilst, taking a section of the town laterally, there is plenty of fall, and, in consequence, a rapid current into the main sewer. On this account the experiments with the electrolysed solution were made on the main sewer, and at present the solution is running in the sewer at Handford-road in close proximity to the beginning of the main sewer. The result is complete deodorisation of the sewage throughout a long length of the sewer. For a distance of 700 yards free chlorine can be instantly detected by test papers, and for a distance of 1,760 yards the chlorous smell is perceptible, although insufficient to have any action on the test paper. Not only does the main sewer receive the arterials, but it receives the drainage of several slaughter-houses and breweries containing much organic matter. Below Church-street, St. Clement's, there is such a great increase in the quantity of sewage that the results were doubtful. On several occasions, however, samples taken from the outfall were without smell and kept two days, and in one instance it kept four days. If the amount of electrolysed solution, or its strength, could have been increased, the sewage at the outfall would certainly have been completely deodorised, if not sterilised. This is a point which I hope the Sewage Committee will aim at, and when putting the plant permanently into the new buildings that they will have sufficient electrolysers and power to produce enough fluid to deodorise all the sewage of Ipswich and have some to spare for flushing or washing infected areas. I noticed in some of my early morning inspections, when the flow of sewage was at its minimum, that the deposit in the sewer was bleached nearly white by the action of the electrolysed solution. This process has not been going long enough to allow me to obtain any statistics as to the health of the borough or the death-rate, compared with previous years and with other towns; but this I am sure of, that where the sewage has been treated no complaints have been received as to offensive smells. I am confident that any town that adopts this process, which will boldly erect plant to produce more than enough of the electrolysed solution, will be spending money well, and in time will feel the benefit by increased health of the inhabitants, and also by having a lower death-rate. This is what I have suggested Ipswich should do, so that in a year or two, when we are able to make comparisons, we will find a reduction in the death-rate. Such a result will make the process cheap at any price."

AN IMPROVED HALLWACH'S ELECTROMETER.*

In a previously described quadrant electrometer† the author (W. Hallwachs) succeeded in eliminating the principal evils arising from water damping, and obtained constant sensitiveness. The instrument had, however, an inconveniently small damping, and the suspension was not sufficiently free from viscosity. This occasioned errors, amounting to 0·2 per cent. of the potential, if complicated corrections were omitted.

In the present instrument these defects are overcome. Magnetic damping was first tried, as in many existing forms of electrometer, both by fixed magnets and moving conductor, and *vice versâ*; but the instrument thereby either lost its important property of being unaffected by external magnetic disturbances, or caused external disturbance itself. Air damping was therefore to be preferred, and it was found possible to construct an instrument in such a way that the deflections were not influenced by the electrostatic action of the damping vane and chamber. The damping can be regulated, so that any degree of approximation to complete aperiodicity can be obtained. A sufficiently torsionless suspension of platinum wire came to hand, when experiments were being made with silvered glass and quartz fibres, which were found to have too high a resistance for many electrometer methods, and were also more brittle than the platinum. The air-damped electrometer, with the new suspension, enables one to compare potential differences with an error of only a few parts in 10,000. On account of the large damping, which reduces vibration, the instrument can be used in places where the magnetic and other disturbances would preclude the use of sensitive galvanometers.

The measured torsion moment is given by a $\frac{1}{50}$mm. platinum wire, drawn in a double sheath of silver and copper, the ends of which are attached to small clamping strips with eyes. The upper strip is clamped in the suspending rod *a* (Fig. 1); the lower carries a double loop *b*, for the support of the needle axis *c*. The suspension rod can be fixed vertically, and is of considerable length, to allow for suspensions varying from 10cm. to 30cm. in length. The torsion head is carefully insulated from the suspension tube by shellac. The needle is made of 0·06mm. to 0·08mm. thick aluminium foil, fixed in such a manner that it may be removed and replaced by a larger one, to attain the utmost sensitiveness. The lower end of the needle axis carries a loop, *d*, from which the rectangular damping vane *e*, of thin aluminium foil, hangs. This vane swings in a rectangular damping chamber *f*, which can be manipulated through the door *g* without disturbing the instrument. In order to eliminate electrostatic effects in the damping arrangement, the vane and box are maintained at the same potential as the needle, the vane being in direct metallic connection, and the box being supported by a shellaced ebonite pillar *h*, and connected to the terminal *i*, which is connected to the needle terminal. The damping box can be adjusted by the three screws *k*, and by sliding or turning the tube *m*, fitting on the tube *n*, which is fixed to the bottom of the instrument case. In order that the adjustment of the quadrants about the needle should produce no consequent motion of the damping chamber, it must be possible to rotate them, to move them horizontally, and to incline them to the horizontal. To fulfil these requirements the quadrant supports are fixed to a ring *p*, which can turn on a second ring *q*. The latter rests upon three screws *r* in the bottom plate, with sockets in the ring, which is sufficiently large to allow of horizontal motion without touching the support of the damping box.

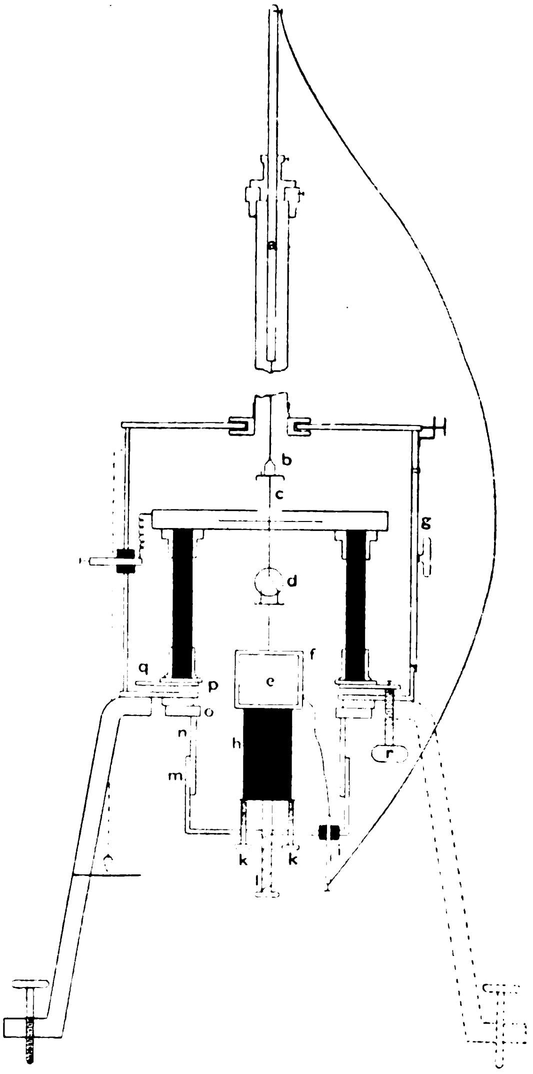

FIG. 1.—Hallwach's Improved Electrometer. Sectional Elevation.

Experiments were made with the object of ascertaining the amount of torsion in the suspension. The first set of observations were made with constant needle potential, and rising and falling

* Abstract from *Wied. Ann.*, No. 5, 1895.
† *Wied. Ann.*, No. 29, 1886.

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potential differences between the quadrants and the maximum difference between the ascending and descending readings of the same potential was only about 0·03 per cent. The same series of observations was also made, when a constant difference of potential was maintained between the quadrants, and small, gradually increased, potentials given to the needle, which was frequently reversed. The maximum error in this case was also 0·03 per cent. Finally, these experiments were made with variation in the damping, and with constantly maintained potentials, when time readings were taken, all of which show a similar maximum error. The instrument in these observations was used with the smaller needle and a 12cm. suspension, the periodic time varying from 11 to 15 seconds with the damping. With 140 volts needle potential, and a scale distance of 2,000 scale divisions, 1 volt on the quadrants gave 140 scale divisions total deflection when reversed. The sensitiveness could be increased about fourfold by using a longer suspension and larger needle.

In these observations a form of commutator was used which has been found very useful. It consists of a shellac plate (as shown in Fig. 2) fixed on a wood base, and carrying nine iron mercury cups, each having a terminal. The diagram (Fig. 2) shows the connections, N being the needle terminal, E earth, Q_1 and Q_2 the quadrants of the electrometer, $+B_1$ and $-B_1$ the charging battery for the needle, $+B_2$ and $-B_2$ that for the quadrants. Two spider connections are used, of the form shown in the figure, and it will be seen that on turning the left-hand connector through a right angle the needle and earth terminals are reversed with respect to the battery B_1, and that by turning the right-hand connector to any one of its four positions, either quadrant may be connected to either pole of the battery B_2, and may be at the same time either insulated or earthed.

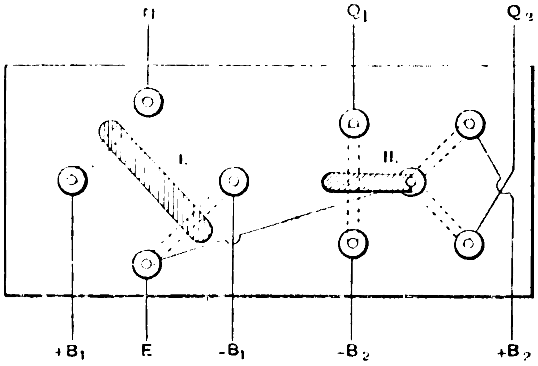

FIG. 2.—Hallwach's Improved Electrometer. Commutator.

LONDON COUNTY COUNCIL.

At the weekly meeting of the London County Council, held at the County Hall, Spring-gardens, on Tuesday, under the chairmanship of Sir Arthur Arnold, it was resolved, on the recommendation of the Fire Brigade Committee, that the tender of Mr. A. W. Jackson, to maintain for two years after the expiry of his contract the electric bells belonging to the brigade, be accepted, the price to be paid for the current year, and for each of the two following years, being £285.

Building Operations.

The Bridges Committee recommended that the consent of the Council be given to the erection of electric lighting buildings on the south side of Bowling Green-walk, in the parish of Hoxton, on the application of the Vestry of Shoreditch, subject to the usual conditions of the Council. The same Committee further recommended that the consent of the Council be not given to the erection of iron water tanks upon the existing one-storey addition at the electricity station, Manor-street, Chelsea, as shown upon the plan submitted by the Chelsea Electricity Supply Corporation (Limited), it being considered undesirable to allow the existing frontage at this part of the street to be disturbed.

The recommendations were agreed to.

National Telephone Company.

The Highways Committee reported that the National Telephone Company had applied for the use of a further 144 square inches of sectional space in the subways of Queen Victoria-street, Victoria Embankment, Shaftesbury-avenue, and Charing Cross-road for the laying of cables. The Company found that the space it now occupied in the subways was insufficient for its requirements, and asked that it might be allowed to occupy double that amount. The Company also desired to connect its cables in the Northumberland-avenue subway with those in the Victoria Embankment subway, and to utilise for that purpose some pipes which were laid down by the Council for the Home Telephone Company, which had been recently absorbed by the National Telephone Company. The Committee thought both requests could be properly complied with, and therefore recommended—"(*a*) That upon the National Telephone Company entering into an agreement, to be prepared by the Council's solicitor, to pay a rent in respect of the user of the subways in Queen Victoria-street, Victoria Embankment, Shaftesbury-avenue, and Charing Cross-road, according to the scale laid down by the Council, and also to pay the outstanding charges (if any) due from the Home Telephone Company in respect of the pipes laid down by the Council for that Company connecting the Victoria Embankments and the Northumberland-avenue subways, the Company be allowed to occupy the further space in those subways now applied for, and also to use the said connecting pipes, upon condition that all work in or about the subways shall be carried out under the supervision of the Council's chief engineer at the sole cost of the Company, and that any damage that may be done in or about the subway in the execution of the work shall be made good by the Company to his satisfaction. (*b*) That it be referred to the solicitor to prepare, and obtain the xecution of, the agreement above referred to."

The recommendations were agreed to.

Size of Transformer Chambers.

Reporting on the appeal of the County of London and Brush Provincial Electric Lighting Company to the Board of Trade against decisions of the Council formally disapproving of the construction of 42 transformer chambers of large size under the public streets of St. Giles and Clerkenwell, the Highways Committee stated that the award of the Board was given on September 12th, and allowed of the construction of 25 of the transformer chambers upon condition that they were constructed in accordance with certain drawings attached to the order, and that there should be no gas pipe within such distance of any box as was equal in feet to the diameter of the gas pipe in inches. The Board further disapproved and disallowed the appeal in respect of the construction of 17 chambers. The Committee regretted the decision of the Board of Trade to allow the construction of these large transformer chambers, but as the ultimate responsibility rested with the Board they had the satisfaction of knowing they had done all in their power for the protection of public interests in the matter.

The County of London and Brush Provincial Electric Lighting Company had given notice, dated August 23rd, of intention to construct 15 transformer chambers in Clerkenwell and St. Luke's, in lieu of the 17 disallowed by the Board of Trade, the proposed position of 12 of them being slightly varied to avoid the special difficulties found to arise in connection with the positions originally selected. The remaining three were in the positions of which the Board of Trade did not approve. In face of the decision of the Board of Trade the Committee did not think the consent of the Council should be refused with regard to the 12 chambers, but they thought their consent to the remaining three should be withheld. Accordingly they had notified approval of the 12 chambers, subject to the conditions stated in the award of the Board of Trade and to the further conditions that the Company should give two days' notice to the Council's chief engineer before commencing any of the chambers, and that they should be constructed strictly in accordance with the plans submitted; they had also directed notice to be served on the Company objecting to the remaining three chambers.

The same Company had also given notice, dated September 13th, of intention, under the provisions of the Wandsworth Order, to construct four transformer chambers in the following positions: at the corner of Colnette-road and Upper Richmond-road; at the corner of Carlton-road and Putney Hill; on Putney Hill near Kersfield-road; and at the Green Man public-house. They recommended that sanction be given to the work.

An amendment, standing in the name of Mr. Thornton, "That the Board of Trade be informed that the Council formally continues its disapproval of the construction of transformer chambers in the thoroughfares of the metropolis," fell through in that gentleman's absence from the chamber, and the recommendation was agreed to.

Loans Completed.

It was reported by the Finance Committee that the loans of £51,000 to the Islington Vestry and of £30,000 to the St. Pancras Vestry for electric lighting installation purposes in those parishes had been completed.

BOOKS RECEIVED.

"Calendar of the Glasgow and West of Scotland Technical College." Session 1895-96. (Glasgow: Robert Anderson.) Price 1s.

"Electrical Measurements." By Prof. H. S. Carhart and G. W. Patterson. (Boston: Allyn and Bacon). Price $2.

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CORRESPONDENCE.

MAGNETIC UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of this week Dr. Lodge refers to the "unofficial sentence"—weber-turns = $\frac{1}{4}$ mean volts per cycle—or better expressed—weber turns = $\frac{\text{mean volts}}{4 \times \text{frequency}}$. There seems in some way to be confusion about the value of the constant 4, as Prof. Perry desired to change it to 2π, while Dr. Lodge states that it is dependent on the law of change of induction. May I point out that it is universally true whatever the law of variation may be, and has no connection with a sine function. When I first quoted it in a letter published in your columns on August 2nd, my intention was merely to show the application of one of the terms—viz., "weber-turn"—to a very usual and useful expression for the induced E.M.F. in any circuit—viz., that mean volts = alteration in number of lines of force per second × the number of turns in the circuit. This is obviously the same as my expression, and clearly it is universally true.

I am glad to find that my proposal to make $\mu = 4\pi \times 10^{-9}$ for air, from the expression permeability = $\frac{\text{webers per sq cm.}}{\text{amp. turns per cm.}}$, has been previously advocated by Prof. Perry. It certainly seems to me the simplest way out of the 4π difficulty, and in fact if the large weber and the ampere-turn hold their own, it must be adopted.—Yours, &c.,

University College, Liverpool. F. G. BAILY.

P.S.—Prof. Lodge asks me to notify another slip in his letter on page 725, namely, that in line 11, where he has written "divided" instead of "multiplied."

THE MAGNETIC FORCE DUE TO ANY PLANE CIRCUIT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to Prof. Minchin's Paper and M. Colard's letter thereon, the magnetic force at any point in the plane of any plane circuit can be expressed by

$$F = i\int\frac{d\theta}{r},$$

where r and θ are the polar co-ordinates of a point on the circuit, referred to the point considered, and i is the current. This is one of the formulæ included in my Paper brought before the British Association.—Yours, &c.,

October 2, 1895. W. H. EVERETT.

LEGAL INTELLIGENCE.

Pink v. Cambridge Electric Supply Company (Limited).

This action was heard at the Cambridge County Court on the 25th ult., and was brought by Mr. O. F. Pink to recover £20 damages for an accident which the plaintiff contended was due to the negligence of the defendant Company in laying down their electric lighting mains. The accident occurred on May 27th, when the defendant was walking from the Free Library in the direction of Market-hill, and the inside of his right heel caught against one of the electric light boxes. He was thrown heavily to the ground, and when he got up he examined the box and found it at least half-an-inch above the level of the pavement. After evidence had been given on behalf of the plaintiff, Mr. J. H. Barker, the manager of the defendant Company, stated that the box in question had not been moved since June, 1893, when he became manager of the Company. If the pavement near any box was irregular the Company notified the Corporation, but no account for repairing the pavement around this box had been sent into the Company. The lid of the box was, however, taken up last Christmas, but afterwards screwed down again to its former position. Eventually the jury returned a verdict for the defendants, and His Honor (Judge Bagshawe, Q.C.) entered judgment for them with costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s.

The Edition for 1896 is in active preparation, and orders for Advertisements and Subscriptions can now be sent in.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices:—*

LABORATORY NOTES AND FORMS.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett *(now ready)*. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. nett, is now ready.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 8s. 6d.; Unvarnished, 8s.—each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

A SHEET TABLE showing Total Capital Outlay and Receipts and Expenditure for the year 1894 of the Statutory Electric Supply Undertakings of the Metropolis is now ready, printed on thick paper, price 6d.

A SHEET TABLE giving similar particulars in relation to Provincial Statutory Electric Supply Undertakings is now ready, printed on thick paper, price 6d.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d. post free (abroad 11s.).

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d (abroad 8s.). Prospectus on application.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson, price 6s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

TENDERS INVITED.—The Lancashire and Yorkshire Railway Company invite tenders for stores for the twelve months ending October 31, 1896. Included in the list of articles required are fog signals, india-rubber, iron castings (hydraulic and water pipes), iron chain, iron hinges, steel, and files, sundry tools, varnish, brake blocks, ironmongery, &c. Further particulars and forms of tender may be obtained at the Stores Department, Osborne-street, Manchester, up to the 5th prox., between 10 a.m. and 4 p.m., and on Saturday between 10 a.m. and 12 noon. Tenders to the Secretary, (Mr. C. W. Bayley), must be sent in not later than 10 o'clock on Monday next.

——— The Great Western Railway Company invite tenders for telegraph instruments, india-rubber goods, copper, iron and steel wire, telegraph ironwork, tools, &c.; electric light carbons, &c. Tenders, to the Secretary, Paddington Station, W., by Monday.

——— The municipal authorities of Tongres, Belgium, invite tenders for the concession for the public and private electric lighting of the town. Tenders to the Administration Communale by 10th inst.

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Tenders Invited.—The Electric Lighting Committee of the Bedford Urban Sanitary Authority invite tenders for the supply and delivery of 200 cast-iron lamp columns, carriers and globes. Tenders must be sent in to the Clerk (Mr. T. S. Porter) by the 8th inst.

——— The Croydon Town Council invite tenders for wiring, and for supplying and fixing electrical fittings at the New Town Hall, Courts and Free Library. Tenders to Mr. C. M. Elborough (Town Clerk), Town Hall, Croydon, by 4 p.m. on Tuesday next.

——— Tenders are being invited by the municipal authorities of Bucharest, Roumania, for the supply of a number of electric lamps and a quantity of arc-lamp carbons.

——— The municipal authorities of Almodovar del Campo (Ciudad Real Province) invite tenders for the concession for the electric lighting of the town during a period of 20 years. Tenders, to be addressed to the Ayuntamiento de Almodovar del Campo (Ciudad Real), Spain, by the 8th instant.

——— Tenders for the supply of a quantity of telegraph cable and copper wire, in two lots, are being invited by the Direction-Générale des Chemins de Fer, Postes et des Telegraphes, Brussels. Tenders by the 16th instant.

——— Tenders are required for the wiring of the Waverley Market, Edinburgh. Tenders to Mr. Thomas Hunter, W.S., Town Clerk, City-chambers, Edinburgh, by the 12th inst.

——— The Corporation of Newport invite tenders for wiring and for supplying and fixing electrical fittings at the Provision Market and Public Baths. Tenders, addressed to the Town Clerk, Town Hall, Newport, Mon., by the 11th inst.

Tenders Accepted.—The Board of Control, Dublin, received 20 tenders for the installation of the electric light at the Killarney Lunatic Asylum. The amounts varied from £957 to £3,195, and the lowest tender, that of Messrs. Ferguson and Co., has been accepted.

——— Eleven tenders were received by the Great Hall Company, Tunbridge Wells, for wiring the Great Hall for the electric light. The estimates ranged from £86. 18s. to £198. 11s. 5d., and the lowest, that of Mr. E. Powell, has been accepted.

——— The London County Council have accepted the tender of Mr. A. W. Jackson for the maintenance of the electric fire alarms for the Fire Brigade for a further term of two years. The amount of the tender was £285 per annum.

Appointment Vacant.—An assistant in the physical department of the City and Guilds of London Technical College, Exhibition-road, S.W., is required. Salary £100 per annum. Applications to Prof. W. E. Ayrton.

——— The Blackburn Corporation require an assistant engineer at their electricity works. Salary £130 per annum. Applications to the Town Clerk (Mr. Robert E. Fox), Town Hall, Blackburn, by the 19th inst.

Removal.—Messrs. Campbell, Macmaster and Co., consulting engineers and manufacturers' agents, notify us that they have removed to 11 and 12, Clement's-lane, E.C. The firm's telegraphic address is *Duke, London*, and the telephone number will continue to be *2011*.

Dissolution of Partnership.—Messrs. D. J. Callow and W. A. Cloud, hitherto trading as electrical and mechanical engineers, at Pier-place, Strand-on-the-Green, Chiswick, under the style of Callow, Cloud and Co., have dissolved partnership.

Bankruptcy.—A meeting of the creditors of the New British Electrical Installation Contractors (Limited) was held at Worcester on Tuesday. The statement of affairs showed that the gross liabilities amounted to £4,363. 18s. 5d., of which £3,922. 16s. is expected to rank, and the assets are estimated to realise £441. 2s. 5d. As regards contributories, there were 160 Ordinary fully-paid £5 shares, and thus the total deficiency was brought up to £4,722. 16s. An abstract of the Official Receiver's observations on the failure was given in our last issue, and Mr. Millington, who was mentioned as one of the promoters of the Company, has now issued a reply to these observations. Mr. Millington protested against the manner in which the report had been compiled, and its publication seven days before the first meeting of the creditors, and alleged that material facts, favourable to the directors, had been suppressed. Mr. Millington further stated that he had lost a considerable sum by the failure, and was, moreover, an ordinary creditor. A heated discussion then took place, the Official Receiver (Mr. Luke Sharp) stating that he had gone carefully into the Articles of Association, and he had grave doubts whether the debentures would stand. Consequently he thought it better that they should apply for the appointment of a liquidator. This course was, however, not adopted, and the matter was left in the hands of the Official Receiver.

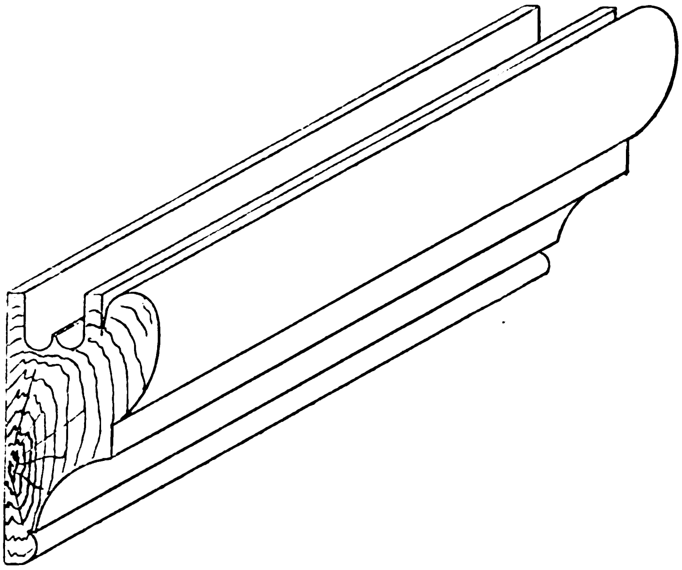
Liquidations.—It has been decided to wind up Lowcock, Hill and Co. (Limited) voluntarily. Creditors must send in particulars of their claims to Mr. A. S. Brewis (the liquidator), 60, King-street, Manchester, by the 28th inst.

Agency.—Mr. D. J. Russell Duncan, formerly senior partner in the firm of Duncan Bros., engineers, Westminster, and late Managing Director of the Steel Pipe Company (Limited), has commenced business at 80, Boulevard Haussmann, Paris, as agent for the sale of machinery, electrical apparatus and specialities of British manufacture suitable for French trade, and also for sale of inventions protected in France.

Drake and Gorham.—This firm inform us that they have been very busy in their installation department for some months past, having at the present moment nearly 30 installations in hand. The firm have been entrusted with the installation of the electric light at "The Lea," Mr. C. C. Wyllie's new house in Surrey, while a similar contract for the lighting of the house of Major the Hon. E. R. Bourke in Great Cumberland-place has also been placed with them.

Safety Tread Syndicate (Limited).—This Company have been appointed contractors to the War Office, Admiralty, and the India Office, for the supply of their well-known safety treads (Mason's Patent).

Electric Wire Picture Rod.—The accompanying sketch represents a picture rod, designed for carrying electric wires around a



room. The rod can, of course, be either of metal or of wood. It has been registered by Messrs. Skegg and Co., of Salford.

Chloride Electrical Storage Syndicate (Limited).—We have received a sheet containing prices and particulars of the new "R" type cell of this Syndicate, which is fitted with a new type of plate. It is claimed for this cell that it can be charged in four hours, thus effecting a considerable saving in the time formerly necessary for charging, and when discharged at a three-hours rate 80 per cent. watt efficiency and 90 ampere-hour efficiency are guaranteed.

Lithanode Electric Storage Company (Limited).—This Company has been formed for carrying on business as electrical engineers, electrical instrument makers, &c. By order of the Court the purchase has been concluded of the Lithanode and General Electric Company's patents, goodwill, plant and stock in trade as a going concern from July 8th last. The Company have also taken over the old Company's works at Westminster, where, for the present, all communications should be addressed. The new firm will continue the manufacture of the now well-known lithanode batteries, &c.

Pneumatically-controlled Switches.—A system of pneumatic control for switches has been developed by Messrs. Seiler Frères, of Paris, and for which Messrs. Julius Harvey and Co., 11, Queen Victoria-street, E.C., are agents. Instead of operating an electric switch directly by hand, this system provides that it shall be thrown into or out of action by means of a pneumatic tube and hand air-compressor, such as a squeezable ball. The advantage claimed for this arrangement is that it enables a single switch to be controlled from more than one point of control, by pneumatically coupling it with several branches of flexible tubing.

"The Engineering Magazine."—The October issue of this magazine is now ready, and maintains its usual high standard both as regards letterpress and illustrations. The subjects dealt with in the present issue (No. 1, Vol. X.) include: "National Supremacy on the Sea," by W. P. Stephens; "The Revolt in Cuba, its Causes and Effects," by a native Cuban; "The Canadian Lumber Industry," by J. S. Robertson; "Architectural Students' Work Abroad," by G. R. Phené Spiers; "Future of the Electric Tele-

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graph," by P. B. Delany; "The Newhouse Tunnel at Idaho Springs," by Arthur Lakes; "Mountain Railroads in Mining Regions," by James R. Maxwell; "Future Methods of Sewage Purification," by W. L. Hedenberg; "Underflow as Related to Irrigation," by H. V. Hinckley; and "Racial Traits in Machine Designing," by Albert Williams, jun., together with the usual exhaustive Review of the World's Industrial Press. All the back numbers may be obtained at the offices, 1, 2 and 3, Salisbury-court, Fleet-street, London. A complete index to the main articles in the magazine from the commencement in April, 1891, is now ready, and will be forwarded post free on request.

Aberdeen.—The *Aberdeen Free Press* advocates the extension of the electric light mains to the West End, where it is stated many of the residents are anxious to substitute electricity for gas lighting. The work of installing the electric light at Castle Newe, the seat of Sir Charles Forbes, Bart., has just been finished. Two 85-ampere Goolden dynamos and two "Achilles" turbines are employed. A battery of Epstein accumulators has also been installed, and the work of installation was carried out by Mr. V. G. Middleton. Messrs. New and Mayne recently installed the electric light at Brackley House for Sir Allan Mackenzie, and the same firm are at present carrying out an installation at the residence of Mrs. Pickering.

Belfast.—The report of the Electric Light Committee presented at the last meeting of the City Council stated that the increased demand for the electric light necessitated the putting down of some additional machinery, for which they had advertised. The Committee further reported that they were considering the desirability of extending their mains in a few of the principal thoroughfares immediately outside the present area of supply. The report was adopted.

Bermondsey (London, S.E.).—The Capital and Counties Electricity Supply Company (Limited) have notified the Vestry of their intention to apply for a Provisional Order for the district. The matter was referred to the Law and Parliamentary Committee for consideration and report.

Blackpool.—An explosion took place in one of the surface boxes in Church-street on the 26th ult. It is stated that there were unmistakable evidences of coal gas being present. A fault on the circuit was the "exciting cause" of the explosion. Lights were out on the circuit for 55 minutes. The ventholes in the surface-box lids had got clogged up, and thus allowed the gas to accumulate.

Bearpark (Durham).—The Parish Council at their last meeting discussed the lighting question, and the matter was adjourned for the purpose of obtaining the probable cost of lighting the district electrically.

Bolton.—At the last meeting of the Town Council the Gas, Electricity and Street Lighting Committee reported that they had almost reached the limit of the capacity of their present generating plant, and that they would have to make some extensions thereto in the near future. Alderman Miles, in moving the adoption of the report, said that the demand for current continued to increase in a most satisfactory manner.

Bristol.—The Electric Lighting Committee have made out their estimate for the half-year ending March 26, 1896, and it is satisfactory to learn the Committee do not intend to make any claim on the rates for working expenses, interest, or sinking fund, and, moreover, expect to make a small profit on the half-year's trading. There are now about 17,500 lamps connected, as against 8,883 in September, 1894. The Committee have several applications for electric current in hand, and they anticipate that by March, 1896, some 24,000 lamps will be connected up.

Broadstairs (Kent).—At the last meeting of the District Council a letter was read from Poole and White (Limited), asking on behalf of an electric lighting company, about to be formed, if the Council would support their application for a Provisional Order for the district. Some time ago the Council decided to oppose a similar application from the County of London and Brush Provincial Company. After a long discussion, initiated by Councillor Whitehead, it was decided to communicate with both companies on the subject.

Bromsgrove (Worcestershire).—At the meeting of the District Council on Wednesday some correspondence with the local gas company as to the quality of the gas supplied and the price thereof was read. The Vice-Chairman (Mr. H. W. Lewis) said if they could not come to an arrangement with the gas company they should be prepared to adopt temporary measures for lighting the town until they could devise an electric lighting or some other scheme.

Church Lighting.—The Parish Church, Oswestry, is to be fitted up for the electric light at an estimated cost of about £100.

Coseley (Staffs.).—At the meeting of the District Council on Tuesday, the surveyor (Mr. Shackleton) presented an exhaustive report on the public lighting question. If the Council adopted an electric lighting scheme he estimated the cost of plant at £8,700, and the annual up-keep at £1,226. The report was referred to committee for consideration and report.

Derby.—Good progress is being made with the electricity extension works. The Corporation have at present 194 customers for electric current on their books, while several others are waiting to be connected up. The electricity department has been working at a profit for some time past, and such is the popularity of the electric light that it is anticipated further additions and extensions will have to be made in the spring. There is also an increasing demand for current for motive power purposes, and this branch of the department has already become a very important one.

Douglas (Isle of Man).—The Health Committee are to consider and report upon the question of providing an efficient fire-alarm system for the town.

Dundee.—The Finance Committee of the Town Council recommend that steps be taken for the purpose of extending the electric lighting area of the Council.

East Grinstead.—The Urban District Council are greatly dissatisfied with the manner in which they are being treated by the gas company, and at the last meeting of the Council Mr. York moved that, in view of the attitude of the gas company, and the alleged deficiency in the supply and quality of the gas, the Council should enter into communication with Messrs. Owen Pike and Lucas as to the introduction of the electric light. This motion was adopted.

Edinburgh.—The Electric Lighting Committee, at their last sitting, decided to adopt the "Brockie-Pell" arc lamp for the lighting of Charlotte-square, George-street, St. Andrew-square, and the streets leading up to them from Princes-street. It was stated that the former contractors (Messrs. Crompton and Co., Limited) could not undertake to supply the present style of lamp at the old price.——The Cleaning and Lighting Committee have decided to recommend that the West Bow and the Grassmarket should be lighted by electricity and to erect arc lamps at the corners of Picardy-place and London-road. The Committee further recommend that until some definite scheme of extension had been resolved upon, the lighting of Castle-terrace by electricity should be postponed.

Exeter.—At the meeting of the City Council on Tuesday last a motion that the seal of the Corporation be affixed to a conditional agreement for the purchase of the Exeter Electric Light Company's undertaking was passed. It was also decided to make application to the Local Government Board for sanction to borrow £11,000 for electric lighting purposes.

Halifax.—At the meeting of the Town Council on Wednesday, detailed plans were presented by Messrs. Easton, Anderson and Goolden for the construction of electric tramways in the town on the overhead system. Two routes were suggested, one from the railway station by Horton-street and Commercial-street to King Cross, and the other from the Grand Theatre to Haley Hill and Boothtown. The road work is estimated to cost the Corporation £12,500 for 3½ miles, while the rough estimate for working and electrically equipping an overhead system is put at £18,500. The matter was, after a brief discussion, postponed till the November elections had taken place.

Harrogate.—At the meeting of the Town Council on Tuesday, it was decided to apply for sanction to borrow £35,000 for electric lighting and other purposes.

Harrow.—At the last meeting of the District Council it was stated that the Board of Trade would allow the transfer, by the Council, of the Harrow Provisional Order to the Harrow Electric Light Company (Limited).

Heaton Norris (Stockport).—At the last meeting of the District Council the Chairman stated that he thought the time had arrived when the Council should take steps to consider the question of lighting the district by electricity, and he moved that a sub-committee be appointed to immediately consider the matter. Mr. Everatt suggested that the Committee should be empowered to obtain information from other Councils who had obtained Provisional Orders. The motion and amendment were adopted.

Higher Commercial Education.—A free lecture, explaining the objects of the lectures and classes arranged for the ensuing winter by the London Chamber of Commerce, in connection with the London School of Economics and Political Science, will be delivered by Mr. W. A. S. Hewins, M.A., at Botolph House, Eastcheap, E.C., on Monday next, at 6:30 p.m. Sir Albert K. Rollit, D.C.L., M.P., will preside.

Limerick.—The Town Council some time ago passed a resolution in favour of the introduction of the electric light, but beyond this they have done nothing to comply with the terms of their Provisional Order, which expires early in 1896. The Board of Trade have now written for the second time, asking what progress they had

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made in the matter, and a special meeting is to be held on Tuesday next for the consideration of the question.

Liverpool.—At their meeting on Wednesday the City Council agreed to the recommendation of the Special Lighting Committee that a further agreement be made with the Liverpool Electric Company to complete the purchase of the Company's undertaking, works and property, in accordance with the agreement already made, within six weeks from the date of an Act of Parliament authorising the sale to the Corporation, provided such Act is passed in the year 1896.

Llanberis.—It is stated that fair progress is being made with the construction of the electric railway leading up to the summit of Snowden. There is, however, no likelihood of its being ready for traffic this year.

Londonderry.—At a recent meeting of the Lighting Committee Alderman Pollock introduced the question of private lighting. He said a very large number of ratepayers were most desirous to have private lighting introduced, and he knew that several churches were anxious to obtain electric current. Alderman Fleming agreed that the electric light was needed in the churches, as the gas was very bad and deficient in illuminating power, and he hoped the Chairman would call a meeting to consider the matter, when Alderman Pollock would probably have some figures to put before them. The further consideration of the matter was deferred for a fortnight.

Maidstone.—At the last meeting of the Town Council the Technical Education Committee presented a report recommending the borrowing of a further sum of £1,300 for the Technical Schools. This additional sum was required for the electric lighting of the building and for fittings and apparatus. The matter was, however, referred back for further consideration.

Northampton Institute.—This Institute, which is now nearing completion, will be lighted throughout by electricity. The Committee have decided to put down their own generating plant. The entire installation is estimated to cost about £3,000.

Pembroke (Dublin).—The Town Commissioners have under consideration the question of the adoption of a combined electric lighting and refuse destructor scheme, and intend to apply for a Provisional Order.

Sheffield.—As the lease of the Sheffield Tramways Company will shortly expire, the Town Council will be called upon to consider the question of either renewing the present Company's lease or of taking the management of the tramways into their own hands. In view of the latter event, the *Sheffield Independent* has been collecting information from various quarters as to the best system of traction to be adopted by the Council, and in its issue for the 27th ult. an abstract of this information is given.

Stafford.—The formal opening of the electric light works takes place on the 15th inst.

St. Helens.—Mr. F. H. Tulloch, M.I.C.E., held a Local Government Board inquiry on Tuesday last into the application of the Corporation for sanction to borrow £10,000 for electric lighting purposes. The Town Clerk (Mr. W. J. Jeeves) gave particulars of the scheme, and there was no opposition to the application.

St. Pancras.—The Vestry have reconsidered the matter of allowing a service pipe to be laid from the London Hydraulic Company's main to premises in Charlotte-street, and have now given their consent to the application, on condition that the power is only used for a lift. The Vestry will shortly be able to supply current from the King's-road station, as the work of equipping is now practically complete.

Sunbury-on-Thames.—The engineer (Mr. Anstie) has presented a report to the District Council on a suggested scheme of sewage pumping by electricity. The estimated cost of the electrical machinery is put at £6,250. The matter is to be further considered at the next meeting of the Council.

Swansea.—The report recently presented by the Electric Lighting Committee on the proposed joint electric lighting and refuse destructor scheme was considered by a specially convened meeting of the Town Council on Wednesday. The subject was discussed at great length, and, after various amendments postponing the matter were defeated, the report was adopted.

Telegraphic Communication in Siberia.—It is stated that a telegraph line is to be constructed between Bachta and Tchugutschesk, Siberia, by which telegraphic communication with Western China will be facilitated.

Telephone Extensions in Germany.—The telephone exchange at Essen was recently fitted up with multiple switchboards (for 6,000 subscribers), which have been manufactured and erected by Messrs. Mix and Genest (Limited), of Berlin, for the German General Post Office. The result is that the telephone service has been greatly improved, as attention is more prompt and less noise is noticeable at the exchange. The neighbouring towns of Dortmund, Bochum, &c., had previously been fitted up with similar switchboards, and the work had given great satisfaction, thereby accelerating the transformation of the old exchange at Essen into one equipped with the most modern fittings.

Torquay.—The report of the Electric Lighting Committee will be presented at the next meeting of the Town Council.

Warehouse Lighting.—Messrs. Arnott and Co.'s new premises in Prince's-street, Dublin, will be lighted throughout by electricity.

Willesden (London, N.W.).—At the last meeting of the District Council some members urged that an arrangement should be come to with the Hampstead Vestry for supplying electric current for lighting both sides of the High-road, Kilburn. It will be remembered that one side, being within the area of the jurisdiction of the Hampstead Vestry, is already lighted electrically. One member said it would look exceedingly bad if there were only gas lights on one side of the road and electric light on the other.

Woking.—A meeting of ratepayers in the St. John's ward was held on Friday last to consider the lighting question, and after a long debate a motion that the ward be lighted by electricity was carried. The arrangements for giving effect to this vote were left in the hands of the representatives of the ward on the District Council.

Worksop.—At the last meeting of the District Council, Mr. Nash's proposal to form a company for the purpose of supplying electric current for public and private lighting in Worksop was approved. It is reported that many of the principal ratepayers and shopkeepers in the district would be inclined to take current if it were available.

Yeadon (Yorks.).—At a meeting of ratepayers on Friday last, the question of the electric light was again discussed. The electrical engineer (Mr. F. H. Medhurst) whom the District Council had engaged to advise them on the tenders sent in, recommended the acceptance of the Brush Company's scheme. The matter was debated at great length, but no decision was come to, and the meeting was adjourned for three months.

York.—Electric lighting matters do not seem to make much headway in this city. At the last meeting of the Streets and Buildings Committee the city engineer reported that he hoped to have a definite reply from Mr. Preece with regard to his proposed report on the electric lighting of the city before the next meeting of the Committee. It was also reported that several communications had been received from various electrical engineers offering their services as consulting engineers to the City. The York Provisional Order will shortly expire, and the Board of Trade recently wrote to the Council, asking them what steps they had taken to carry out the provisions thereof, and, in reply to this letter, the Town Clerk sent a *résumé* of the various attempts which the Council had made to "find" a suitable electric lighting scheme.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

September 9, 1895.

16,826. E. Andreoli. London. Improvements in the electrolysis of saline solutions.

September 10, 1895.

16,866. E. J. Piper. London. Improvements in arc lamps.

16,897. H. Hirst and W. E. Gibson. London. Improvements in holders and supports for electrical candles.

16,898. G. Binswanger. London. An improved wall socket and plug for electric lighting and kindred purposes.

16,910. D. S. Regan. London. Improvements in and relating to power transmitting mechanism for the power shafts of electric and other high-speed motors.*

16,918. H. A. Cutmore. London. An improved junction coupling for electric lighting installation.

16,924. C. D. Tisdale and J. D. Gould. London. Improvements in electric fire alarms.*

16,925. C. D. Tisdale and J. D. Gould. London. Improvements in electric fire alarms.*

16,939. J. Devonshire. London. Improvements in electric locomotives. (E. W. Rice, jun., United States.)*

16,940. F. J. Warden Stevens. London. Improved electrical tool.

16,950. J. H. George. New York. Electrolyte baths, appliances and system.

16,952. W. Rowbotham and H. Levetus. London. Improvements in incandescence-electric lamps.

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September 11, 1895.

17,004. P. R. J. WILLIS. London. Improvements in and in the method of constructing incandescent electric lamps. (R. Greer, United States.)

437A. J. B. BARTON. London. Improvements in and connected with arc lamps. (W. Jandus, United States.) [Date claimed under Patents Rule 19, January 7, 1895.]

September 12, 1895.

17,063. T. L. WILLSON. London. Improvements in electric smelting. [Date applied for under Patents, &c., Act, 1883, Sec. 103, February 20, 1895, being date of application in United States.]

September 13, 1895.

17,123. H. HIRST. London. Improvements in linked suspensions for electroliers, electric light pendants and the like.

September 14, 1895.

17,202. V. FABBRIS. London. Improvements in battery cases, to render the contents of the same unspillable.

17,205. J. A. F. ASPINALL. Manchester. Improvements in machinery or arrangements for lifting, lowering, carrying or transporting loads, actuated by electricity.*

17,210. A. J. MARQUAND, E. HANCOCK and D. LOWDON. London. Improvements in the manufacture of electrical resistances.

September 16, 1895.

17,232. J. DIXON. London. An automatic and electrical tell-tale apparatus for indicating water and other liquid levels.

17,249. A. E. WOODHOUSE. London. An improved gauge for gauging electrical and other wires, drills, boring bits and other similar articles.

September 17, 1895.

17,283. E. BOOTH. Halifax. A method or system of utilising town's water for generating electricity.

17,287. W. DIBB and A. VICKERS. Manchester. Improvements in and relating to insulators for telegraph and telephone poles.*

17,288. W. A. ROSENBAUM. Manchester. Improvements in and connected with the electrolytic decomposition of alkaline salts.*

17,328. G. H. DAVIS. London. Improvements in electrical attachments for playing pianos.*

17,330. H. V. KERSON. London. Improvements in electric exploders.

17,365. R. BELFIELD. London. Improvements in and relating to automobile cars for electric railways.

September 18, 1895.

17,400. J. T. WOOD and J. A. BRODIE. Liverpool. Improvements relating to permanent way, electric conduits and conductors of electric tramways.

17,430. R. BELFIELD. London. Improved methods of and means for making and breaking electric circuits.

17,436. H. B. COX. London. Improvements in thermo-electrical generators, and the method of operating same.*

17,442. L. B. STEVENS. London. Improvements in electrical resistances.*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

12,045. SCHANSCHIEFF. Secondary batteries.
14,765. WILLIAMS. Electrically reproducing graphic matter or designs.
16,418. CERPAUX and ANOTHER. Telephonic apparatus.
16,999. COWPER-COLES AND ALLIOTT. Electric switch.
17,761. BROCKIE. Arc lamps.
17,922. IMMLER. Arc lamps.
17,877. SCHINDLER. Electrically-heated grills.
18,501. KERR. Incandescent electric lamps.
20,397. CREFFIELD. Arc lamps.
21,142. SIEMENS BROS. AND CO. (LIMITED) (Siemens and Halske). Electro-motors.
21,827. IMRAY (Société Anonyme pour la Transmission de la Force par l'Electricité). Dynamo electric generators.
24,934. WAGG. Electric switch.

1895.

57. HOPKINSON. Ascertaining difference of electric potential.
3,548. EDGE. Electric switch.
12,275. BERKENHOFF. Coating or galvanising wire, &c.
13,348. ROYCE and CLAREMONT. Distributing power by electricity.
13,380. MOSKOWITZ and OTHERS. Electric lighting.
13,411. ROYCE and CLAREMONT. Distributing power by electricity.
13,416. WALTERS. Electric lamps.
13,434. SIEMENS BROS. AND CO., LIMITED (Siemens and Halske). Electrolytical production of zinc.
13,635. GRIER and OTHERS. Electric gas lighters.
13,978. BONTA. Stopping electrically-propelled cars.
14,014. JONES (Stuebner and others). Electric switch.
14,049. HIGHAM. Arc lamps.
14,114. HESSBERGER. Electrical apparatus.
14,481. POOLE and LOWRY. Imitation candles for electric lights.

COMPANIES' MEETINGS AND REPORTS.

Froggatt's Electric Lighting Company (Limited).

The first annual general meeting of this Company was held at Winchester House, Old Broad-street, on Monday last, under the presidency of Mr. A. de Murrieta.

The SECRETARY (Mr. Arthur S. Hiley) having read the notice calling the meeting,

The CHAIRMAN said: It is a very great disappointment not to be able to meet you with a more favourable report of the past year's business of the Company, but in all new businesses the first year is very difficult, and more especially we have found it full of difficulties, particularly in regard to the lighting of public vehicles, which is a branch to which we have specially devoted ourselves. However, after the experience we have gained, we feel confident now of overcoming all obstacles, and we are now actually lighting under contracts the London Tramways (over 500 lights), the Glasgow Corporation Tramways (over 800 lights), and omnibuses for Messrs. Ball Bros. (88 lights), Tillings (45 lights), and a few others. We have also sold apparatus for lighting six omnibuses to the Isle of Man Tramways and Electric Power Company, who are trying our system. The extension of this business, however, requires very serious consideration, owing to the large amount of capital it absorbs, the very rough treatment our batteries are exposed to, and the unreliable class of men we are obliged to employ for night work, and particularly in bad weather. The latter difficulty, however, we have got over in the case of the South London Tramway Company, by an arrangement lately made with them by which their own staff now do this work, and we hope shortly to make a similar arrangement with the Glasgow Corporation. Our lighting has attracted a great deal of attention, and we have constant inquiries on the subject, and applications for agencies both from abroad and the provinces. We are now devoting more attention to portable lights for houses, cycles, travelling lamps, and policemen's and postmen's lights, for all of which we think there is a growing demand. Another very important field for lighting has been started by us, but I do not think it advisable to refer to it more in detail here; but I may mention that a very influential firm connected with this particular business has been so much impressed with what we have already done that it has approached us with a view to acquiring the agency for the whole of this branch of the business. A considerable amount of friction has on several occasions arisen between the Directors themselves and between the Board and the management. Under these circumstances we think it very advisable that the shareholders should appoint a committee to confer with the Directors with a view to reorganising the Board and the management generally. The Chairman concluded by moving "That the report be adopted," which was seconded by Mr. McGill, and which was agreed to.

In answer to a question, the SOLICITOR (Mr. H. Keeble) said that he had advised the Chairman that the subject of the appointment of the committee could not be entered into that day, as it did not come within the scope of the meeting. The committee would have to be appointed at an extraordinary general meeting summoned for the purpose.

The CHAIRMAN said that they would call such a meeting within about a month.

The retiring Director (Mr. C. de Murrieta) and the auditors (Messrs. W. P. Eldrid and Co.), were re elected, and the usual vote of thanks to the Chairman terminated the proceedings.

Willans and Robinson (Limited).

The third half-yearly report of the Directors of this Company, to be submitted at the meeting to be held at the Cannon-street Hotel, London, E.C., on Tuesday next, the 8th inst., at 3 p.m., states:—

The engine orders for the half-year ended June 28th amounted to 12,832 I.H.P., against 10,315 in the corresponding half of 1894, and 9,290 in 1893 (old company). As previously pointed out, the Company has had great difficulty in keeping pace with its orders, and the fast increasing demand for the Willans engine, though encouraging for the future, is only a source of embarrassment in the present, and must continue to be so until the new works at Rugby are completed. After writing off as depreciation from plant, patents, &c., the large sum of £3,762. 0s. 3d. (exceeding by nearly £900 the amount written off last half-year), the balance to the credit of profit and loss account for the half-year is £10,614. 2s. 7d. The Directors propose that dividends be paid at the rate of 6 per cent. per annum upon the Preference shares, and at 7 per cent. per annum (as before) upon the Ordinary shares, which will together absorb £6,586 5s. 2d. It is proposed to carry £2,500 to the reserve fund, which will then amount to £5,146. 9s. 11d., and to carry forward a balance of £319. 10s. 2d.

Arrangements for the manufacture of the Willans engine upon the Continent, under licence, have made further progress. For the first time "Royalties receivable" appear in the accounts, and this source of revenue is likely to increase. Licences for certain countries have been granted upon satisfactory royalty rates, and in connection with these licences certain cash payments have also been made. After writing off all expenditure incurred in arranging the licences, the sum of £3,632. 12s. 1d. remained to the credit of profit and loss, which enabled the Directors (as already stated) to write off about £900 as increased depreciation, and to reserve an equal amount in the valuing of other accounts, as well as to carry an unusually large sum to the reserve fund.

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The balance of the shares authorised to be issued has been taken up. The applications for these shares considerably exceeded the number to be allotted. The entire debenture debt, amounting to £9,910, was paid off as from March 31st last, but many of the debenture-holders applied for and were allotted shares in lieu of the cancelled debentures. It was thought desirable to perpetuate the system of workmen's debentures, which had been for some years in force, and workmen's bonds, to the amount of £1,080, were issued to the holders of cancelled workmen's debentures, bearing the same interest as the latter.

The new works at Rugby are making satisfactory progress, though it is anticipated they cannot commence to add to the out-turn from the Company's workshops for another six months. Contracts for buildings, &c., to the amount of £18,700, have already been placed.

NEW COMPANIES, STATUTORY RETURNS, &c.

In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1895, *pages 304-332, &c., &c.*

UNIVERSAL ELECTRIC CARRIAGE SYNDICATE (LIMITED).—This Company was registered on September 25th, with a capital of £5,000, in £1 shares, to carry on in the United Kingdom or elsewhere the business of electricians, electrical engineers, mechanicians, manufacturers and owners of electrical vehicles and carriages, workers of and dealers in electricity, electrical machinery, appliances, apparatus, &c.; to carry into effect an agreement with Walter C. Bersey, electrical engineer, to construct, purchase, equip, maintain and work omnibuses, vans, and other vehicles for the carriage of passengers and goods, and to make experiments in and give public exhibitions of electric force, traction, and lighting, and of electrical appliances, &c. The subscribers, with one share each, are: D. C. Miller, J.P., C. N. Stewart (mechanical engineer), R. J. Hinton, Walter C. Bersey (electrical engineer), G. E. Thompson, R. Wheeler, and R. H. Wheeler. The first Directors are: D. C. Miller, J.P., R. J. Hinton, C. N. Stewart; and (after allotment) Walter C. Bersey will act as Managing Director.

BABCOCK AND WILCOX (LIMITED).—The annual return to September 24th has been filed. The nominal capital is £240,000, divided into 14,000 Ordinary and 10,000 Preference shares of £10 each. The whole of these shares have been taken up, and 4,666 of the former and 3,333 of the latter have been issued as fully paid. The full amounts have been called on the remaining 9,334 Ordinary and 6,667 Preference shares.

CHILI TELEPHONE COMPANY (LIMITED).—The annual return to August 13th has been filed. 44,000 shares have been subscribed for out of a nominal capital of £250,000, in £5 shares, and the full amount has been called and paid.

COLUMN PRINTING TELEGRAPH SYNDICATE (LIMITED).—The annual return to August 13th has been filed. 289 £50 shares have been taken up out of a capital of £25,000, and 100 of these have been issued as fully paid. The full amount has been called on the remaining 189 shares.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE (*now* **MANUFACTURING**) **COMPANY (LIMITED).**—The annual return to June 20th was not filed until September 10th. The nominal capital is £234,938, divided in 47,363 £6 per Cent. Preference shares and 75,150 Ordinary shares of £1 each, and 224,850 Ordinary shares of 10s. each. All of the last-named class have been subscribed for, and the full amount paid thereon.

D.P. BATTERY COMPANY (LIMITED).—The statutory return to September 23rd has been filed. The nominal capital of £10,000 is divided into 4,996 "A," 4,996 "B," and eight "other" shares, all of £1 each. The whole of these have been subscribed for, and the full amount has been called on the "other" shares, while calls, amounting to 14s. per share, have been made on the "A" and "B" shares.

LONDON AND LANCASHIRE ELECTRIC AND ENGINEERING COMPANY (LIMITED).—The annual return to July 29th has been filed; 1,987 shares have been taken up out of a capital of £20,000, in £5 shares, and of these 1,000 have been issued as fully paid. A call of £2 per share has been made on the remaining 987 shares.

NATIONAL COMPANY FOR THE GENERATION OF ELECTRICITY BY SECONDARY GENERATORS (LIMITED).—The annual return to August 28th has been filed. The nominal capital is £500,000, in 3,000 Preference and 47,000 Ordinary shares of £10 each. 2,669 of the former and 20,000 of the latter have been taken up, and 1,000 Preference and all the Ordinary have been issued as fully paid. The full amount has been called on the remaining 1,669 Preference shares. 100 shares have been forfeited.

TELAUTOGRAPH COMPANY (LIMITED).—The statutory return to August 6th has been filed. The nominal capital is £42,000, in 16,000 Preference and 26,000 Ordinary shares of £1 each; 8,492 of the former class have been subscribed for, and a call of 10s. per share has been made on 8,485 of these.

WALSALL ELECTRICAL COMPANY (LIMITED).—The annual return to September 19th has been filed. Of a nominal capital of £10,000, in £10 shares, 683 shares have been taken up, and of these 200 have been issued as fully paid. The full amount has been paid on the remainder.

CITY NOTES.

MEMORANDA.—Bank rate, 2 per cent. (Feb. 22, 1894). Price of silver, $30\frac{11}{16}$d. per oz. (Oct. 3rd). Consols ($2\frac{3}{4}$ per cent.) $107\frac{5}{8}$—$107\frac{3}{4}$ for money, $107\frac{5}{8}$—$107\frac{3}{4}$ for account (Oct. 3rd); $2\frac{1}{2}$ per cent. 106—$106\frac{1}{4}$. Stock Exchange Settling Days: Consols, Nov. 1st; Stocks and Shares Continuation Day, Oct. 14th; Ticket Day, Oct. 15th; Pay Day, Oct. 16th; Mining Shares Carry-over Day, Oct. 12th.

BELL'S ASBESTOS COMPANY (LIMITED).—An extraordinary general meeting of the shareholders of this Company was held at the Cannon-street Hotel on Friday last, when the resolution as to the division of the existing £5 shares of the Company into five £1 shares, passed at a former meeting, was confirmed.

BIRMINGHAM ELECTRIC SUPPLY COMPANY (LIMITED).—An extraordinary meeting of the shareholders of this Company was held at the offices, 14, Dale-end, on the 26th ult., when the resolution authorising the further issue of 10,000 shares of £5 each referred to in our last issue was approved.

CHARLES CAMMELL AND CO. (LIMITED).—The Directors of this Company have decided to pay an instalment on account of dividend for the present year of £2 per share on the Ordinary, and 10s. per share on the "A" and "B" shares.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—This Company's traffic returns for the week ended September 29th were £823, against £881 in the corresponding week of 1894, a decrease of £58. The total receipts for the half-year amount to £10,971, against £11,119 for the corresponding period of 1894, a decrease of £148.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of September, 1895 were £2,072 against £1,898 in the corresponding period of last year.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The Board of Directors of this Company have resolved to pay an interim dividend of 2s. per share, free of income tax, being at the rate of 2 per cent. per annum, for the quarter ended September 30th last. The dividend is payable on and after the 24th inst.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The Directors of this Company on Wednesday declared an interim dividend, for the quarter ended June 30th last, of 2s. 6d. per share, free of income tax, payable on the 15th instant. The share register will be closed from the 7th to the 14th instant, both days inclusive.

EVERED AND CO. (LIMITED).—The Directors of this Company have declared a half-yearly interim dividend at the rate of $7\frac{1}{2}$ per cent. per annum.

GLOBE TELEGRAPH AND TRUST COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend of 1s. 3d. per share.

HAWAIIAN TRAMWAYS COMPANY (LIMITED).—At the meeting of this Company on Monday last the Chairman (Col. C. M. Davidson), in moving the adoption of the report, said in 1890 they obtained permission from the Legislature to use electric traction, but up to the present, although they had been watching the development of electric tramways, they had been unable, owing to the expense involved, to recommend its adoption to their shareholders. In America electric traction was greatly used, and no doubt in many instances it had an advantage over horse traction. There was, however, a desire to introduce electric traction on their tramways, and they were making inquiries as to the cost of conversion, &c. It was very difficult to obtain correct details as to renewal, as electric tramway accounts were not yet perfectly clear under this head. They would wish to do the work themselves—to convert, to run, and to renew; but while doing this they must be assured that their shareholders would receive a benefit as well as the travelling public. When they had the whole information ready they would then call a meeting of the shareholders. The report and accounts were adopted.

ISLE OF MAN TRAMWAYS AND ELECTRIC POWER COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend for the six months ended June 30th last at the rate of 6 per cent. per annum on the Preference and $7\frac{1}{2}$ per cent. on the Ordinary shares.

LEIPZIGER ELEKTRISCHE STRASSENBAHN-GESELLSCHAFT.—This is the title of a Company which has just been formed by the Allgemeine Elektricitäts-Gesellschaft in conjunction with several well-known German banks for the erection and working of an electric tramway at Leipzic. The capital of the Company is to be £300,000.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended the 29th inst. amounted to £1,266. The amount for the corresponding week last year was £988; increase, £278.

REUTER'S TELEGRAM COMPANY (LIMITED).—The Directors have declared an interim dividend at the rate of 5 per cent. per annum, free of income tax, for the half-year ended June 30th last, payable on the 9th inst.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to appoint a settling day in, and to grant a quotation to, 9,104 fully-paid £10 shares and 207,649 £2-paid shares of the Central London Railway Company (Limited); and also to appoint a settling day in the shares of the Smelting Company of Western Australia (Limited).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended September 27th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,249.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, Sept. 25.		Price Wednesday, Oct. 2.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Sept. 28. Highest	Lowest
			TELEGRAPHS.								
£1,012,880	Stock	11/0	Anglo-American	48	50	48	50	4 0 0	Jan., Apr., July, Oct.	..	..
£2,993,560	Stock	22/0	Do. Preferred	89	90	89	90	5 8 0	" "	89¾	89
£2,993,560	Stock	5/0	Do. Deferred	8½	9	8½	9	..	" "	8¾	8½
£173,400	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 16 11	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	14	14½	14	14½	4 9 8	Mar., June, Oct., Dec.	14 5/16	14¼
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 7 11	June and December	..	..
10,000,000	$100	1¾%	Commercial Cable Capital Stock	160	165	160	165	4 5 9	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	13¾	13½
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20	21	3 16 2	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid) xd	4	5	4	5	4 0 0	April and October	..	—
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10½	9½	10	5 0 0	" "	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	103%	106%	4 5 9	..	..	—
60,710	20	2/0	Direct United States Cable, 1877	9	9½	9	9½	4 4 3	Jan., Apr., July, Oct.	..	..
400,000	10	5/6	Eastern	17⅛	17⅜	17⅛	17⅜	3 14 10	" "	17 5/16	17⅛
70,000	10	6%	Do. 6 per Cent. Preference	18	18½	18	18½	3 4 10	" "	13¾	..
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	129	132	129	132	3 1 2	May and November	131½	128½
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	106	109	107	110	4 11 11	February & August	..	..
250,000	10	2/6	Eastern Extension	18	18¼	18	18¼	4 1 1	Jan., Apr., July, Oct.	18¼	18
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	128	131	128	131	3 1 4	February & August	129¾	129
£54,100	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	102	106	103	107	4 14 7	January and July	104½	..
£80,600	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	102	106	103	107	4 14 7	" "	104	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	107	110	108	111	3 12 5	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	113%	116%	114%	117%	3 9 3	May and November	115¾	115½
180,227	10	3/3	Globe Telegraph and Trust	10⅛	10⅜	10⅛	10⅜	3 19 6	Jan., Apr., July, Oct.	10⅜	10⅛
180,042	10	6%	Do. 6 per Cent. Preference	17	17½	17	17½	3 9 7	" "	17 1/16	17
150,000	10	5/0	Great Northern	21¾	22¼	21¾	22¼	3 16 3	Jan., April, and July	..	..
£180,000	100	5%	* Do. 5 per Cent. Debentures, 1883 issue	103	106	103	106	4 14 9	March & September	104½	..
17,000	25	37/6	Indo-European	50	53	50	53	4 14 4	May and November	52½	51¼
37,548	10	..	London Platino-Brazilian	..		..		..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	104	108	105	109	5 10 7	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	108	111	108	111	3 12 9	..	..	..
11,839	8	4/0	Reuter's	4	5	5	6	..	April and October	..	..
3,381	£100 Cert.	..	*Submarine Cables Trust 6 per Cent.	127	132	128	133	4 12 4	" "	129½	..
15,609	10	2/0	West African Telegraph	5½	6½	5½	6½	..	January and July	..	..
£233,300	100	5%	* Do. 5 per Cent. Debentures (red.)	104	107	104	107	4 13 11	March & September	..	—
30,000	10	2/0	West Coast of America	1½	2	1½	2	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	104	100	105	7 15 4	June and December	..	..
88,321	10	6d.	West India and Panama	¾	1	¾	1	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10½	10¾	10½	10¾	5 14 3	May and November	10½	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	6 13 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110	113	110	113	4 9 6	June and December	112½	..
64,242	15	6/0	Western and Brazilian	10	10½	10	10½	4 5 9	May and November	10	..
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	—	..	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4	4½	4	4½	..	..	4½	4
£165,200	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	102	105	103	107	5 13 2	February & August	—	..
£206,400	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	102	106	103	107	5 13 2	" "	..	..
$1,177,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	6 1 9	May and November	..	..
£164,300	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	103	100	103	5 17 1	March & September	..	..
			TELEPHONES.								
44,000	5	2/6	Chili Telephone (fully paid)	3½	4	3½	4	..	..	3¾	..
224,850	10/0	1½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	—
171,504	£1	8·215d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	—	..
484,597	5	2/6	National	6⅜	6⅝	6⅜	6⅝	3 18 5	June and December	6 5/16	6¼
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	16	18	16	18	3 6 8	" "	..	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	" "	..	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	6¼	6¾	6¼	6½	3 16 11	—	5 5/16	5½
1,100,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	106	108	106	108	3 5 3	January and July	107½	106¾
58,000	5	3/0	United River Plate	2¾	3¼	2¾	3¼	..	" "	..	..
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	93	98	93	98	5 3 4	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	13½	14½	13	14	1 15 9	—	14¾	13½
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	14½	15½	14½	15½	3 17 5	..	15⅝	15⅝
£100,000	Stock	5%	* Do. 5% Debenture Stock (red.)	133	137	133	137	3 13 8	June and December	135½	134
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	—	..	—
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	—
8,322	£5	..	House-to-House Electric	—		—		..	—	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	—		—		..	—	—	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	—	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7⅞	8⅛	7⅞	8⅛	..	—	..	..
111,000	5	..	London Electric Supply	..		..		..	—	..	—
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	12	12½	11¾	12¼	2 9 0	..	12 3/16	12
150,000	Stock	4½%	* Do. 4½% Debs.	117	119	117	119	3 16 4	June and December	9	..
6,452	£10	2/0	Notting Hill Electric	8½	9½	8½	9½	..	—	..	..
..	..	..	Rand Electric	⅜	½ prem	7/16	9/16 prem.	..	—	..	..
19,980	£5	2/0	St. James and Pall Mall	8¼	8¾	8	8½	..	—	—	..
20,000	£5	7%	Do. 7 per Cent. Preference	9	10	9	9½	3 13 8	—	..	..
59,900	5	2/6	Westminster Electric Supply (fully paid)	8¾	9¼	8½	9	3 1 1	..	9 1/16	8⅞
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	1½	1¾	1½	1¾	3 11 8	—	1¾	1 11/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	1⅞	2⅛	1⅞	2⅛	5 12 11	—	2 1/16	2
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	111	114	112	115	3 18 3	March & September	113½	112½
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1	2	1	2	..	January and July	1¼	—
12,139	5	1/6	Edison and Swan United	2	2½	2	2½	..	..	..	..
£100,000	Stock	..	Do. 4% Mortgage Debenture Stock	104	107	104	107	4 5 0	..	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		..		..	..	—	..
120,000	2	..	Electric Construction	⅝	⅞	⅝	⅞	..	..	..	..
12,845	2	2/9½	Do. 7 per Cent. Cumulative Pref. xd	2¼	2½	2	2½	5 11 0	..	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	¾	1	¾	1	..	..	..	—
20,000	5	..	Fowler-Waring Cables (fully paid)	½	¾	½	¾	..	..	..	..
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	19	21	19	21	4 15 3	February & August	19 13/16	19¾
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896 xd	102	104	100	102	4 8 3	March & September	..	—
15,995	£10	..	International Okonite Ordinary	..		..		..	—	—	..
16,000	£10	..	Do. 8 per Cent. Preference	—		..		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	⅛	⅜	⅛	⅜	..	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	43	45	43	45	4 0 0	March and July	44½	43¼
£150,000	100	5%	* Do. 5 per Cent. Bonds	104	107	104	107	4 14 1	January and July	..	—
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	—
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	—
£100,000	10	6/0	W. T. Henley's Telegraph Works Ordinary	12½	13	12½	13	..	..	12 15/16	12⅝
£30,000	10	7/0	Do. 7 per Cent. Preference xd	15	16	15½	16½	4 4 10	..	..	..
£[illegible]0,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock	104	107	104	107	4 4 5	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1½%	City and South London Railway	38	40	38	40	3 2 6	May and November	..	..
7,000	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 4 6	..	—	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	134	136	134	136	2 19 7	May and November	..	..
87,500	£10	2¼%	Liverpool Overhead Railway	11⅝	11⅞	12⅛	12⅜	1 16 9	—	—	—
6,295	10	5%	Do. 5% Preference	15	15½	15	15½	3 4 6	..	..	—
25,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July	—	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 908. [No. 24. Vol. XXXV.] FRIDAY, OCTOBER 11, 1895. PRICE SIXPENCE.

NOTES.

There is a tone of old-world imperial largesse about the festal arrangements by which the Directors of the Bristol tramways intend to celebrate the public opening, on the 14th inst., of the electric tramway between Bristol and Kingswood. One almost expected to find the list of festivities terminating with the announcement of a hecatomb. Not only will there be the usual opening ceremony, and a banquet to "a number of leading scientists of the country" and other important personages; but local shareholders are to be given an "opportunity of publicly testing the advantages of an electric car," whatever the process may consist in; and then, most beneficent of all, "a substantial dinner will be provided for 1,200 aged and deserving poor, selected from the localities through which the line goes, and after the repast each person will receive a ticket which will give the holder the privilege of a free ride." We are assured that only really deserving persons are to be the recipients of these benefits. This is bounty indeed; and the only doubt which exists in our mind is, as to what class of aged and deserving poor deserves, after a "substantial repast," to be carted freely about on a tramcar.

We have received an exceedingly lucid pamphlet, written by Mr. T. H. Brooke Hitching, of the Marylebone Vestry, and entitled "Cheap Electric Light for Marylebone." It is needless to say that, according to Mr. Hitching, the way to obtain this desideratum is to parochialise the electric supply, and employ dust "utilisers." For our own part, although we naturally desire to see electric lighting progress, we have not as yet found ourselves able to place entire trust in the alluring percentage profits, such as the 7 per cent. at St. Pancras, which have been so disinterestedly worked out for so many municipal concerns, and we shall feel more enthusiastic about refuse "utilisers" as aids to electric lighting when there has been more experience of them in that capacity. Mr. Hitching, in his eagerness to prove the advantages of the scheme he advocates with so much force and ingenuity is scarcely fair to the Company which is at present engaged in supplying the electric current to Marylebone. To talk of £500,000 as "immense" capitalisation for a concern whose district covers an area of nearly five square miles is mere rhetoric. Again, who but Mr. Hitching would consider a company which earned 5 per cent. *gross* profit as being "in a very prosperous condition"? Before a competitive municipal electric supply is put in hand in Marylebone it is to be hoped its supporters will take a more sober view of its possible profits; it tends more to the genuine advancement of electric lighting to make 5 per cent. where only 3 per cent. was anticipated than to reverse the process.

Prof. Perry describes in our columns this week a wattmeter in which any error due to lag is completely avoided in a simple manner. The use of such an instrument may prove advisable in some cases, although, as Prof. Perry points out, an ordinary dynamometer-wattmeter is quite accurate enough for most purposes, if a large non-inductive resistance is placed in series with the pressure coil. There are, however, two disadvantages about the new form of instrument. In the first place, its accuracy depends on the adjustment of the two oppositely wound coils, each of which carries a heavy current; and it would appear that a slight shift of one of the wires leading up to the coil would be enough to introduce a perceptible error. A more serious objection is due to the fact that whereas the magnetic effect, and hence the sensibility of the instrument, depends on the difference of the currents in the two opposing coils, the space occupied by the coils is determined by the necessity for providing for the two large and nearly equal currents. Thus if one of these is 30·1 amperes and the other 30 amperes the magnetic effect depends on the difference of 0·1 ampere, and many turns of wire will be required to produce an appreciable magnetic effect. But the wire on each of these turns must be thick enough to carry 30 amperes. Hence the space occupied will be disproportionately large.

The Paper by Herr Peukert, a brief extract of which we give in another column, makes certain assertions and describes certain experiments to prove them. The experiments and assertions relate to the fact that in a bar of iron magnetised by a coil at the centre, the lines of force emerge into the air at all points along the bar and not only at the ends; and to the fact that eddy currents induced in the bar cause a lag in the phase of the magnetisation, which increases as the distance from the central coil is increased. The truth of these assertions is undeniable and the record of the experimental verification of the first has probably been lost in the mists of antiquity, while the second phenomenon was demonstrated by Trowbridge some three years ago, and in various forms by

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other experimenters, besides being an obvious deduction from Prof. ELIHU THOMSON's magnetic repulsion experiments; it is, moreover, an integral property of more than one alternating current meter. But Herr PEUKERT proves too much, for he shows that the effect is produced in laminated iron to about the same extent as in a solid iron bar, though he gives no explanation of this interesting discovery. The accuracy of his curves of $d\,N/d\,t$ must be doubted, since they show a much larger area on one side of the zero line than on the other, and his explanation that this is due to residual magnetism is difficult to believe. It would require an initial magnetisation of altogether impossible amount, since the readings for a single curve extend over many cycles.

SOME rather extravagant and unintelligible claims have been made on the Continent for what are there commonly called "bi-metallic" conductors; to wit, wires, the core of which is of one metal and the sheath of another. So far as these claims relate to the superiority of such compound conductors for the purposes of military telephony, they are conclusively disposed of by the experiments carried out by the officials of the German Post Office, an account of which will be found elsewhere in the present issue. It is evident that the simple secret of success, when running bare wires along the ground to meet temporary emergencies, lies, so far as the line is concerned, in the employment of fine wires, light wires, and mechanically strong wires. Not only, of course, do great lengths of such wire mean small weight, and occupy little space when coiled, but the wire presents but a small leakage surface, sinks but little into the soil, and is not easily put *hors de combat*. Possibly rusty pianoforte wire would prove as good as anything for the short lines and rough-and-ready transmission required in the field.

ELECTRICAL engineers will have no difficulty in perceiving that the results of any reliable experiments on the transfer and radiation of heat from metallic plates, with variously arranged surfaces, are useful in more than one field of practical work. It is not only the boiler maker who wants to know whether any advantage is to be derived from the attachment of ribs and other extensions to the exterior or interior surface of a heat-transmitting plate. The obvious instance of hot-water, hot-air or steam pipes for heating buildings will occur to everyone's mind; and no doubt many will also remember that an attempt has been made to cool internal combustion engines in a similar manner. Within the province of directly electrical work, two chief classes of apparatus are concerned—namely, electrical radiators and thermopiles. In the first-named class the metallic surfaces have the heat generated practically within their mass; or, at any rate, the effect is substantially the same as if it were thus generated. But, after generation, this heat has to pass through the thickness of the radiating plate and then be diffused from a suitable surface. The suitability of the surface depends upon the coefficient of emissivity—as to whether the surface is dull or bright—on the facilities for convection air-currents, and on the extent and contour of the surface. In the second class mentioned, a thermo-electric generator, to be practically useful, must be capable not only of absorbing heat rapidly at the hot junctions, but also of dissipating it with facility from the cool junctions; and it will readily be seen that both these effects are influenced by the arrangement of the heat-absorbing and heat-dissipating surfaces.

THERE is, therefore, a direct interest for electrical engineers in the "Experiments on the Transfer of Heat through Plates with Variously Arranged Surfaces," which Mr. WILLIAM G. WALKER described before Section G, at the recent meeting of the British Association. Mr. WALKER's Paper is a useful contribution to the already voluminous literature of this subject; and a reprint will be found in our columns this week. The author has restricted his researches mainly to the influence of radial internal and external metal ribs, attached to a metallic cylinder in such a way as to oppose their thin edges to any convection currents which might be set up either within or outside the cylinder. He has investigated the influence of these ribs under various conditions; namely, when the cylinder—filled with cold water—is caused to absorb heat from steam, and when it is subsequently caused to radiate out that heat into the air, or to pass it into a tank of water in which the heated cylinder has been immersed. The results are given in a set of curves and tables. In face of the results of tests that have been made from time to time, as to the effect of ribs and conducting rods of copper on the water-side of the crown, and flue surfaces in boilers, the marked inactivity of the internal ribs is a matter for some surprise. The sluggishness of the external ribs, when steam is permitted to condense upon their surfaces, is also a matter of interest, in view of the researches of BRYAN DONKIN and others on the influence of moisture films on the conductivity of steam cylinder liners. We venture to suggest that the influence of moisture films might be eliminated by employing superheated steam or highly-heated air, in place of saturated steam, the water in the cylinders being replaced by some liquid, such as oil or melted paraffin wax, which, at a sufficiently high temperature to start with, would entirely obviate condensation upon the metallic surfaces.

AN interesting description of the electrical equipment of a large coal mine, near Pittsburg, U.S.A., will be found in our columns this week. Electric power, generated in a machinery house near the pit's mouth, is transmitted to the workings, where it is used for coal-cutting, haulage and lighting. Only a portion of the haulage—namely, that over the main tracks above and below ground—is worked electrically, mules being employed to do the gathering and distributing. The main haulage locomotives are of the single-motor, four wheel type, running on 42in. gauge, and developing nearly 4,000lb. draw-bar pull at eight miles an hour. The coal-cutters, it will be observed, have exposed commutators and brushes, only possible in non-fiery mines, and even then not particularly safe. The use of a bare conductor, such as a trolley wire must be, does not altogether commend itself in collieries, unless there is absolutely no risk of the surrounding atmosphere becoming fiery with gas or dust. At the present time, it is true, there

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are two such trolley wires in use in collieries in this country; but these are erected only in the main tunnels, near to the ventilating shaft, and at a safe distance from actual workings of the coal seams.

NOBODY but an American would have had the audacity to question the existence of the inventive faculty, and at the same time suggest that the education of human beings should from the entrance to the kindergarten to the exit from the University, be persistently directed towards its cultivation. This, however, it seems to us, is very much what Mr. W. H. SMYTH does in his interesting disquisition which we reprint in the present issue. He argues at great length that the inventive *faculty* is a myth, but insists to the end that "the first and most important prerequisite to invention is an absolutely clear insight into, and a comprehensive grasp of, all the conditions involved in the problem." The theory that the power of inventing is not strictly speaking a faculty like the power of perpetrating poetry, may be the correct one, and inasmuch as accuracy of thought, even in small matters, is a gain, Mr. SMYTH's theory may be an advance. Practically, however, it does not carry us very much ahead, since, humanly speaking, no amount of training will endow some minds with "the first and most important prerequisite to invention," whilst other minds, with next to no training, possess this great prerequisite in a high degree. In spite of the new theory, we are left, therefore, very much where we were before, and shall have to depend in future as in the past for the major portion of our new mechanical devices upon the "rare-brains" with a bent for inventing. To train everyone according to Mr. SMYTH's plan would doubtless have some marked result, but we may safely predict not the one he anticipates; no pedantic scheme of the kind indicated ever does yield exactly the fruit the prophet foretells.

WE have been compelled to hold over until our next issue several additional letters dealing with the magnetic unit question.

Cable Interruption :—

	Date of Interruption.
Cadiz—Teneriffe	Sept. 25.

Obituary.—The death is announced in the German technical papers of Herr Eugen Langen, part proprietor of the well-known cable works of Felten and Guilleaume, of Mülheim-on-Rhine, and inventor of the aerial railway system named after him.

Thermo-Dynamics.—Prof. Perry will deliver a special course of four lectures on "The Principles of Thermo-Dynamics and their Application in Engineering" on alternate Thursday evenings at Finsbury Technical College. The opening lecture will be delivered on the 24th inst. Further particulars appear in our advertisement columns.

Electric Lamps in London Tramcars.—Several of the cars on the Aldgate and Stratford line of the North Metropolitan Tramways Company have recently been fitted with electric light. The number of cars belonging to the South London Tramways Company, thus lit, is gradually increasing; and these cars are much more popular after dark than the dingy oil-lighted cars.

The Niagara-Buffalo Franchise—Latest.—The Niagara Falls Power Company and the Buffalo City Council have now, says the *Electrical Engineer* of New York, so far reconciled their differences as to the proposed franchise that terms have been agreed upon, and a franchise will at once be granted. In the main, the reasonable requests of the Company have been granted, and there is now every reason to believe that Niagara power will be delivered in Buffalo during 1896.

The Institution of Junior Engineers.—The annual general meeting of this Institution was held on Friday, October 4th, at the Westminster Palace Hotel, the retiring Chairman (Mr. H. J. Young) taking the chair. The principal business was the presentation of the Council's report on the proceedings of the past year, and the election of officers for the ensuing session. The report showed that steady advancement had been maintained. The membership roll had increased by 45, the total at the present time being 418. Mr. H. J. Young was re-elected Chairman.

An Agricultural and Mineral Light Railway in Missouri.—According to the *Western Electrician* of Chicago, a cross-country electric railroad has just been completed between Carthage and Carterville in Missouri. The distance is 15 miles. Carthage and Carterville are in the centre of the rich lead and zinc-producing section of Missouri, and a great deal of mining machinery is scattered along the line of the road. If the line proves a success it will be extended to Kansas City, 10 miles farther. The projectors propose to try in a limited way to furnish power to a mill on the line, and also to experiment in lighting farmhouses. The subject of furnishing power to threshing machines will be considered next year.

Thomson-Houston Tramway System in Europe.—Statistics published by the Union Elektricitäts Gesellschaft of Berlin, show that on May 1st last there were working in Europe on the Thomson-Houston system 14 tramways, with a total length of line of 105 miles and 381 motor cars. There were further in course of erection and preparation 142 miles of lines with 644 motor cars. Germany has five lines in operation, viz.: Bremen, Remscheid, Hamburg, Gotha and Erfurt, with nine lines in progress. The first tramway on the Thomson-Houston system was run in 1887, and to-day there are 450 lines worked on this system, representing a total length of about 9,000 miles, with 7,000 motor cars.

Electricity in Blast-Furnace Plant in America.—According to the *Railway Review* of Chicago the Carnegie Company will shortly erect six blast furnaces close to their steel works at Duquesne, Pa. The furnaces will be the largest ever built and the whole plant equipped with the best apparatus in such a manner that most of the work will be done automatically by electric and steam power. When completed the electric power station will generate about 3,000 H.P. for light and power. There will be about 30 electric cranes, three or more electric travellers of 250ft. span, about 15 electric motor cars, half-a-dozen electric conveyors and a large number of stationary motors for driving miscellaneous apparatus. There will not be a single belt in the whole power station, as the generators will be direct-connected to the steam engines, and the arc machines direct-connected to the electric motors. In all the Carnegie Works electricity is used as much as possible, and with great success, especially at their Homestead Steel Works and their works at Bessemer. In Homestead alone are running electric motors aggregating 4,000 H.P., and in Bessemer about 2,000 H.P.

The Schuckert Projector.—Mr. W. H. Pretty writes us as follows :—

It was with deep regret that I read the announcement of Herr Schuckert's death in your columns, and many who have worked his projectors after working other types will long regard him as a benefactor. It is necessary to know the difference by actual working to fully appreciate his improvements. The workmanship of the Schuckert projector left little to be desired, and, perhaps, for really rough weather and general outdoor exposure it was finished too well. It was about six years ago that I first saw and worked one of these large projectors, after several nights' suffering, caused by working other projectors, with which dark glasses were used for viewing the arc, and in which the adjustments had to be made by hand, without the refinement of a fine adjustment. The dark glasses or spectacles were not sufficient to protect the eyes satisfactorily, and often made it impossible to shut them or read with comfort for a day or two. I have also recollections of drops of molten copper from the negative carbon (which was coppered) finding their way to my wrist. I have no doubt there are many besides myself who will recollect the pleasure of working a large projector by Schuckert after such an experience as that

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just mentioned. There was, with Schuckert apparatus, a plan and side elevation of the arc focussed on ground-glass surfaces, and the inequalities in burning would be readily adjusted without getting the hands burnt or the eyes hurt. The solenoidal control for the arc was very good, and the arc required little attention.

The Telegraph Service.—Mr. J. E. Naylor, Assistant Superintending Engineer of the Postal Telegraph Department, has just retired, owing to failing health, from the active service of the General Post Office. Mr. Naylor has been associated with the telegraph for a period of 40 years. Joining the British Telegraph Company in 1855, Mr. Naylor was appointed clerk-in-charge of that Company's office at Wakefield in 1860, and five years later he was promoted to a similar position at Sheffield. In 1868 Mr. Naylor became an inspector of the Engineering Department, and had charge of all the Magnetic Telegraph Company's wires and apparatus upon the Lancashire and Yorkshire Railway, from Sowerby Bridge to Goole and Leeds, and also upon the South Yorkshire Railway from Barnsley to Sheffield and Doncaster. On the taansfer of the telegraphs to the State he was appointed to the York district, and carried out the extensive erections of new lines that were then made from Beverley to Scarborough and Whitby, and from Leeds to Harrogate and Northallerton. On the rearrangement of districts that took place in 1878, Mr. Naylor was appointed to Leeds, where he carried out extensions and additions rendered necessary by the adoption of the sixpenny rate for telegrams. More recently he has taken an active part in the erection of the new trunk telephone lines that have been erected by the Post Office.

Bitumen Insulated Cables.—An interesting patent expires to-day; it is that granted 14 years ago to Mr. William Ormiston Callender, and numbered 4,409. Its title is "IMPROVEMENTS IN THE MANUFACTURE OF TELEGRAPH CONDUCTORS AND MATERIALS FOR COVERING AND INSULATING WIRE OR OTHER CONDUCTORS USED FOR TELEGRAPHIC, ELECTRIC OR OTHER SIMILAR PURPOSES." The invention consisted in the use of bitumen, combined with other hydro-carbons or their equivalents, in such a manner as to produce a compound suitable for insulating electric conductors, being "at the same time very efficient and inexpensive as compared with insulating materials ordinarily used." Trinidad bitumen is used, and the mode of manufacture is as follows: Thirty-five parts of bitumen and (in a separate cauldron) 35 parts of oil residue are melted, in each case three to four parts of vegetable oil being added. When thoroughly dissolved the two liquids are mixed at a temperature of about 220°F to 250°F. At this point about three parts of ozokerit or other equivalent wax may be added. The temperature is then raised to 280°F. to 290°F., and when the material is required (as is generally the case) to be vulcanised, about three or four parts of flowers of sulphur, or the equivalent thereof, are added, and the heat being raised to about 340°F., the mixture is stirred gently for about 45min., when it is brought into a thick elastic condition. It is kept for about two hours at the above temperature, and the result is the compound material found suitable for the purpose indicated. The claims are as follows: (1) The manufacture of the compound material produced by combining the natural deposits of bitumen with the oil residue or its equivalent, substantially as above described, whether the compound be vulcanised in the usual way or used without being vulcanised. (2) The manufacture of insulated conductors for telegraphic or other purposes by covering or coating the conducting wires with the compound prepared and vulcanised, substantially as above described.

An Electric Fire.—The following paragraph appeared in the *Standard* of Monday:—

A fire broke out early yesterday morning at 91, Onslow-gardens, South Kensington, a private residence in the occupation of Mr. A. Hughes. A man passing the house noticed flames issuing from a grating close to the pavement. On an examination being made of the vault under the roadway it was discovered that an electric transformer had caught fire. The flames were speedily extinguished, but the electric apparatus was completely destroyed.

Acting on the well-tried principle that the daily Press may always in matters of this kind be trusted to exaggerate and misstate, we made inquiries of the Company concerned, and received the following reply:—

DEAR SIR: Replying to yours of yesterday's date, the report referred to is, as usual, a gross exaggeration. The facts are these: Owing to the abnormal rains, water obtained access to the converter house, causing the fuses to be blown; but prior to this taking place the secondary of the transformer had commenced to smoulder. No flames whatever were seen, and no serious damage whatever done, as the transformer is fixed in a chamber built of brick, and this is in an out-house. The report contained in one or two papers is most certainly untrue, for the smoke issuing from the ventilating holes in the converter house was first seen by the servant, who informed the tenant, and he at once communicated with the local fireman instead of advising the Company, the result being that far more damage was very soon done and more smoke caused with the water which they poured on to the converter house by means of a hand pump than would ever have taken place if it had been left alone. This was due to the water being poured on to the high-tension fuses. In fact, the whole cellar was so badly flooded that our engineer could not obtain access for some considerable time, when, after the water was baled out, everything was made satisfactory and a new transformer fixed. We may mention that we have written to the tenant asking him that should such a circumstance take place again at his house we should be glad if he would please inform the Company before sending for the firemen, which only causes a good deal of alarm, and gives a very erroneous impression when such statements appear in the daily Press. We shall certainly be very pleased if you will kindly contradict the report.—Yours, &c.,

HENRY W. BOWDEN, Manager and Engineer,
The House-to-House Electric Light Supply Company (Limited).

Current Electrical Science.—Among the electrical monthlies *Wiedemann's Annalen* again bears the palm for the interest attached to its contents. No. 9 contains two entirely new and original devices for exorcising that evil genius of the advanced electrician—GROUND VIBRATION. Prof. Einthoven, of Leyden, supports his capillary electrometer on an iron slab weighing some 3cwt., and floating on a film of mercury 1mm. thick, and with excellent results. H. Julius suspends a small table by three long vertical wires attached to the vertices of an equilateral triangle. On this table he places his hypersensitive instrument, taking care to lower the centre of gravity by an adjustable weight under the table, and then he defies the earth tremor and the rumbling vehicle. H. Rubens adds to his spectroscopic and bolometric laurels by describing a VIBRATION GALVANOMETER for measuring alternate currents, which is claimed to be more sensitive than the electro-dynamometer and the thermo-voltameter, and more adjustable and useful than Wien's optical telephone. It is based upon the latter. An armature of soft iron wires is attached to a stretched wire, and is set into torsional vibration by an alternate current traversing four tungsten electro-magnets suitably arranged. The amplitude of the vibration is a maximum when its period is the same as that of the current, and this maximum is proportional to the strength of the current. It is attained by altering the length or the tension of the wire. A bright slit viewed in a small mirror attached to the wire appears as a luminous rectangle, whose breadth measures the amplitude. Peter Lebedew takes another step in the direction of using optical apparatus for ELECTROMAGNETIC WAVES. As a resonator he uses a small thermo-couple. Polarisation, interference, rectilinear propagation, reflection, and refraction of electromagnetic waves are all shown by instruments a few centimetres in size. A small prism of ebonite 1·8cm. high, serves to determine the refractive index, which figures at 1·6. Double refraction is exhibited and measured in a prism of rhombic sulphur rubbed (not cut) into its proper shape, and a quasi-nicol prism is constructed of two sulphur prisms with a plate of ebonite between them! We need only glance at a further Paper by E. Wiedemann and G. C. Schmidt, "On the Cathode Luminescence of Organic Bodies," and at R. Reiff's mathematical disquisition upon the laws of electric motion in metals and electrolytes, to appreciate the *embarras de richesse* in German electrical science.——When our Italian friends have had enough, for a time, of seismometers and transcendental geometry, they sometimes come out with a striking electrical novelty, such as electrostatic hysteresis. The recent numbers of the *Rendiconti dei Lincei* do not, however, show such a reawakening, and we only find Prof. Cattaneo in the August number struggling to unravel the intricacies of ELECTROLYTIC CONDUCTIVITY—a field which needs unselfish workers.——The *Journal de Physique* for September contains an investigation by Pierre Weiss on the comparison of mutual inductions by the BALLISTIC GALVANOMETER. When the two opposite impulses are not given at exactly the same instant they must at least be infinitely near in order to measure their difference to within an infinitesimal of the second order. Well, it might be worse.

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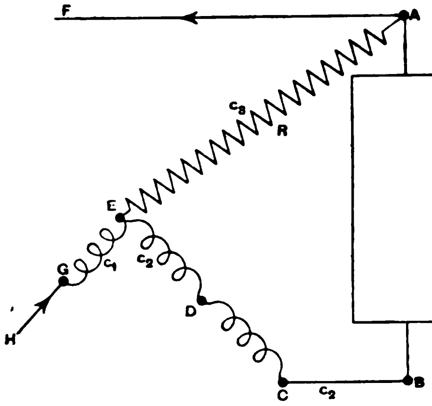
AN ALTERNATING CURRENT WATT-METER.

BY PROF. JOHN PERRY, F.R.S.

About two years ago I invented a very simple instrument, which measures watts exactly, however great the lag may be in amperes behind volts. Only one reading is necessary, and the instrument costs about the same as a Siemens dynamometer. I have had only one specimen made, and I have made no efforts to get it manufactured because I have found that in nearly all practical work the error when one uses an ordinary dynamometer is quite negligible. This is due to the fact that sufficient power is wasted even in an unloaded transformer in eddy currents and hysteresis to prevent the lag being excessive. But it may be that in the future greater exactness may be wanted, and it may be well to describe my instrument. I had intended to publish a number of tests made by Mr. Eborall, late of the Finsbury Technical College, but as they only bear out what anyone can see to be true from the construction of the instrument I need not trouble the reader with them. Mr. Eborall constructed the instrument which he tested.

In the figure, A B is any contrivance to which electric power is being given by alternating currents; it may contain motors, condensers, choking coils, lamps or other apparatus. There are two coils of wire, E G and E D, which are wound together on the fixed bobbin of a dynamometer in such a way that if the same current passes from G to E and E to D no magnetic effects will be produced; in fact, the fixed bobbin is differentially wound. The coil D C is the movable coil of the dynamometer.



It is therefore evident that the reading of the instrument represents (to some scale dependent on number of turns of wire and the controlling moment) the average value of $(c_1 - c_2)\, c_2$ or $c_3 c_2$. Now, E A is a non-inductive resistance of amount R, and if this is known, since $R c_3$ represents the voltage between E and A, the reading of the instrument represents the average power supplied to A B and to the part E B. The power supplied to the part E B is insignificant. The instrument is easily graduated and tested by continuous currents. Also at any time, by disconnecting E A, we can test whether G E and E D completely destroy each other's effects on the movable coil, and if they do not do so it will usually be found that a slight adjustment in position of one of the wires to the binding screws G or D will be a sufficient correction.

Even if the small power supplied, say, to an unloaded transformer is to be measured, and if the ordinary Siemens dynamometer frame and method of control be employed, I have found that the cost of and space taken up by the non-inductive resistance are not of importance. Of course, they are of less and less importance as the power is greater, and as the volts are less and if a more delicate method of control is employed. Anyone who cares to employ this method will find it well to remember that if he uses considerable resistance between E and A, or if from any other cause the currents c_1 and c_2 are considerable and their difference small, it will depend upon the nature of the control whether there may not be too much heating of the fixed coil for its structural safety when measuring up to the limiting readings of the instrument.

In this description the words fixed and moveable are interchangeable. The method is applicable to motor supply meters.

NOTE ON SOME MANGANIN RESISTANCE COILS.

BY E. O. WALKER.

Dr. Alex. Muirhead has in his laboratory two B. A. units constructed of the manganin of Dr. Lindek, the constituents of which are copper 73 per cent., nickel 3 per cent., and manganese 24 per cent. The wire of which the coils is composed has not been annealed, and is covered with silk and shellac. So far as observations have been taken the coils seem to increase in resistance with temperature, and *vice versâ*, and do not therefure acquire, at a critical temperature, say 16°C., as some experimenters have found, a negative temperature coefficient above, and a positive coefficient below, that temperature.

The material has, as is well known, a remarkably low temperature coefficient, and if this remains constant throughout a range on the thermometrical scale, say from 0deg. to 30°C., without change of sign, manganin may yet prove to be a valuable standard of reference. Coil No. 1 is certified at the Cavendish Laboratory to have a value of 0·99996 B. A. unit at 13·7°C. It was tested against a Matthiessen B. A. unit, No. 78, of platinum-silver alloy, which was kept at as constant a temperature as possible, while that of the manganin was varied. No. 78 was immersed in a jar of water enveloped with a double wrapping of thick flannel. The manganin coil was in a double tin, two water spaces and a wrapping of cotton wool separating it from the air of the room; a glass tube connected with a reservoir permitted water to drop into the outer tin, and an escape pipe drew off the overflow. By this means temperatures up to 33°C. could be maintained constant for half an hour even in cold weather. It was found that this period was essential to permit of the innermost parts of the coil assuming the same temperature as that of external parts, and of the case and air space surrounding it. The comparison standard, No. 78, varied in temperature during the tests (which occupied some hours) only from 14°C. to 17·4°C., and allowance for a corresponding change in its resistance, using a temperature coefficient of 0·00025 (or percentage variation per degree C. of ·025), was made in the calculations applied to find that of the manganin No. 1 coil. The temperature coefficient in question is that found by actual test for coil No. 78, between 14°C. and 33°C.

Manganin coil No. 1 was raised in temperature from 14°C. to 25°C. in warm water, and by the means above indicated. Tested on the bridge against No. 78, it showed an increase in resistance equivalent to an average temperature coefficient of 0·000011, or percentage variation per degree C. of 0·0011.

Manganin coil No. 2 was then compared with manganin coil No. 1. When both were at 12·6°C. No. 2 was found to be 0·036 per cent. higher in resistance than No. 1. When No. 2 was in melting ice, and at a temperature of 0·3°C., and No. 1 was at 12·5°C., the temperature of the room, then No. 2 was found to be 0·013 per cent. less than No. 1. This would give a temperature coefficient of 0·00004 per degree from 0·3°C. to 12·6°C. for No. 2 coil. It is evident that this alloy, or these particular coils made from this alloy, does not at low temperatures behave differently from other known alloys. While No. 1 was kept at a temperature of 14·2°C., No. 2 was now heated to 32°C. The latter was now found to be 0·046 per cent. greater than No. 1, and shows a calculated temperature coefficient of 0·000006, from 12·6° to 32°C.

These coils seem, therefore, to have properties different from most others of manganin, and if they can be imitated, some valuable units may be made available.

All the necessary tests were made by the aid and with the resources of Dr. A. Muirhead.

THE ROWLAND REFLECTING GALVANOMETER.

In a great number of cases at the present day, where accurate measurements of resistance and tests of insulation by direct deflection are required, the small space available in electric light engine rooms and power stations renders the employment of an ordinary pattern of reflecting galvanometer

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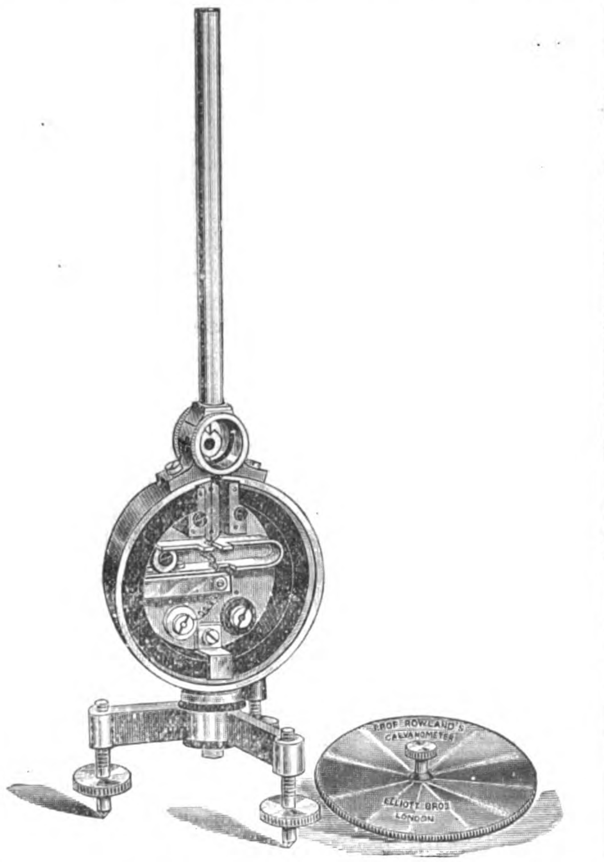
almost useless, on account of the strong magnetic fields in which testing instruments are now required to work. These conditions have tended to develop to a high degree of perfection galvanometers of the d'Arsonval type. The accompanying illustration shows one of the latest instruments of this type the various features in which are the result of a great amount of experiment and practice by Prof. Henry Rowland, of America, and from his experiments and designs the instrument has been put into practical shape by Messrs. Elliott Bros.

One of the chief points which has been borne in mind in the design of this instrument is that the suspension should be easily got out for renewal. In many galvanometers nowadays the renewing of the suspension involves a considerable amount of work, and requires experience, in order that the galvanometer shall keep its zero. In the instrument under notice these difficulties are, it is claimed, almost entirely overcome. By removing the covering tube at the top of the instrument, a portion of the tube which carries the top end of the suspension is entirely cut away in the front, so that the suspension pin at



the top of the instrument can be lifted right out; the suspension, mirror, coil, &c., passing through a vertical slot, which is continued right down through the front of the instrument.

Another point worthy of notice is, that the suspension is fixed to the stem passing through the coil, and the suspension pin at the top. By means of specially designed spring hooks at each end of the suspension, which is of special metal to ensure reliable deflections and permanent zero, two small links are fixed by a method which does not require any heating of the suspension strip. These suspensions are all made of an exact length, and can be had of various strengths. The links are hooked on to the small hooks on the coil stem, and the suspension pin at the top, thus making the replacing of a broken suspension a matter only of a few seconds. To ensure good contact between these hooks and the suspension they are all gilded, and are thus found to give a very satisfactory and permanent means of ensuring good connection.

The instrument, which in itself occupies a very little space, is mounted on a small tripod frame, and is movable about on a vertical axis, so that the light spot can very readily be set round to any desired position. The suspended system can very readily be raised when the instrument is carried from place to place. These advantages, combined with the high grade of sensibility of the instrument, should make the instrument one specially suitable as a practical galvanometer for the use of central station engineers.

CONVERSION TABLE FOR "RATIONAL" UNITS AND PRESENT UNITS.

In our leading article on "Magnetic Units" on the 13th ult. we gave, on what we believed to be good authority, the value of a conversion factor between Mr. Heaviside's unit of magnetism and the corresponding unit at present in use. In our report of the discussion which took place at the British Association on the proposed magnetic units, an equally good authority gave the reciprocal of the former number as the value of the conversion factor. We can only attribute this to the persistent and inherent property of 4π of turning things upside down. In order to remove any misconception which may have arisen, and to prevent confusion for the future, we have compiled the following Table of conversion factors, which we have every reason to believe correct:—

1	"rational"	unit of magnetism	= 0·28205	of present	unit of magnetism.
1	"	unit magnetic field	= 3·5441	"	unit magnetic field.
1	"	magnetic line	= 3·5441	"	magnetic line.
1	"	unit of magnetic potential	= 3·5441	"	unit of magnetic potential.
1	"	ampere	= 2·8205	"	amperes.
1	"	volt	= 3·5441	"	volts.
1	"	ohm	= 1·2566	"	ohms.
1	"	henry (or secohm)	= 1·2566	"	henrys (or secohms).
1	"	ampere-turn	= 2·8205	"	ampere-turns.
1	"	ampere-turn	= 3·5441	"	gauss.
1	"	coulomb	= 2·8205	"	coulombs.
1	"	farad	= 0·79577	"	farads.
1	"	watt	= 10	"	watts.
1	"	joule	= 10	"	joules.

It may also be pointed out that 1 "rational ampere-turn" = 1 "rational gauss"; and that in passing from the rational absolute system to the rational practical system only *one multiplier* (or divisor), viz., 10^8, is employed.

THE PROPAGATION OF THE MAGNETISATION OF IRON.*

BY W. PEUKERT.

When a long straight iron bar is excited by a magnetising coil situated at the centre, the lines of force, all of which pass through the coil, do not keep in the iron up to its extreme end, but emerge into the air at all points along its length, so that the induction in the bar falls off continuously as the distance from the central source of magnetisation is increased. With a periodically varying magnetising force the same effect is produced, and, moreover, the corresponding periodic changes in the induction induce eddy currents in the iron. These cause a lag in the phase of the induction which increases as the end of the bar is approached.

Experimental proof of this was carried out on rods of about one metre length of wrought and cast-iron, and on a large bundle of soft iron wires of 1mm. diameter. The induction at various points was measured by search coils placed at intervals on the bar, and readings of the instantaneous values of the induction were taken through a complete period for each coil. The readings were obtained by means of a contact-maker fixed on the alternating-current dynamo used for exciting the magnetising coil, the momentary currents being indicated by a Wiedemann galvanometer. Magnetomotive forces of 288 and 1,306 ampere-turns were used. The curves of induced E.M.F. obtained from all three samples show a shift of phase which increases with the distance of the search coil from the centre of the bar, both at the lower and at the higher values of the induction. The curves are not symmetrical with the zero axis, the difference being attributed to residual magnetism. There is no marked difference between the changes of phase produced in the solid and in the laminated specimens, the amount of shift not being sufficiently clearly defined to show any distinct difference. The magnitude of the deflections continuously falls off along the bar, showing the diminution in the induction.

* Abstract from the *Elektrotechnische Zeitschrift*, September 19th.

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THE LA GOULE POWER TRANSMISSION PLANT.*

The La Goule transmission plant is at the present time one of the largest of its kind in Switzerland, and supplies current to 11 villages of the Bernese Jura district, which are situated up to 15 miles from the generating station. As motive power the water of the Doubs near La Goule is used, there being a minimum supply of 530 cubic ft. per second at a fall of 85ft., which represents a total capacity of 4,000 H.P. A canal, consisting of a tunnel, an open way, and wrought-iron pipes, conveys the water to the power house about 700 yards distant. Here provision is made for the utilisation of 2,000 H.P. At present there are erected three horizontal Girard turbines of 500 H.P. each, running at 200 revolutions per minute, and coupled direct to three Oerlikon alternators. The turbines are of Escher, Wyss and Co.'s make, and fitted with automatic regulating apparatus. This is driven by belt off a horizontal shaft, which receives its motion from the vertical turbine shaft by means of bevel wheels, &c., which also drive the exciter. To prevent the water in the main pipes freezing, a special valve is placed between the second and third turbine to permit of an artificial circulation being created in the mains when the turbines are stopped. The ordinary alternating current is employed at 5,500 volts. The reason for this was mainly to simplify the working of the plant, as the current supplied was used for power and lighting purposes. The principal business of the district is watchmaking, and therefore a large number of motors will be connected up in time, besides the extensive lighting installations, which will be erected in the different workshops. For lighting, the single-phase alternating-current system was thought the most suitable, and to ensure unity in generation the same was also adopted for the power section. There are, however, two separate sets of conductors—one for lighting and one for power, but all generators feed on to the same switchboard.

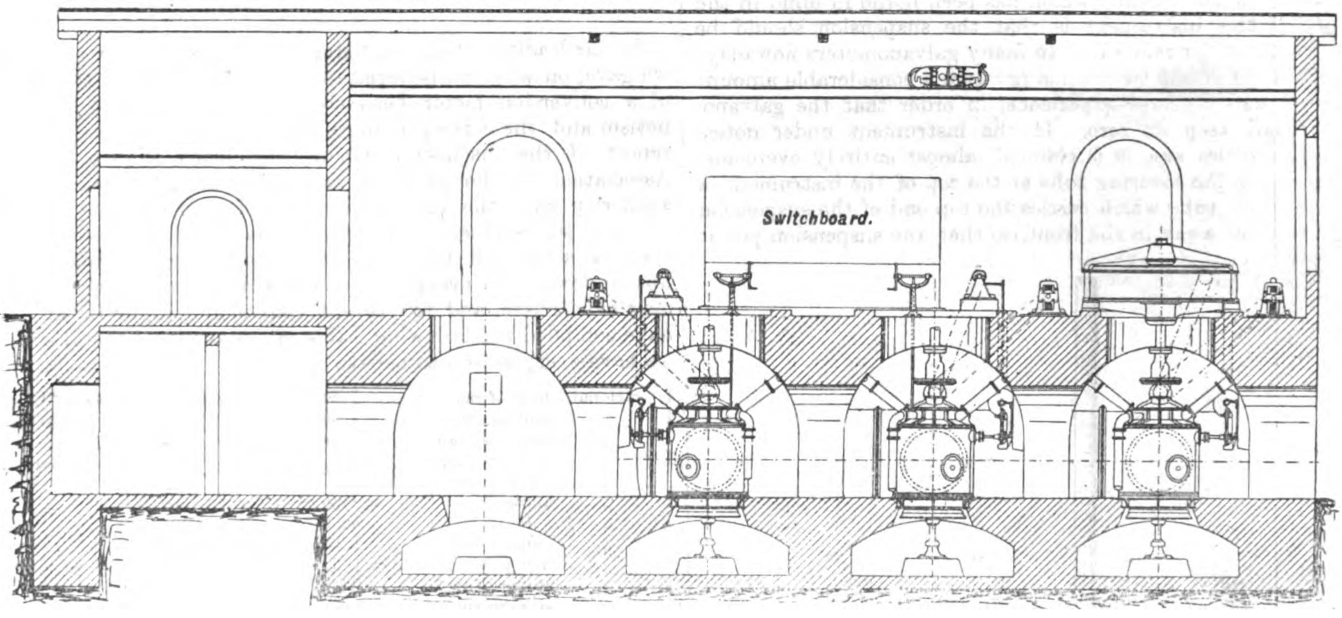

Fig. 1.—Sectional Elevation of Power House.

Figs. 1, 2, and 3 show the general arrangement of the station. The alternators, of the Oerlikon horizontal type, with revolving fields, are placed direct over the turbines. At 200 revolutions, and with 500 H.P. absorbed, the output of each machine is 63 amperes at 5,500 volts, which is equivalent to an efficiency of 94 per cent. The periodicity is 50 per second. The stationary armature, which is insulated from the bed-plate of the machine, is of the channel type, and contains 30 coils, pressed in to the projecting teeth. The field is excited by one large coil, receiving its current through two collecting rings. The excitation of each alternator requires 2,400 watts, or about $\frac{3}{4}$ per cent. of the capacity of the machine. The field ring is 8ft. 3in. in diameter, and weighs nearly 10 tons. The armature with the two bearings weighs $12\frac{1}{2}$ tons. The exciters are ordinary two-pole machines, having an output of 30 amperes and 80 volts when running at 700 revolutions, and are driven by belt, as described above. The connecting conductors between generators and switchboard are carried through a subway. The switchboard is of black marble, and arranged in three sections. Power and lighting circuits occupy the two outside sections, and dynamo and exciter instruments and switches the centre one. All the outgoing circuits are provided with lightning arresters. The high-pressure mains have an extent of 22·4 miles, with a total length of 186 miles of bare copper wire, having a total weight of about 77 tons. There are three complete high-pressure ring mains for power and lighting.

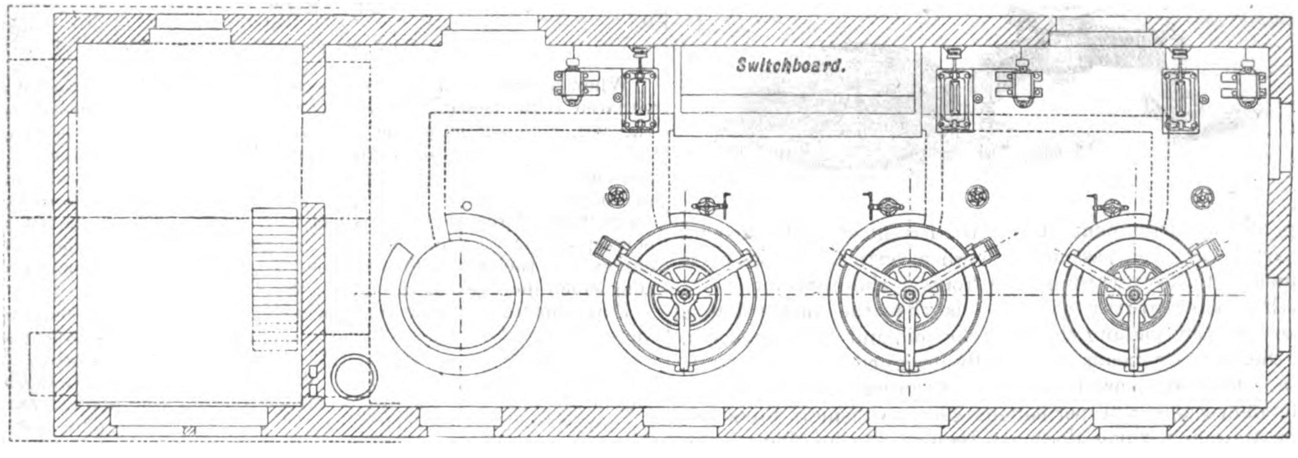

Fig. 2.—Plan of Power House.

The general positions of the different villages is shown in Fig. 4. The conductors range in diameters from 2·5mm. to 7·5mm., and are

* From the *Elektrotechnische Zeitschrift.*

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carried on porcelain insulators fixed to wooden poles. Eighteen wires leave the power house, and run as far as Noirmont. This represents about 5cwt. of copper between two poles. The fall of potential in the primary mains attains a maximum of 10 per cent. for lighting and 20 per cent. for power.

In each village there is one transformer sub-station a small brick building, fairly centrally situated. Two separate circuits are provided for the distribution, one for lighting and one for power. Distribution is carried out on the three-wire system, and, like the high-pressure circuits, the distributors are mostly overhead. Telephones connect all the sub-stations with the power house and the offices at St. Imier.

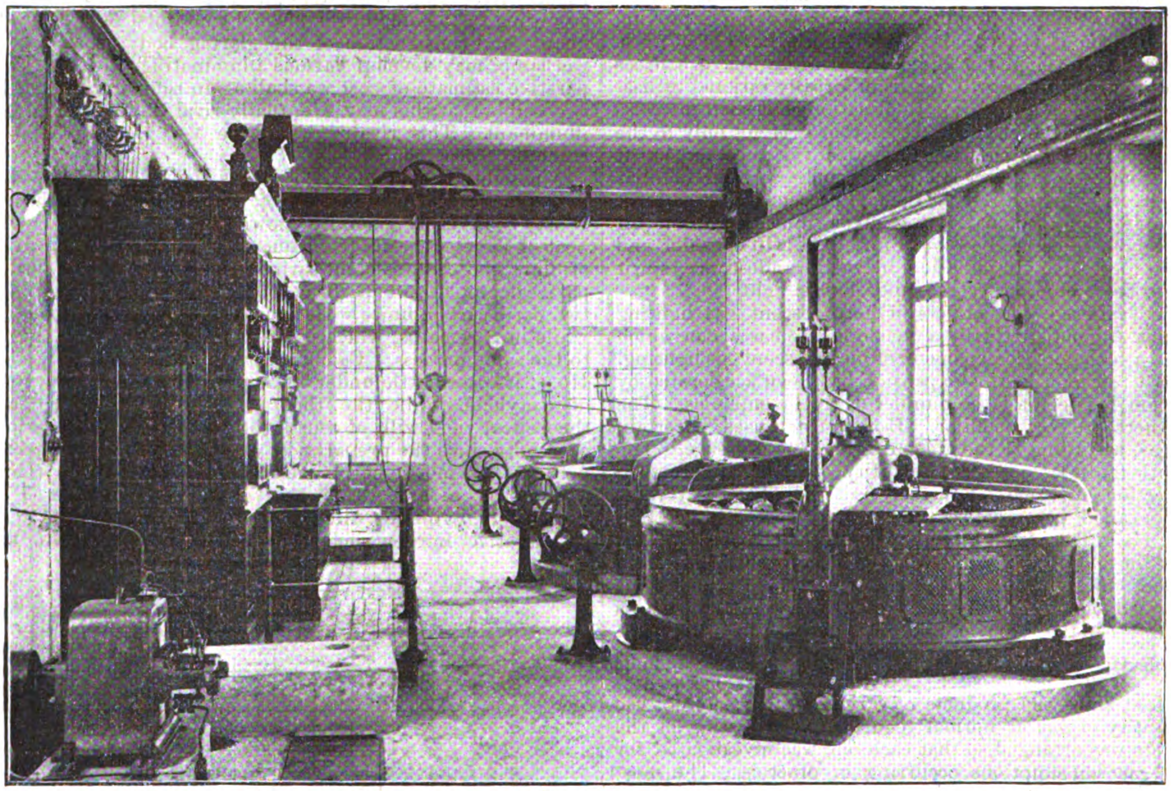

FIG. 3.—General View of Power House.

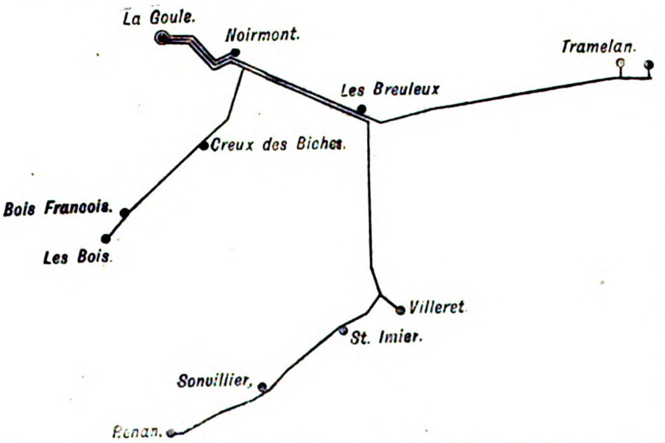

FIG. 4.—Sketch Map showing relative positions of villages among which power is distributed.

⊙ Generating Station. ● Transformer Sub-Station. — Conductors.

Distance from La Goule to—

Noirmont..........	1·5 miles.	St. Imier	3·2 miles.
Creux des Biches ..	3·5 ,,	Sonvillier........	10·2 ,,
Bois Francois	5·1 ,,	Renan	11·9 ,,
Les Bois	5·7 ,,	Tramelan dessus.	8·6 ,,
Les Breuleux	4·0 ,,	Tramelan dessous	9·1 ,,
Villeret............	7·6 ,,		

The motors used in the district are of the Oerlikon single-phase alternating current type, with special starting apparatus in which the middle wire of the three-wire system is made use of.

It is generally thought that this kind of motor starts rather badly, even at a very light load, and the Oerlikon Company has overcome this difficulty by providing an extra loose pulley on the motor, allowing it to start with no load whatever. The act of starting is as follows: The belt rests on the loose pulley, the motor is started up, and when running at its normal speed the loose pulley is pressed against the fast one of the motor by means of a friction arrangement. As soon as the belt is running at the proper speed it is shifted on to the fast pulley by means of an ordinary striking gear, and the loose pulley is then disengaged. In Fig. 5 the connections of the motor to the secondary three-wire system is shown. The handle H of the throw-over switch, which is in the middle position when the motor stops, is brought into the position L. Two copper bars, insulated from each other, fixed to the switch handle, connect the three contacts on the left of the handle, and also the two contacts on the right of the same; and, as will be seen from the diagram, the starting current is taken from the middle wire and one of the outside ones, the main coil of the motor being connected to terminals 1 and 2, and the starting coil to 2 and 3. When the armature has run up to its normal speed, taking about ½min., the

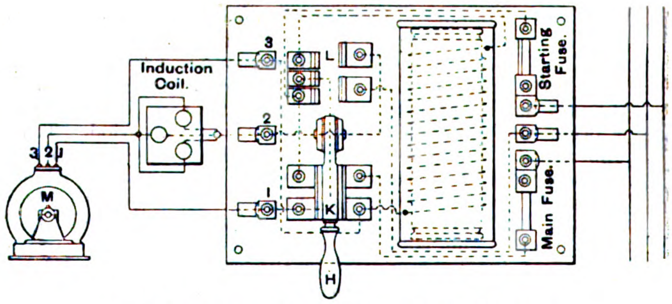

FIG. 5.—Diagram of Connections for Starting Motor.

switch handle is thrown into the position K, and then left there during the time the motor is working. As will be seen from the diagram, the current is then taken from the outside mains of the three-wire system. The middle wire is therefore only used for starting the motor, as mentioned before. If an induction coil is inserted in conductor 2 of the motor, the iron core of the same must be pushed right in before the switch handle is brought into position L, and then drawn gradually as the motor starts running.

The plant runs continuously with only a stoppage of half an hour at noon every day. Current is supplied to private customers for lighting purposes at 1s. 2d. per candle-power per year; for power purposes at £13 per horse-power per year for motors from 2 H.P. to 12 H.P. For larger motors special terms are made.

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COMPARATIVE STUDIES OF ACETYLENE GAS LIGHT AND THE ELECTRIC ARC.*

BY W. WEDDING.

Owing to the vast development of electrical engineering during the last 10 or 20 years the whole subject of illumination has undergone a great and progressive change. Not only is the use of electric arc and glow lamps extending, and their working improving every day, but on the other side also great efforts have been made towards the further development and greater utilisation of sources of light. In practice we are still far from a really rational utilisation of energy for the purposes of illumination, but such progress has been recently made in this direction that it is not only to the general interest to consider the present state of the question, but it is important that every electrician should make himself familiar with this progress. On the basis of the more recent investigations, for which ample numerical material is given in the *Journal für Gasbeleuchtung und Wasserversorgung* (Bunte), we will consider and compare the progress in illumination by gas incandescence, spirit incandescence, petroleum, acetylene, and electric light.

About eight years ago the success of incandescent gas lighting was very doubtful; but gradually a development has set in which has now led to a considerable expansion of incandescent gas lighting. During the last few months this expansion has been accelerated by the competition between a large number of rival companies. The types of burners are very similar. Each burner uses a certain quantity of gas, according to the apertures and the pressure. The glowing mantle radiates a certain quantity of light, different in different directions in space. For each unit of light (the Hefner light, shortly called one candle) the burner consumes a certain quantity of gas. The quantity of gas necessary to sustain one candle-power for one hour we will call the effective consumption. For the Auer incandescent gas light (German Incandescent Gas Company) an hourly consumption of 1·38 cubic ft. of gas is reckoned for a candle-power of 60 in a horizontal direction. Hence the effective consumption is $\frac{1\cdot38}{60}=0\cdot023$ cubic ft. per hour for 1 c.p. Now, since the products of various factories do not use the same quantity of gas at normal regulation, the testing of the various burners was arranged so that each one was investigated for the different gas consumptions occurring in practice. The most favourable—*i.e.*, the lowest effective consumption—was taken as characteristic for the burner, and the test of efficiency was only applied at this rate of consumption and at this pressure. The value above given for the Auer gas burner was verified, but the candle-power sometimes falls to 40 or rises as high as 90.

Tests made at Christmas last year showed that competitors were still far behind the efficiency of the Auer lamp. In general the initial lighting power was 20 c.p. to 30 c.p., and the effective consumption two or three times that of the Auer. But the initial consumption is not decisive. The total consumption over a longer period is what is practically important. On burning the lamps for 230 hours it was found that the effective consumption exceeded 0·07, while the Auer mantle did not reach 0·03. But although these first competitors must be considered failures, there soon was a change. This was first observed in the so-called diamond light, manufactured by Trendel. The effective consumption began under 0·024 in many cases, and only reached 0·037 after 200 hours. Those made by Butzke have shown an approximation to the Auer mantle to within 17 per cent. No lamp need be tested for a period exceeding 300 hours, since that is the normal life of a mantle. In some way or other the mantle is destroyed within that period. That with proper treatment the mantles may keep longer has been made evident by previous measurements. For six Auer burners, which up to the present have burnt 3,000 hours, the average result is that after the first 500 hours the candle-power falls to two-thirds, and after 2,000 hours to one-half of its initial value.

The colour of the light emitted by the different makes differs with the nature of the earths with which the mantles are impregnated. The Auer body has a slight green tinge. That of Kramme is very white, while Butzke's lamp is reddish. This is no doubt pleasanter for the eye, but if we bear in mind that the luminous effect of the different colours are—red 1, yellow 28,000, green 100,000, and violet 1,600, it is evident that the prevalence of green rays will give the greatest efficiency.

The incandescence of the earths used in incandescent lighting need not be produced by the high temperature of the Bunsen gas burner, but may also be brought about by using other gases or liquid hydro-carbons converted into gas. The method of illumination by spirit incandescent burners is based upon the latter principle. Imagine a common lamp filled with spirits instead of petroleum. Through a wick the liquid spirit is sucked up in a tube, and is heated to vaporisation by a small spirit flame attached to the side and fed from the same reservoir. The spirit vapour is conducted through the tube into the usual incandescent gas burner, which is screwed immediately on to the tube; and instead of the coal gas the spirit vapour is used to render the mantle incandescent. To ensure greater constancy in brightness when the lamp is moved, the tube containing the heated spirit vapour has recently been widened out into a little boiler, and the mantle is thus kept in a uniform state of incandescence, even when moving it about in the room. According to the amount of spirit vaporised, and especially according to the amount of alcohol contained in the liquid, and the quality and construction of the glaring body, such a lamp, like a gas lamp, may develop various illuminating powers. In the comparative estimate of cost we shall again refer to this new lamp. It is possible that this may eventually rival the petroleum lamp as an illuminant. This rivalry would be very important and of far-reaching consequence.

A possibly formidable rival to gas lighting has been born in the now practicable manufacture of acetylene from calcium carbide. It may be taken as generally known that by the influence of the great heat of the electric arc (continuous or alternating) upon a mixture of lime and coal, calcium carbide is generated, consisting of one part calcium to two parts carbon. On pouring water over this, two parts carbon unite with two parts hydrogen to form acetylene, while lime remains, which is again mixed with coal and subjected to the same process. Calcium carbide is commercially obtainable; 1lb. of it costs a little under 3d. at present, and gives out 0·6 cubic ft. of acetylene, while the theoretical yield is 2·1 cubic ft. The theoretical yield will, of course, be further approached in practice, especially since the preparation of almost pure calcium carbide (95 per cent. or more) has been accomplished. When there is production on a large scale also it is to be expected that the present high price will be reduced. Burnt in a two-hole regenerative burner such as is used for oil gas, the flame give

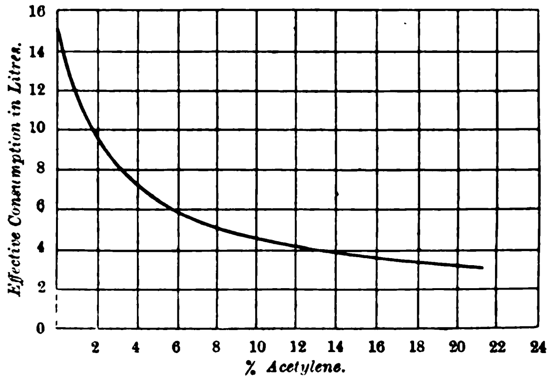

FIG. 1.—Effective Consumption with various percentages of Acetylene.

34 c.p., with an hourly consumption of 0·26 cubic ft. of acetylene. Hence the effective consumption is 0·077, and the amount of gas used is one-third of that for incandescent gas.

If acetylene is burnt with an open flame in a Bray burner, such as is usually used in street lamps, it is necessary to mix air with it artificially to prevent smoking, and to obtain a brilliant quiet flame. The best percentage for the mixture is 47 per cent. acetylene. With such a burner the candle-power was 52, and the effective consumption was 0·01 cubic ft. of acetylene per candle-hour. But since this mixture is very explosive we tried carbonic acid instead of air, which made the effective consumption half as high again; hence this experiment must be considered a failure. If acetylene is to be used for street illumination, the object must be to enrich the coal gas wherever that exists. In experimenting in this direction we obtained the curve shown in Fig. 1, which shows the effective consumption of gas in its dependence upon the percentage of acetylene in the mixture. Without acetylene the burner had an effective consumption of 15 litres (1 litre = 0·035 cubic ft.); with 6 per cent. acetylene it only required 6 litres of the mixture of coal gas and acetylene; at 12 per cent. the consumption fell to 4 litres, and at 21 per cent. to 3 litres.

We will now compare the cost of the most usual illuminants.

With the present prices of gas, coal, petroleum, methylated spirit, and calcium carbide in Berlin, the 16 c.p. lamp, according to the various systems, would cost per hour—

Incandescent gas	0·06d.
Incandescent spirit	0·144 to 0·3d.
Petroleum	0·24d.
Argand burner	0·30d.
Electric glow lamp	0·36d.

The Berlin prices assumed are: gas, 6s. per 1,000 cubic ft.; methylated spirit, 1s. 2d. to 2s. per gallon; petroleum, 1s. 4d. per gallon.

* Abstract of a lecture delivered before the third annual meeting of the Verband Deutscher Elektrotechniker, Munich.

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As regards acetylene, its economy depends altogether upon the price of the acetylene which is to be mixed with the gas. Coal gas alone would require ½d. per hour for a 16 c.p. light, and an addition of acetylene up to 21 per cent. would steadily increase the price up to ¾d. If the price of acetylene falls, the cost of the light falls, especially with a *slight* admixture of acetylene. If the price of the cubic foot of acetylene should ever fall from the present figure of 5d. to ½d., the economy of the gas would increase with every addition of acetylene, although any additional admixture beyond 10 per cent. would have hardly any effect. If the acetylene is not burnt in the open, but in the regenerative burner, the price per 16 c.p. would be 0·6d.—*i.e.*, ten times as much as incandescent gas. Hence great reductions must yet take place before the latter can be competed with. We see, then, that the succession of economy is—incandescent gas, incandescent spirit, petroleum, argand burner, electric incandescent light, acetylene.

Above all these, as regards economy, stands the electric arc light. It is well known that the efficiency of the arc light is seven times that of the incandescent lamp. Hence the arc lamp costs only 0·06d. per 16 c.p. But the arc light has many advantages which make it in many ways unquestionably superior to all other illuminants. In the first place, the light is chiefly given out at an angle of 45deg. below the horizontal, which gives a uniform illumination, even at greater distances. In the incandescent gas light the maximum lies above the horizontal, and the shades applied hitherto have only succeeded in concentrating the light immediately below the lamp. For large spaces no light approaches the arc light. With gas we can approach 100 or 200 c.p., but not the thousands of the arc. Since arc lamps have been constructed for currents as low as 1 ampere and 40 watts, giving out 40 c.p., with a maximum of 65 c.p., such lamps have come into use for smaller requirements, and can be used unshaded, like incandescent gas. Another advantage of the arc is in its colour. Although it contains many violet rays the other radiations are present in such quantities that everything of a light colour appears light, whereas red objects appear dark by the somewhat greenish incandescent gas light. Although, therefore, the costs for arc light and incandescent gas are the same, still there are such essential and unattained advantages on the side of the arc light that the illumination of large areas by its means is distinctly the most advantageous.

IMPROVEMENTS IN ACCUMULATORS.

In a Paper read before the May meeting of the Electrotechnical Society at Cologne, Dr. E. Sieg described the new type of cell manufactured at the Cologne Accumulator Works, and gave an account of some exhaustive experiments which have been made on it. The difficulties connected with the casting of the Hagen lattice grid have been overcome by the use of an improved mould which allows of the easy withdrawal of the casting. Even with this improvement, it is not possible to cast grids having a less thickness than 4mm., so in the construction of the negative plates the firm employ the form patented by Herr Aloys Zettler, of Munich, which allows of a still thinner lattice. The need for portable accumulators constantly increases, and this has led the Company to pay special attention to this type, of which they now consider they have a very good practical form. The plates are kept apart by perforated, waved celluloid separators, which form of construction gives great resistance to lateral pressure, while allowing the electrolyte to circulate. The distance between the plates is reduced to 2½mm. to 3mm. The cells are formed of hardened lead, and are closed with soldered covers. These batteries are well adapted for traction and train-lighting purposes. The railway post-office carriages have accumulators of the Boese-Lütcke system; the Dortmund-Gronau Railway is lighted by accumulators from the Hagen factory; the Marienburg Railway uses the Cologne factory accumulators. Each carriage contains a battery of eight cells. Four wooden cases, each holding two cells with six positive and seven negative plates of 15cm. by 18cm., are connected, and put into a wooden case. Wooden ledges on the front and back of the case press against india-rubber bands, and prevent any movement of the cells. Their capacity is 108 ampere-hours, with 15 volts and 28 amperes maximum discharging current, the charging current being 18 amperes and the weight 170 kilogrammes. The high rate of charge which can be employed with the lattice grid is a special advantage, as the cells can be charged in six hours, whilst the post-office accumulators require 22 hours. The arrangements on the Marienburg Railway are interesting, as the accumulators not only serve for the lighting of the trains, but also for that of the platform, the first and last passenger carriages being provided with an arm at each side, by the laying out of which a 20 c.p. lamp is automatically switched on. The train is chiefly employed for goods traffic towards the Russian frontier. All unnecessary use of the light is avoided, as, besides the main switch to the carriages, each compartment has its own switch, which is not turned on by the guard until a passenger enters. For trains with small passenger traffic this arrangement seems practical, and the lighting of the carriages and stations is better and cheaper than it was under the old system with oil and candles.

The well-known belief that accumulators can be over discharged for a short time without injuring their durability was made the subject of very severe tests, full accounts of which are given. As the result of these experiments the author concludes that accumulators which are subjected to great strains should not be discharged beyond the guaranteed performance, which is about two-thirds of their capacity. With a very high rate of discharge an accumulator has not the same capacity as when it is discharged with a normal or weaker current; as with slow discharge more and more of the inside of the active material comes into use. As the result of these experiments the firm has no hesitation in allowing a short discharging at too high a rate, provided it does not affect the limit of discharge, as it is the too prolonged discharge which is especially injurious to accumulators, since it is the sulphating which then takes places which causes the buckling of the plates, especially when, as often occurs in private installations, the too long continued over discharge is not immediately followed by a charge.

These experiments were confirmed by those recently carried out in Carlsruhe. The General Committee of the Baden State Railways sent out a tender for the delivery of a battery for the electric crane in the Mannheim harbour, and on the strength of the offers of three firms, required cells capable of discharging at the rate of 1,000 amperes for the purposes of comparison. These experiments lasted over three months. As it was found that the discharge at two and three times the normal rate injured the cells so little that no definite opinion as to their relative merits could be formed, the current strength was gradually increased to 5,300 amperes, when a further increase was rendered impossible by the failure of the provisional connections with the measuring instruments. The cells were further discharged with a strong current, and left two days and nights short-circuited through the leads; in short, all means were tried to cause a rapid destruction of the cell. The cells of the Cologne factory stood the ordeal best, and the firm obtained the contract. On examination the plates appeared in exactly the same condition as three months before. The active material was perfectly retained, and all the plates were straight. The author then discusses the relative merits of stations worked with accumulators charged by dynamos driven by slow-speed engines, and of those in which the current is supplied direct from dynamos coupled to high-speed engines, the verdict being in favour of the former.

ELECTRIC TRANSMISSION OF POWER IN UTAH.*

BY G. H. GUY.

The Wahsatch range, under the shadow of which Salt Lake City springs out of the plain, is studded thickly with water streams, fed by the springs and drainage of the mountain, the overflow from which has always been utilised by the Mormons for the fertilisation of their valley farms. Lake Blanche and seven other of the Wahsatch lakes, at altitudes of 11,000ft., to 13,000ft., are now being dammed, and converted into a power that will develop the resources of Utah in mines, products, and manufactures, to an extent almost unparalleled in the history of the West. The Big Cottonwood Power Company has practically completed its plans for the generation and transmission of electric power from the various water supplies in the Big Cottonwood Cañon, thirteen miles south-east of Salt Lake City, for the supply of light and power within the limits of the city and to the factories and small towns in the vicinity.

The power station is located in the Cañon, at "The Stairs," 14 miles by pole line from the distributing station of the Salt Lake and Ogden Gas and Electric Light Company, in Salt Lake City. At this station, there is a minimum flow of 3,400 cubic ft. of water per minute, which, working under 380ft. head, produces 2,447 H.P. During nine months of each year, it will give nearly 4,000 H.P. The storage reservoir at the head of "The Stairs" has an available capacity of 24 hours' continuous flow of the stream, making all of the water available by using an excess during maximum loads and allowing the reservoir to accumulate during minimum loads. 58,800 H.P. hours per day of 24 hours is looked for from this source, of which 68 per cent. can be delivered in Salt Lake City, in contract form, making 40,000 H.P. hours net daily. The 68 per cent. efficiency is derived from: Pelton water wheels, 80 per cent.; "G. E." generators, 94 per cent.; "G. E." transformers (raising), 97½ per cent.; line transmission, 95 per cent.; "G. E." transformers (reducing), 97½ per cent., or a total of 68½ per cent.

The outside dimensions of the generating station are 34ft. by 100ft. The generating plant consists of four 450-kilowatt three-phase "General Electric" generators, separately excited, non-compounded. Each generator is driven by one Pelton wheel, 60in in

* Abstract from the *Electrical Engineer* of New Yor

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diameter, provided with two nozzles 3¼in. diameter. The straight nozzles are provided with a gate valve for shutting off, and the lower nozzle is equipped with a hood regulator, so that both good regulation and economical use of water are secured. Each nozzle, at 370ft. effective head, produces 310 mechanical H.P. at 300 revolutions. The water wheel is keyed directly on the armature shaft. In addition to the generators named, four 12½-kilowatt exciters, made up in two sets, will be used, both generators of each set being connected together by friction couplings, and each generator to be driven by a 14-in. Pelton wheel, with cast housings. Each set will consist of two generators, and two wheels will be built up on a cast-iron base-plate, making a rigid and direct connection. This application provides exciting energy in two units, and at all times either one or two exciters are in reserve. The exciters are to be run in multiple, and all connected to one common "bus line" on the switchboard. The three-phase generators will also be operated in parallel. There will be six raising transformers, 265 kilowatts each.

The poles for the line construction were selected from Sand Point (Idaho) cedar. The smallest are 40ft. long, and 8in. in diameter at the top. They are placed 100ft. apart. The line conductors consist of 12 wires—four circuits of three wires each, all No. 2 soft-drawn bare copper, and connected to the same common "'bus line" at the generating and at the distributing station. The line loss, in delivering 1,520 kilowatts at 10,000 volts, will be something less than 5 per cent.

The transmission line from generating to distributing station is 14 miles by pole line. The distributing station is owned by the Salt Lake and Ogden Gas and Electric Light Company, who rent it to the Big Cottonwood Power Company at a nominal rent. It contains, for "step-down" transformation, nine 175-kilowatt air-blast transformers, from the secondary side of which the Electric Light Company buys the current wholesale by meter. This arrangement is a most convenient one for both companies. The actual terms of the contract are that the Electric Light Company is to be supplied with all the current it can dispose of for electric lighting and power in units of 10 H.P. and under, the Big Cottonwood Company reserving the right to supply power to motors in units exceeding 10 H.P., and the right to reach such wholesale users of power by wires erected on the Electric Light Company's poles, throughout all the districts within the city limits. The contract begins January 1, 1896, and runs for a term of five years. Its conditions are that the current is bought at 2,000 volts, three-phase, at a stipulated price per kilowatt-hour, which will be used to supply electric light and power for any purpose up to 10 H.P., and for elevator service up to any limit desired by the lessees; 2,000,000 units annually is the minimum limit of the consumption of current.

The present production of the electric light company is practically 3,000,000 units per annum by the use of coal, after the usual central station methods, and the contract provides that as soon as the transmission power plant is in operation, the steam plant of the Electric Light Company is to be abandoned, the price to customers reduced, and other changes made that will be to the advantage not only of both companies but also to that of the public, by promoting the production of cheap electric power.

The final cost of the complete development is estimated at $300,000 (£60,000). An estimate of $300,000 for the original outlay for "The Stairs" would give for construction expenses—at 2,258 H.P.—$132.72 (£26. 10s.) per net horse-power delivered in the city ready for use. The Company's affairs have been so well administered that much more than half the power to be developed has already been disposed of absolutely, and the guaranteed total revenue from completed contracts is over $100,000 annually. Although the Company is confining its operations for the present to "The Stairs" supply, it has other valuable water rights partly developed by means of which it could at any time largely supplement its output.

The new distributing system, when complete, will consist of a network of primary mains with a network of low-tension secondaries. The primary mains will be at 2,000 volts. There will eventually be ten feeding points, though at first only six will be required. The secondary mains will be used almost entirely; only when the houses are very scattered will separate house transformers be used. In the commercial district, the secondary and primary mains will eventually be put underground, though this is not immediately contemplated. The transformers will be placed at street intersections in banks either fixed on the poles or in any suitable location near the intersection. Arrangements will be made for switching out alternate banks of transformers during light loads to save the waste of energy. The secondary mains will consist of three wires and a neutral wire. The voltage between any one of the three wires and the neutral will be 115. Motors, synchronous or non-synchronous, can be connected at any point to the secondary mains, or, when the motor is large, separate transformers will be used. It is intended to eventually use the alternating current for all arc lamps, in which case they will be connected to the secondary mains with small transformers.

The distributing station will be a substantial fireproof building, with a room for the 10,000-volt step-down transformers, a room for the 2,000-volt switchboard, and a room fitted up with instruments for testing and calibrating meters, &c. The current will be brought from the step-down transformer to the distributing board.

The change from the old to the new system will be no easy matter, and will have to be done gradually. In order to take the initial steps immediately three 150-kilowatt three-phase alternators will be driven by the existing steam engines, and will supply energy in the commercial district until the Cottonwood plant is ready. When the Cottonwood supply is established these generators will be used as synchronous motors to drive the arc-lighting machinery, and when the direct-current arc lamps are replaced by alternate-current lamps the machines will be available for use as motors wherever required. It is contemplated to use later on the old single-phase alternators as motors. In this way much of the old plant can still be utilised.

IS THE INVENTIVE FACULTY A MYTH?*

BY W. H. SMYTH.

To the ordinary mind a profound mystery appears to envelope the work of the inventor. He is looked upon with a species of awe, as one endowed by nature with what is known as the "inventive faculty"; a special organ or sense, having occult capabilities of inspiration and creation; a sort of automatic mental mechanism, needing only that its fortunate possessor should "touch the button" in order that, presto! the desired invention may instantaneously evolve from nothing. In fact, the great mass of even intelligent people of our age regard a noted inventor as nothing less—and nothing more—than a "wizard." As we go on, we shall see that this extraordinary delusion is shared, not only by the majority of inventors themselves, but in effect by the federal courts having jurisdiction in controversies relating to patents for inventions, as well as by the tribunals of the patent office. The intimate relations which it has been my fortune to sustain with many different inventors through a long period, and my experience in a capacity which may perhaps be regarded as that of a professional inventor, have led me to adopt certain views as to the nature and qualities of invention, and the mental processes of which the completed invention constitutes the tangible result, which in many respects are widely at variance with those which have heretofore found general acceptance. Whatever may be thought of the correctness of these views, it may at least be affirmed that, when formulated into a working hypothesis, they have enabled inventions to be conceived and worked out with no less certainty and accuracy of results than are common in other departments of science in which the phenomena and processes have been investigated, classified, and subjected to fixed laws. They have further led to the belief that not only is the popular conception of the mental operation of invention a wholly erroneous one, but that what is loosely termed the "faculty of invention" is one which is just as much capable of acquirement by proper instruction and cultivation as any other; in short, that, like carpentry or shoemaking, it is nothing more or less than an art. If these conclusions be well-founded, it is at once apparent that they tend to bring within the scope of scientific methods one of the most important departments of human endeavour, and one which, even in its present chaotic condition, has perhaps been the most important of all agencies in the advancement of modern civilisation.

I hold that that which is commonly termed the "inventive faculty" is nothing more than a combination of certain mental faculties with which every rational human being is endowed to a greater or less extent—namely, visualisation, memory, and reason.

The mental process involved in making an invention is analogous to that employed by the child in building with his toy blocks. Conceiving the idea of building some sort of house, he first arranges those which he thinks most suitable for the foundation, and continues by selecting from his store of blocks of various shapes and sizes those which he finds best adapted to form the various parts of the complete structure he has in mind. So too the inventor selects from the store of elementary mechanical parts or combinations with which memory has furnished his mind those which he regards as available for his purpose. The child builds and rebuilds; he changes a block here, and removes or adds a block there; so does the inventor, although in his case the mental operations of selection and arrangement are often so quickly and so automatically performed as to escape even his own observation. The material, too, with which the inventor works is infinitely better adapted to its purpose than are the blocks of the child with their unchangeable shapes and dimensions. It may be hard or soft, hot or cold, pervious or impervious, transparent or opaque, elastic or rigid, fluid or viscous; in short, it may be regarded as infinitely

* From the *Engineering Magazine*.

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plastic, though possessing every other inherent quality known in nature or art. When confronted with a defect in his structure, the child is compelled to laboriously select from his heap of blocks, critically examining each one and trying its effect as a part of the whole; but the inventor's mass of material is of a much more manageable character. In an instant the panorama of memory is unfolded, and he makes his selection—a process which may be repeated not merely once, but a hundred times, while the hand of the child would be faltering over a single block. Among this material the mind of the inventor works as a modeller in infinitely plastic clay. With such facilities and such material why should not great results be accomplished? On the contrary, would not he be a bungler indeed who under these conditions should prove to be incapable of producing a worthy result?

Why, then, do we find the patent office at Washington to be a vast storehouse, filled with every conceivable form of foolish, silly, illogical, and useless contrivance? Why this immeasurable waste of money, time, and effort in the production of useless rubbish? Why is it that the very name of "inventor" has become a synonym for an irrational and cracked-brained enthusiast, and a title which the originator of an important or valuable device no longer cares to accept? The reason for this state of affairs is not far to seek.

Let us again revert to our illustration of the building-block, and add to the other conditions under which the child is compelled to work one more which is necessary to complete the analogy. Let us assume the blocks to represent, not only the actual things from which the inventor's conceptions have been derived, but his mental conception of those things. A very strange state of affairs now arises, which is due to the difference between the concept and the reality. It is as if, the instant a block were picked up for use, it should, wholly unperceived by the child, assume a distorted shape—the cube, for example, being no longer cubical, or the cylinder no longer cylindrical. The extent of the distortion, being a variable quantity, may range from an almost immaterial difference to the assumption by the cube and cylinder of the characteristics of each other, to say nothing of infinite possibilities of error in all other directions. Such an imagined distortion of the shape of the blocks is more than paralleled in the distorted mental impressions of exterior objects existing in the mind of the ordinary untrained observer; in fact, it is only the few who observe with even approximate accuracy, and still fewer who have the capacity to retain a correct mental impression of that which they have observed. Let the ordinary person attempt to make a drawing of, say, a round-topped table. After a careful examination, he will probably proceed to draw, to the best of his limited ability, a circle, and next, with more or less accuracy, the legs, ending upon a horizontal line intended to represent the floor. Now mark! the circle has been drawn, not because the impression of a circle has been made upon the retina of the draftsman, and so on his mind, but because he knows, or thinks he knows, that the top is circular. The fact that the legs rest upon the horizontal floor is quite sufficient to justify the delineator in his belief that he sees that which is not to be seen, and he represents it accordingly. Think of a man, no matter how quick in perception or how logical in mind, but with his memory stocked with erroneous conceptions like these, often not even rising to the dignity of caricatures of the external objects which they are assumed to represent! From such a mass of mental material is it conceivable that it would be possible to produce anything whatever which, when completed, should bear any logical relation to real things? Most certainly not; such a production could only find its fit place among the aggregation of abortive refuse which already encumbers the cabinets of the patent office.

The field of invention extends far beyond the narrow limits which custom has assigned to it; ingenuity and invention may be and are manifested, not alone in the works of the mechanician, but in those of the musician, the poet, the author, the lawyer, the physician, or the theologian. But, alike in the case of these and all other inventors, a certain mental equipment is an indispensable requisite to success. There must exist, first, an unerring and accurate perception of those similarities and differences which are fundamental in their nature; second, the capacity to distinguish the pertinent from the fortuitous in the particular problem under consideration; and, third (and this applies particularly to the mechanical inventor), the ability to clearly visualise, so that he may examine his structure as it progresses, and may select and, if need be, adapt, the elements he selects from his store, to the end that they may be co-ordinated with that structure.

The process of mind which I have termed "visualisation" is curiously exemplified in an incident which I will give as nearly as possible in the language of the narrator: "I have on several occasions surprised myself, so to speak, in the act of going through a mental operation which, for want of a better name, I will call 'manualisation'—that is, using mental hands to manipulate mental material. This has only occurred, so far as I can recall, on occasions when I have been struggling mentally with some aggravatingly refractory problem of mechanical detail, which, though really no more than a pretty little puzzle, has concentrated my attention until the entire mental effort was focussed on the rebellious point in strained and intense abstraction, the incomplete portion being in clear and sharp visualisation. Then, slowly, and as if with great effort, two hands would be laboriously pushed into view, and would take hold of the unfinished part and twist and shape it until it assumed a form adapted to the desired end. Then, like a flash, the strain would relax, the apparition vanish, and I would perceive myself to be a relieved, but exceedingly tired, individual. The visualisation, including the hands, would still remain in mental view for possibly a second or two after the completion of the work."

If it were true that the so-called "faculty of invention" is something unique and apart from other forms of mental activity, it would certainly seem as if its manifestations must be so characteristic as to be at once recognisable. Such, however, is by no means the case. Is it not a most suggestive fact that, while the question of the presence or absence of "invention" has constituted the sole and only issue in thousands of contested cases which have been passed upon by the patent office and by the federal courts, not one of these august tribunals has ever succeeded in laying down a definition of that which constitutes invention? Listen to the observations of a learned judge of the Supreme Court of the United States:—"The truth is, the word [invention] cannot be defined in such a manner as to afford any substantial aid in determining whether a particular device involves an exercise of the inventive faculty or not. . . . In a given case we may be able to say that there is present invention of a very high order. In another we can see that there is lacking that *impalpable something* which distinguishes invention from simple mechanical skill."* Is not this condition of mental confusion readily explicable, in view of the suggestion contained in the title of this Paper?

Prof. Robinson, perhaps the leading authority to-day, at least in the United States, upon questions of this kind, says: "The mental faculties employed in the inventive act are the creative, not the imitative, faculties. An invention is the product of original thought. It involves spontaneous conception of some idea not previously present to the mind of the inventor. Industry in exploring the discoveries and acquiring the ideas of others, wise judgment in selecting and combining them, mechanical skill in applying them to practical results—none of these are creation, and none of these enter into the creative act. Only when the mind of the inventor originates an idea new to himself, if not to all the world, does he call into exercise his own inventive skill, and perform the mental portion of the inventive act."†

If the above extract does not embody the popular conception of the nature and attributes of invention referred to in the first paragraph of this Paper, I am at a loss to know what meaning is to be attributed to it. I take direct issue with the propositions laid down by Prof. Robinson, and contend that the very qualities, faculties, and acts stated by him to be foreign to invention are those which constitute its very essence. It is assumed that something is *created* in the mind of the inventor; that something which had no previous existence is spontaneously generated there. On the contrary, I say that the mind of the inventor is a selective mental apparatus, in which material gathered from the outside is rearranged and adapted to new uses, and that this is nothing different from the normal operation of the human mind in all other operations. If this is not true, and if invention in fact is something other than this, then I can only say that the possibility has been demonstrated that, by the exercise of those faculties of the mind which are "foreign to invention" and those only, results may be produced which are absolutely undistinguishable from "invention of a very high order." If, on the contrary, my contention is well founded, and there is really no such thing as the so-called "inventive faculty," and if the act which we call invention is nothing more that the normal result of the operation of mental endowments of which all are possessed in a greater or less degree, it must logically follow that, inasmuch as our mental faculties are admitted to be no less capable of cultivation and improvement than our physical faculties, the power of invention or the capacity to invent may be improved and strengthened. It further follows that the operation of these faculties, like other processes, must be capable of being reduced to a definite system, governed by well-defined laws, with manifest advantage in respect to economy of time and effort and certainty of result.

Despite the unscientific and haphazard way in which these important results are attempted to be reached, we boastfully speak of the present time as the "Age of Invention." To me the past and present ages, as respects invention, seem ages of pure empiricism, which bear to the future and real "Age of Invention" much the same relation that the last century bears to the present in respect to theoretical and applied science. Examine at random any one of half-a-dozen lines of mechanical invention; one striking characteristic, common to almost all, instantly arrests the attention; they present nothing more than a mere outgrowth of the manual

* McClain *v.* Ortmeyer, 141 U.S., 419.

† "Robinson on Patents," Vol. I., Sec. 1, par. 78.

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processes and machines of earlier times. Some operation, once performed wholly by hand tools, is expedited by some device which enables the foot as well as the hand to be utilised. Then power is applied; the hand and the foot operation, or perhaps both, are made automatic, and possibly, as a still further improvement, several of these automatic devices are combined into one. The fundamental basis is the old original hand process, and hence, except in the extremely improbable event that this was the best possible method of accomplishing the result, all the successive improvements are simply in the direction, not of real novelty, but of mere modification and multiplication. This inevitable tendency of the human mind to follow along well-worn grooves of habit serves to explain the reason of a fact often noticed—namely, that the most radical and important departures from old methods, by which many of the industries of the world have been completely revolutionised, are nearly always originated by persons wholly ignorant of the accepted practice in the particular industry concerned. There is no conservatism so unyielding as that of the specialist. It is one of the most insidious enemies which the inventor has to encounter; it is so easy to take things for granted, to let well enough alone. It is this and other considerations of no less significance that I have in mind when I say that the Age of Invention is not yet; we see only its vague and ill-defined fore glimmer. The ideal invention is as positive as a geometrical demonstration; hence the actual invention should at least be the logical mechanical complement of the conditions incident to the operation to be performed; it should be the logical answer to the problem which has been set, and should change only when external conditions change. Therefore an improvement on an invention should be of rare occurrence. The true and complete solution should be reached in the first instance.

I cannot close this line of argument without insisting upon the fact that the first and most important prerequisite to invention is an absolutely clear insight into, and a comprehensive grasp of, all the conditions involved in the problem. My own experience leads me to believe that this prerequisite alone constitutes nine-tenths of the work of invention, and that the remainder, in most cases, practically invents itself, or, to be more accurate, flows therefrom as a logical sequence.

And now, if it be admitted that invention is not an impalpable and indescribable "something," but that, on the contrary, it is the result of wise judgment and trained mechanical skill co-operating to select, combine, and apply observations and conceptions already accumulated, what then? My answer to this is twofold, inasmuch as it necessarily implies two radical and far-reaching departures from existing conditions. The first change should consist in eliminating from patent law and patent practice the conceptions which attach to the words "invention" and "invented," and in substituting therefor the ideas embodied in the words "discovery," "discovered," "produced," "thought out," "reasoned out." The mere change of phraseology would in itself go far to put an end to the existing maze of confusion, incident to the determination of the ever-recurring question whether a given device does or does not involve that undefinable "impalpable something" which the law says is the indispensable requisite to patentability, and would restrict the whole scope of the inquiry to the comparatively simple questions of novelty and utility. The second, and by far the most important, change should consist in the inauguration of a science of invention, with all the attributes which that phrase implies. Impressed as I am with the transcendent importance of this branch of the subject, I venture to offer such suggestions as have occurred to me, in the hope that others more competent may be induced to take the matter in hand, and give it the consideration which its importance warrants.

The following should form (in part) the basis of a scheme for the cultivation of invention: (1) Accurate and methodical observation. (2) Cultivation of memory, including the faculty of association. (3) Cultivation of clear visualisation; (4) logical reasoning from actual observations.

Particular importance should be attached to accurate observation, inasmuch as this is the indispensable foundation of all real education.

With the above considerations in view, a course of training in which the following exercises are included has suggested itself to me:—

First. Drawing from simple objects (not copies) under the following conditions: The object to be carefully examined, then removed, and a drawing made wholly from memory; this to be repeated until the last effort depicts the object as correctly as if drawn directly from it; each successive drawing to be on a separate sheet, and removed from view while the succeeding one is in progress; when considerable proficiency has been attained, more complex objects to be substituted, and the time-interval increased; the class of objects to have as wide a range as possible; as proficiency increases the time allowed for preliminary observation to be shortened, until the briefest possible glance at an object shall be sufficient to impress its appearance clearly upon the mind, the power of visualisation becoming so highly cultivated that at any future time the image may be called up and reproduced with absolute fidelity of detail; as a modification of the foregoing, drawing objects from description, oral and other.

Second. Other exercises of the same general character, with or without the aid of drawing, having reference to other characteristics than form, as, for example, material, structure, and function.

Third. The solution of problems pertaining to the construction of the sample object, its manufacture and improvement, together with the discovery of means for the accomplishment of definite ends. These are, of course, merely suggestions, the scope of which may be extended and modified almost indefinitely. It may, perhaps, be objected that while the first and second of the exercises above suggested might have the effect of cultivating the mental capacity for accurate observation, retentive memory, and clear visualisation, the third would often prove to be beyond the scope of the ordinary mind. That such is not the case I am able to show by citing as an example the invention of an actual machine of no inconsiderable utility for the purpose of assembling fruit cans in the process of manufacture. For convenience of description, the experiment is thrown into the form of a colloquy.

Q. Of what shape is a fruit-can?—*A.* Cylindrical.

Q. What is the principal peculiarity of the cylindrical form?—*A.* Roundness.

Q. What does this adapt it to do?—*A.* Roll on a plane surface.

Q. To provide means of conveying cylinders a short distance in the simplest manner, how would you proceed?—*A.* Make an inclined plane.

Q. Then, to convey bodies and heads of cans to a place to be operated upon, what would you provide?—*A.* Inclined planes.

Q. Suppose you had to unite two pieces of stove-pipe in the usual way; how would you go about it?—*A.* Hold them carefully opposite each other; then shove them together.

Q. Suppose you had to unite many such pieces of stove-pipe in lengths of two, and to do it quickly?—*A.* Fix something that would hold them opposite each other, and then shove them together.

Q. Now, with regard to the tops and bottoms of fruit cans; how would you assemble them?—*A.* The same as stove-pipes.

Q. How is that?—*A.* Let them roll down into something which will hold them in line with one another, and then shove them together.

Q. How will you make room for the next ones?—*A.* Let the finished ones roll away.

Q. How would you instruct a mechanic to build your machine?—*A.* Make three inclined runways, one for the can bodies and one on each side for the covers. At the lower end of the runways, make something that will hold these three things in line with each other. Then fix something that will push all three together, and make a runway for the finished cans to roll away.

Will anyone deny that the above course of reasoning is not within the capacity of an intelligent boy of 12 years of age, or that a mechanic skilled in the construction of such machinery could not build a practically operative can-heading machine from the above specification?

A course of instruction such as I have attempted to outline would serve to confer upon all capabilities now enjoyed only by the few, and would give to them such capacities for dealing with novel and unexpected problems and conditions as would vastly increase the productive capacity of the community. Language fails me in attempting to express my sense of the vast importance and urgent necessity of systematic culture and education in the direction which I have indicated. The science of invention should take its place as the first study in the kindergarten, and the test of proficiency therein should be the last one to which the student should be subjected before leaving his Alma Mater to struggle with the ever new problems which will surely confront him in actual life. It requires far more than the necessarily brief space which can be allotted to a magazine article to treat this subject in the manner which its importance demands, but I trust that enough has been said to show that such a course of training, if generally adopted, would vastly increase the dominion of man over the forces of Nature, and immeasurably hasten the advent of the real Age of Invention.

Electric Traction in Berlin.—An electric tramway, about 1¾ mile in length, connecting Pankow with Berlin, was opened for traffic on September 10th. The line is on the overhead trolley system, and was constructed by Messrs. Siemens and Halske. The conductor lies exactly over the centre of the rails, but instead of the trolley wheel sliding collector bars are used. The feeders are bare copper wires, 6mm. thick, and are carried overhead, fixed to the side poles which carry the span wires. The cars, which are for 30 passengers, run at a speed of from 9 to 12 miles per hour. The line has a double track, and the maximum gradient is only 1 in 300.

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The Oldest Electrical Journal (1861—1878.)

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny. Editorial, Publishing and Printing Offices,

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THE RETIREMENT OF PROFESSORS.

As old age creeps on, even the most untiring engineer grows rusty. Be his intellect ever so nimble, his frame ever so wiry, his gait ever so active, there arrives a time when the unceasing march of science sweeps past him, and leaves him intellectually in the lurch. New ideas need new men. The brain, which at seventeen was teeming with novel conceptions, eager to follow the new clue, or lend itself to the untried process, is at seventy in a different condition to receive, assimilate, or even grasp ideas that do not follow along the habitual grooves of thought. Though the eye be undimmed, and the natural force unabated, something is gone that in earlier years made the man what he was. Veterans cannot pioneer. It is in the inevitable order of things, not to be changed by wealth, or weight of will, or, even by Orders in Council. Of no science, surely, is it more true than of electricity that its development has needed the mental pliability of youth. Certainly, the youth of some of its pioneers has been remarkable. But the very youths whose researches and inventions made them famous have in not a few cases notoriously failed to keep pace with the progress of discovery, and have in their later life fallen hopelessly to the rear. Each succeeding discovery has found a number of the earlier workers so fixed in their own order of ideas as to be incapable of adapting themselves to the new. Thus

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the discovery by FARADAY of the property of specific inductive capacity, and of the curved shape of the lines of electric force, proved a stumbling block to the older electricians, who had learned to think only of forces acting at a distance in straight lines. Thus, again, FARADAY himself was entirely unable to understand the views of SNOW HARRIS as to the lightning discharge being conducted rather by the surface than by the whole cross-section of the conductor. Thus, too, when the telephone first compelled attention to the phenomena of alternating currents, many of the older electricians were puzzled to find that the simple law of Ohm no longer sufficed to calculate the flow in the circuit. Nay, is it not true in our own day that the strenuous objections which are urged against the use of alternating currents come from men who once were pioneers, but whom now the progress of the age is slowly but surely leaving stranded ? In another decade, perhaps, even the present pioneers will be left behind, incapable of grasping the ideas of the *nouveau siècle.* When Hertzian waves are used for universal signalling, lighting and power, and when Heavisidal units have superseded the ancient relics of the C.G.S., the now buoyant apostles of modern views will have lapsed into mere fogies of the old nineteenth-century type.

These reflections have been called up in the editorial mind by the appearance of a parliamentary blue-book on the subject of the compulsory retirement of professors. It seems that the rule according to which Civil servants on attaining the age of sixty-five are compulsorily retired had been taken to apply to the professors who hold office under the Crown in the colleges of the Royal University of Ireland, and who, like the professors of the Royal Colleges of Science in Kensington and Dublin, are nominally Civil servants. The compulsory retirement by the late Government of a distinguished Irish professor on reaching the limit of age gave rise to so much indignation, real or apparent, that a Committee was appointed by the Treasury to consider the question of superannuation of those who thus serve under the Crown. In passing, it may be noted that one of the Committee, Lord PLAYFAIR, is himself a retired professor of chemistry. The Committee recommend that there should be fixed rules as to superannuation of presidents and professors, and that they should be framed as College statutes, and not by way of an Order in Council. Their opinion is that when a professor reaches the age of sixty-five the president of the college should be bound to report to the Government the condition and efficiency of the teaching. If these are, and continue to be, satisfactory, the professor need not be superannuated till seventy, but at this age his retirement should be absolute. The report concludes with the following words: "As the professors are not appointed till middle life, the addition of seven years to their period of service in calculating their superannuation obviously tends to secure eminent specialists as candidates for office." No one can regard these terms as harsh. The professor is, from the first, freed from anxiety in the matter of receiving a fixed salary, even though it be small compared with that paid by a commercial firm to a confidential clerk, or by a fashionable draper to a head of a department; and that he should feel sure of a pension is an additional element in his favour, though here he is only in line with Civil servants of every branch.

But the concern of the electrical profession would be very small in this parliamentary report if it were measured by the half-dozen Government professors which it affects. It does not touch the majority of the professors in our universities, university colleges, and technical schools. Their income is not only a more precarious matter, but is not fortified by visions of a pension at the termination of their services. But neither are they frightened by the spectre of compulsory retirement. Lord KELVIN's tenure of his professorship at Glasgow has lasted all but half a century, and he has passed the three-score years and ten. But none would wish to deprive the University of Glasgow of the honour of his services, or wish him any other retirement than the long six months vacations which the Scottish Universities grant to their teachers. In Germany they manage things differently. The professor is not retired. He may celebrate his jubilee, and drag on in tenure of his chair, but shorn largely of his emoluments; for his income depends greatly on students' fees, and these, as his fame wanes, drop off. The students attend instead the lectures of some of the younger "extraordinary" professors, who are licensed by the university to teach, and in a measure to compete with the "ordinary" professor. Doubtless the system has it advantages. Doubtless also its hardships.

In the case of the holders of professorial chairs in the modern university colleges and technical colleges of England, we believe none of these are appointments for life. None are highly paid compared with the holders of chairs at the older universities, or with the chairs in Edinburgh or Glasgow. None, indeed, have any pensions attached to them. And in some instances, notably in some of the earlier appointments of the City and Guilds Institute, the very wholesome condition was attached that the holder was expected to remain in professional practice while carrying out the duties of his chair. Only so could the colleges be sure of getting the services of a real live worker, in touch with his profession. This clause, too, presents another side; for while a kind of spurious dignity attaches to the appellation of "professor"—in compensation, we suppose, for the limited remuneration attached to his office—he is often tempted to quit his teaching for more lucrative work. We know of one distinguished ex-professor in London whose professional income immediately doubled on his laying down his professorship; and probably similar results would occur in the case of others, in whom, however, the passion for teaching is too strong to permit them to lay aside a work which seems to others little less than drudgery. It would be invidious to particularise; but we venture to think that the science and the practice of electricity in England, and particularly in London, owes more to its professors, old and young, than many are willing to admit. The names of DANIELL, of GROVE, of FARADAY, of MAXWELL—to name no others, dead or living—will be imperishable in electric science. And they were—only professors. FARADAY, indeed, seems to contradict the notion that progress and discovery are the prerogative of the young. It was not till the age of 31 that he discovered the liquefaction of chlorine—not until the age of 40 that he discovered the induction of electric currents by magnetism. When he was 46 he discovered specific inductive capacity. At the age of 54 he made the observation of the rotation by the magnet of polarised light, and followed this up with his investigations of diamagnetism. When 56 he wrote the "Thoughts on Ray-Vibrations," which MAXWELL described as FARADAY's electromagnetic theory of light. GOETHE at 80 writing his "Faust," or GLADSTONE in retirement writing on BUTLER, present exceptions to the general rule. But to few men is it given to preserve to a green old age such a youthful elasticity of brain. Science has had, and still has, its grand old men. Yet in nine cases out of ten it had been better had some happy scheme of superannuation brought younger men to fill a post needing strong vitality for the adequate performance of its duties. For in technics, even more than in pure science, superfluous lags the veteran on the stage.

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REVIEW.

The Steam Jacket Practically Considered as an Efficient Fuel Economiser. Second Edition. By WM. FLETCHER. (London: Whittaker and Co. 1895.)

The principal details of a steam engine have become so highly differentiated, and the theories of their action are developed into so amazing a complexity, that it is no wonder that each individual organ claims a text-book of its own. A separate treatise devoted to the steam jacket is at once a good idea and a useful development of the literature of the steam engine; and we are glad to see that Mr. Fletcher has made an essay in this subject an addition to Messrs. Whittaker's generally admirable "Specialist Series." There is no doubt that a reliable and sufficiently comprehensive treatise on the steam jacket, which should take into account on the one hand the modern researches of Bryan Donkin, and on the other hand the practical work done by Willans and others, was wanted. The only question is, whether Mr. Fletcher's book has satisfied this want. In our opinion it only partially and incompletely satisfies it; though, we hasten to say that there is a great deal of useful information to be found in this book. The author, indeed, is happier and more accurate in his practical treatment of his subject than in his attempt to formulate a theory.

To provide a theory of the steam jacket, Mr. Fletcher goes back to the pages of an engineering contemporary in the year 1871, and extracts a ready-made hypothesis, which he puts forward with due approbation and blessing as the "whole theory." Here it is:—

"All the liquefaction due to the performance of work by the steam within the cylinder is transferred to the steam within the jacket. The water resulting from this liquefaction is restored to the boiler, where it is re-evaporated, and flows to the cylinder to do more work; whereas, if the liquefaction had taken place within the cylinder, the resulting water would have been re-evaporated there instead of within the boiler, and the resulting steam, although obtained at just the same expenditure of power, would, instead of doing work on the piston, do it in heating the condensing water. It thus appears that, in a properly jacketed engine, *the true seat of the entire energy of the engine is in the jacket, and not in the cylinder*; and, startling as the statement may appear at first sight, it is none the less virtually true, that it is *in the jacket, and not in the cylinder, that all the work of the steam is performed*. It follows, as a consequence, that the condensation which takes place in the jacket does not in any way represent loss of fuel, except in so far as that condensation is a result of radiation and conduction through the sides of the cylinder to the condenser during the time the exhaust port is open, and of radiation to the external atmosphere."

(The italics are in Mr. Fletcher's book.) Now, this antiquated "theory" is a strange and incongruous admixture of half-truths with utterly erroneous and preposterous assertions (those, oddly enough, in the italics), the whole being bound together with a specious but fallacious logic. It *is* true that the steam jacket prevents wasteful liquefaction in the cylinder, by permitting liquefaction to go on unwastefully, or rather, far less wastefully, within itself. But to argue from this that the whole work of the engine is done by the jacket steam is simply to arrive at a totally wrong conclusion by an illogical argument based upon an inadequate, not to say irrelevant, premise.

Nor is the author any more happy in the details of his theory. For example, in explaining radiation he makes the quite erroneous statement that—

"The rapidity with which heat radiates varies, other things being equal as the square of the temperature of the hot body is in excess of the temperature of the cold one, so that a body if made twice as hot will lose a degree of temperature in a quarter of the time; if made three times as hot, it will lose a degree of temperature in one-ninth of the time; and so on, in all other proportion. The loss of radiation is not affected by the form of the radiant body: a cube or cylinder will radiate the same amount of heat with equal areas under the same conditions."

It is hardly necessary to say that the author is entirely wrong here; besides which, he confuses between the rate of radiation from a surface (at a steady temperature) and its rate of cooling when not supplied with heat; two considerably different phenomena.

We fear that Mr. Fletcher has exaggerated a laudable desire to make prominent the virtues of the steam jacket, into an attempt to make its value pre-eminent. From the thermodynamic point of view, he almost wishes us to believe that to be a steam engine is to be a steam jacket. Little wonder, then, that he has no patience for unjacketed engines; neither is it altogether surprising that he ventures to attack the electrical engineer for his practice in using high-speed engines of this class. Here is the amusing tirade in which he expresses his views in this matter:—

"We regret to say that small unjacketed vertical engines are now being most extensively adopted for driving dynamos for electric lighting purposes, and the amount of steam consumed by some of these wasteful abortions is, we believe, never realised by the users, and known only to those who have tested the engines, or to others who have had the privilege of stoking the boiler supplying them with steam."

Electrical engineers who have been using "these wasteful abortions" can afford to smile at these mistaken views. Their author is evidently quite unacquainted with well-established facts. Yet it is regrettable that Mr. Fletcher has not put to better use the mass of practical data which apparently he has had at his disposal. Had a scientific and impartial attitude of mind been taken by the author, and had he taken the trouble to acquaint himself with the latest technical research on this subject, he would have produced a work possessing quite ten times the value of the one before us.

The author's account of the history of the steam jacket is complete and interesting. He traces its development from the time of Watt, points out the early misconceptions and failures in practice, and shows how this useful appendage to the modern steam engine has gradually arrived at its modern efficient condition. He tells, in a later chapter, a story which we cannot refrain from repeating, as it well illustrates the erroneous ideas of the function of a steam jacket, which characterised its earlier as well as its later opponents:—

"Some little time ago a well-known engine maker was asked if the cylinder of a steam engine we were looking at was steam-jacketed. He, placing his hand on the cylinder lagging of the working engine, said, 'There is no need for a steam jacket, as the loss of heat is very slight.'"

Three important chapters are devoted to "The Abuse of the Steam Jacket," and in these the author has many practical things to say, as to how a jacket should be constructed and worked if it is to do good instead of harm. Here are some experiences gained by Mr. Coath, which he repeats:—

"In thirteen steamers *he found the drain pipe full open to the condenser*, and the steam supply cock to the jacket partly open. In three steamers the jackets were only used on starting to warm up the cylinders, and, when the engines were well under way, the steam supply was totally closed, *and the outlet opened to the condenser*. In two cases the inlet was left wide open, *and the drain pipe kept closed, and the condensed steam was blown out once a watch.*"

We have not space to make any further detailed comment on Mr. Fletcher's book. In conclusion we can say that, despite that in theory it is defective, as a practical treatise it is excellent, and as a book to read it is simply charming.

THE HEATING OF DYNAMOS.

BY ERNEST WILSON.

It is usually stated in the temperature specification of a dynamo that after it has run for six hours at full output the temperature shall not exceed a given maximum. Apart from the bearings this, of course, refers to the armature and magnet windings. For instance, the Admiralty specification lays down a maximum rise of 70°F. above the temperature of the room.

When an armature is rotating in a magnetic field and delivering its current to the external circuit, or receiving a current from the external circuit, there are in it four causes for dissipation of energy:—

(1) The armature current itself, in virtue of the electrical resistance of the armature conductors;
(2) Magnetic hysteresis;
(3) Induced currents in the iron of the armature;
(4) Induced currents in the armature conductors.

Since the ultimate temperature to which an armature will rise for given conditions as to speed, radiating surface, and temperature of surrounding atmosphere, is a function of each of the quantities (1), (2), (3), (4), it is our duty first of all to determine these under given conditions.

Taking them in order:—

(1) is easy to determine if the resistance of the armature and its current are known.

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(2) is easily dealt with from the known magnetic qualities of the iron of the core if we make this assumption : that the dissipation of energy by magnetic hysteresis is the same whether the magnetism of the core is reversed by diminishing and increasing its intensity, or whether it is reversed by turning round its direction without reducing its amount to zero.

(3) and (4) are more difficult to handle; in regard to (3) we make the same assumption as in (2).

Before going further it will be well to give the results of a simple experiment with the machines* in the Siemens Laboratory, King's College, London these being specially referred to in this Paper. Their axles being rigidly coupled together, one of them was arranged to run as a motor at varying speeds, the power delivered to it being measured at any time. The other had its brushes carefully set on the neutral line and connected to a voltmeter; its field could be varied in magnitude and its exciting current made or broken at will. The speed was measured on a Buss tachometer.

The method of test was as follows: the motor was run at, say, 1,000 revolutions per minute, the generator not excited, and the watts delivered to motor noted. The generator was then excited, its volts noted, and the watts given to motor again noted, the speed being kept constant. Finally, the exciting current of generator was broken, and the watts again taken as a check upon their former value.

From the volts on generator armature and speed we are able to deduce induction per square centimetre in armature, and the

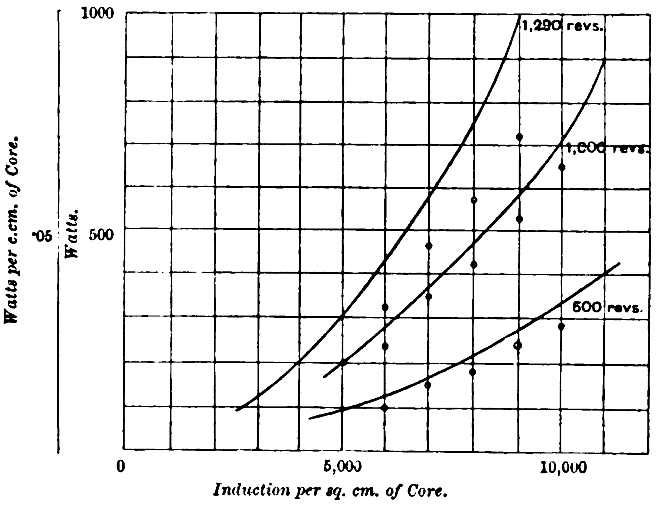

Fig. 1.

difference between the watts taken to drive the combination, generator excited and not excited, can be taken roughly to be the rate of dissipation of energy due to causes (2), (3), (4).†

The full lines in Fig. 1 give the watts dissipated in terms of maximum induction per square centimetre **B** for 500, 1,000, and 1,290 revolutions per minute respectively. Fig. 2 gives another aspect of the same thing—that is, for a given **B** the watts dissipated in terms of revolution per minute or frequency in periods per second.

It is necessary to state here that the armature core consists of soft iron discs not specially insulated from one another, except only by any oxide or dirt that may be between them, compressed together by means of screwed plates on the shaft.

Their thickness may be taken to be about 1mm.; they have, when allowance is made for the shaft, from which they are not insulated, a cubic capacity of about 9,450 cubic cm. and a cross-sectional area for induction of 518 square cm.

It is clearly our object, when determining *à priori* the losses in an armature core, to pre-determine the curves given in Fig. 1, and then, given a suitable relation between total watts dissipated, radiating surface, and circumferential velocity, to predict the ultimate temperature, or the temperature after any time, of the armature.

The relation between the dissipation of energy by induced currents in ergs per cycle per cubic centimetre and maximum average induction per square centimetre **B** for two frequencies has been found* in the case of a cylinder of very soft Whitworth steel 4in. diameter, and is shown in the curves *a* and *b* (Fig. 3). Curve *a* gives this relation with 20 seconds periodic time, and curve *b* with 80 seconds; or frequencies of $\frac{1}{20}$th and $\frac{1}{80}$th of a period per second.

Since similar magnetic events will occur in bars of different diameters for the same material at the same temperature, but at times varying as the square of the diameters, these same curves can serve also for cylinders of other diameters. In the core of our armature we have plates instead of circular wires, and since a plate in regard to induced currents in its substance is roughly comparable to a wire having a diameter double the thickness of the plate, these results can be used also for plates. Fig. 4 gives another aspect of the curves in Fig. 3—that is, for a given maximum average induction per square centimetre, the relation between ergs dissipated by induced currents per cycle per cubic centimetre, and frequency, or revolutions per minute, in the case of a two-pole machine, is given for a given thickness of plate in millimetres.

Although the 4in. cylinder is not of the same material as the plates in our armature, we may form from these curves a rough idea of the dissipation of energy by induced currents in the core.

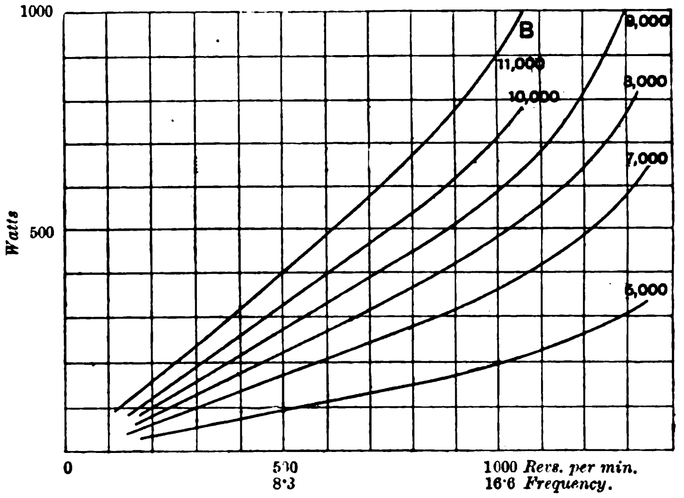

Fig. 2.

Let us, then, see if we can reproduce the curves in Fig. 1 from an assumed relation between maximum **B** and the ergs dissipated per cycle per cubic centimetre $\left(\frac{1}{4\pi}\int \mathsf{H}\, d\,\mathsf{B}\right)$ due to magnetic hysteresis, and the curves in Figs. 3 and 4 for induced currents.

The figures are tabulated in Table I., and explain themselves. They give the total core losses due to hysteresis and induced currents at the three speeds 500, 1,000, 1,290 revolutions per minute.† These ordinates have been doubled before plotting, in order the better to compare the form of the curves, and are shown for each speed thus: 0 in Fig. 1.

It will be observed that in each case the form of the curves is similar, but the ordinates are less than half what would be required to make the calculated and observed watts agree.

There are reasons why these curves should *not* agree, even supposing that the data for hysteresis and induced-current losses were obtained for the particular iron of the core itself:—

(*a*) We have not taken account of the induced currents in the copper conductors of the armature; this can be made a

* For a full description of these machines see *Proc.* R.S., Vol. LI., p. 49; Hopkinson's "Dynamo Machinery"; or *The Electrician*, April 8, 1892.

† The dissipation of energy due to induced currents in the pole-pieces with our smooth armature and any increase in the bearing friction there might be due to magnetic pull are neglected.

* See *Phil. Trans.*, R.S., Vol. CLXXXVI. (1895) A, pp. 93—121; also *The Electrician*, February 22, 1895.

† It is obvious that in cores where the induction density is greater—say 16,000 or 17,000 C.G.S. units per square centimetre for the same frequency—that the plates should be much thinner or better insulated from one another if the temperature is to be kept down.

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small quantity by proper construction, and is small in our machine.

(*b*) The core plates are not specially insulated from one another, and therefore there is much greater conductivity than we assumed in the first instance. This is probably the principal cause of the difference between the observed and calculated watts in Fig. 1.

(*c*) There is the loss in the steel shaft due to hysteresis and induced currents.

(*d*) The magnetic pull on armature, which is small.

For the same copper conductors it is simply a question of extra expense to ensure better insulation between the plates, as against a small gain in efficiency consequent upon a lower ultimate temperature of the armature. *Given* that the plates are perfectly insulated from one another, we have still the induced currents in the conductors and the loss in shaft to deal with in applying the above process of calculation. Further than this, when the machine is loaded there is a considerable variation of induction density on account of armature reaction,* and this would again increase the losses due to hysteresis and induced currents for the same maximum average total induction. The conductivity of the core would be decreased by rise in temperature of the armature, thus lowering the induced-current

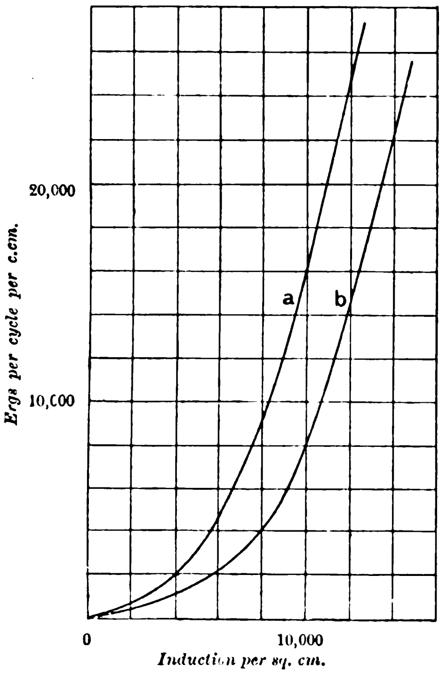

Fig. 3.

losses; but the expansion of the plates in our core might again increase conductivity.

Unless the plates are perfectly insulated, and the relations for hysteresis and induced currents above discussed be known for the particular iron, the problem is complicated. A careful experiment was made to see if the curves in Fig. 1 are much altered by change of temperature of the armature. It shows that for a rise of 42°F as shown by a thermometer at commutator end of armature, at a speed of 1,000 revolutions per minute and B in armature about 8,000, no sensible change is produced.

If reference be made to *Engineering* for March 24, 1893, it will be seen that in these machines the losses due to causes (2), (3), (4), together with the friction in the bearings and brushes and wind friction, vary from 5 to 6·6 per cent. of the total power given to the machine as generator and motor, the total watts by Method II. from these causes being 1,520. The curves in Fig. 2 give the watts due to causes (2), (3), (4) as 430 in generator and 550 in motor. Adding these and subtracting from 1,520, we have 540 watts due to bearing, brush, and wind friction, which we can equally divide between the two machines. So that 1 or 2 per cent. might be gained by insulating the plates.

* See *Proc.* R.S., Vol. LI., p. 49; Hopkinson's "Dynamo Machinery"; or *The Electrician*, April 8, 1892.

The temperature of armature and magnet windings of a dynamo is in practice a difficult subject to deal with, on account of the varying conditions under which dynamos have to work; but in order to give some idea of what might be expected from these machines, the following experiments were made:—

The armatures were uncoupled, and one of them fixed so that it could not rotate, the other being driven by a steam engine. The exciting current of the driven dynamo was measured by a Siemens dynamometer, and kept constant; the machine was run for six hours at constant speed, its current being passed through the stationary armature, a Thomson balance, and extra resistance to take the load.

Every hour the dynamo was stopped, and by means of a Thomson double bridge* the resistance of its armature was measured between opposite segments of the commutator (the same segments being always taken); the other armature was treated in the same manner, and the temperatures of the two armatures were taken by a thermometer. The resistance of the armatures at 20°C. was in each case 0·0416 ohms. The resistance of the magnet coils of the generator was measured by means of a Wheatstone bridge, the temperature being also noted by a thermometer. The time between stopping and starting again was about 5 minutes. Table II. gives the results of the tests.

It is usually assumed that the practical ultimate temperature to which a magnet winding of given dimensions, and wound on the limb in a given manner, will rise, can be expressed as

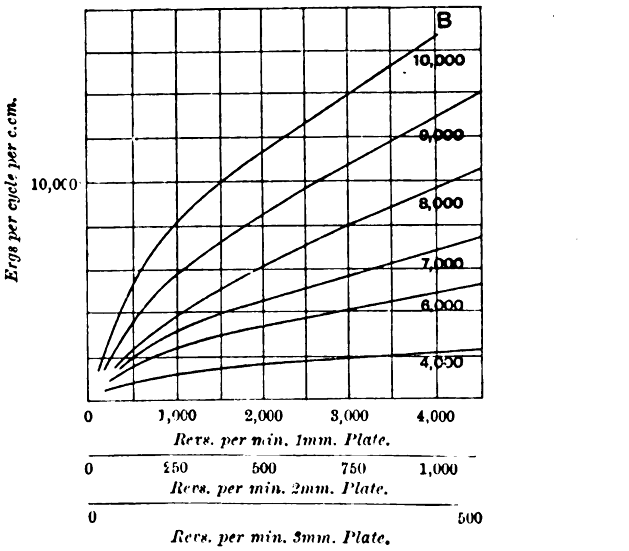

Fig. 4.

follows†:—$t^0\text{F} = \dfrac{a\,\text{W}}{\text{A}}$, where t = practical final temperature, W = watts dissipated in winding, A = radiating surface in square inches, and a being a supposed constant. It is obvious that some convention must be come to in estimating A. With regard to the magnet windings, the two surfaces between them are neglected, and the distance right round the two windings as they stand is multiplied by the height between the wooden formers—these dimensions are 70in. and 12in. respectively, there being no ventilating space between limb and winding. The depth of winding is 2in. For the armature we have taken the total area in square inches of a cylinder, the length of the armature not including commutator and its radial connections; this comes out at 619 square inches, the length being taken as 20½in. and diameter 8in.

When an armature is rotating and delivering a current to the external circuit or receiving a current, we have stated that there are losses in it other than those of current squared into resistance. In these tests the average B has been found in the usual way for the rotating armature, and from curves in Fig. 2 the watts due to hysteresis and induced currents have been estimated.

*See *Engineering*, August 19, 1892.
† This subject is fully treated in "The Dynamo," by Hawkins and Wallis.

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Table I.

Maximum average induction per square centimetre in armature. B	Ergs per cycle per cubic centimetre due to hysteresis. $\frac{1}{4\pi}\int H\,dB$.*	500 revolutions per minute.		1,000 revolutions per minute.		1,290 revolutions per minute.	
		Ergs per cycle per c. cm. due to induced currents for 1mm plates.	Watts for whole core due to hysteresis and induced currents combined.	Ergs per cycle per c. cm. due to induced currents for 1mm. plates.	Watts for whole core due to hysteresis and induced currents combined.	Ergs per cycle per c. cm. due to induced currents for 1mm. plates	Watts for whole core due to hysteresis and induced currents combined.
6,000	5,200	1,400	52	2,300	118	2,700	160
7,000	7,900	1,800	76	3,200	174	3,600	233
8,000	9,500	2,200	92	4,000	212	4,700	288
9,000	11,400	3,200	115	5,400	264	6,400	361
10,000	13,400	4,300	140	7,400	327	8,600	447

* These values have been purposely chosen high, and probably represent magnetically a much worse sample of soft iron than we have in our armature core.

Table II.

Hours after starting test.	Stationary armature.				Rotating armature.				Magnet winding.	
	Test I. Rise in deg. Fahr. above atmosphere.*		Test II. Rise in deg. Fahr. above atmosphere.*		Test III. Rise in deg. Fahr. above atmosphere.*		Test IV. Rise in deg. Fahr. above atmosphere.*		Test V. Rise in deg. Fahr. above atmosphere.*	
	By resistance.	By thermometer.	By resistance.	By thermometer.	By resistance.	By thermometer.	By resistance.	By thermometer.	By resistance.	By thermometer.
1	29·4	23	...	...	54·6	38	...	...	...	...
2	36·3	31	18·5	11	67·5	45	63·4	29	44	...
3	48·6	38	...	15	73·7	48	...	...	57	40
4	55·4	46	25·0	18	79·8	50	65·0	41	65	46
5	62·9	47	26·0	19	83·6	51	68·4	45	69	54
6	65·7	50	27·4	22	86·0	52	74·6	49	72	57

* Atmospheric temperature, 20°C.

Table III.

No. of test in Table II.	Output.			Watts.		Watts per sq. in. of radiating surface.	*a*		*b* Feet per minute.	*c*		Amperes per sq. mm of copper conductor.	Average B in armature.
	Volts.	Amperes.	Revs. per minute.	C^2R	Hysteresis and eddy currents from Fig. 2.		By resistance.	By thermometer.		By resistance.	By thermometer.		
I.	...	69	...	226	...	0·37	179	136	...	...	...	2·13	...
II.	...	42	...	78	...	0·13	216	174	...	...	...	1·30	...
III.	144	69	900	236	530	1·25	179*	136*	1,880	1,150	836	2·13	9,100
IV.	83	69	510	230	300	0·86	179*	136*	1,070	1,030	771	2·13	9,390
V.	...	...	...	619	...	0·74	98	77	...	...	...	1·42	...

* Taken from Test I. on account of current being the same.

The formula $t^0\ \mathrm{F} = \frac{a\,W}{A}$ must be modified on account of rotation; if the rotation is zero, as is, in fact, the case in our stationary armature, we can use this formula, and the modification might be stated thus* $t^0\ \mathrm{F} = \frac{a\,W}{A\left(1+\frac{b}{c}\right)}$, where b = circumferential velocity of armature in feet per minute, c being a supposed constant.

Coming to the results of the tests we see at once a difference between temperatures taken by means of thermometers and average temperatures got from a determination of resistance. The thermometer was placed some minutes before stopping on the stationary armature, but was in the case of the other only in contact about three minutes. The temperature varies at different parts of the surface of an armature, the commutator and its radial connections having a cooling effect. Experiments show that in the case of the stationary armature the commutator end differs in temperature from the other by about 5°F. for a current of 69 amperes in the armature. But in the case of the rotating armature and the same current, there is the fan action of the radial commutator connections, which makes this difference about 9°F. by thermometer. All the temperatures of armatures given in Table II. as taken by thermometers were taken at the commutator end of armature. In our case no special means are provided for ventilation. Thermometers with small thermal capacity should be used.

* This formula is the same as in Messrs. Hawkins and Wallis' "The Dynamo."

The results show that after about six hours the temperature for given conditions is fairly constant; this is not necessarily the case, and, *cæteris paribus*, the larger the machine the longer will it be before it becomes fairly constant in temperature. Then, again, the whole subject is greatly complicated by the varying temperatures of the rooms where dynamos have to work.

Table III. gives the constant *a*, *c*, and other particulars of the tests given in Table II. It should be noted in connection with the test of stationary armature and small current that the results are not so reliable on account of the small rise in temperature above atmosphere.

In conclusion, I wish to express my best thanks to Messrs. Cobb, Evans, Makovski, Shawcross and Welbourn, student demonstrators in the Siemens Laboratory, King's College, London, for their assistance in these experiments.

Telegraphic Communication between England and Germany. The *Kölnische Zeitung* of Cologne is complaining of the delays which have for some time been occurring in the transmission of messages from England, especially in connection with market reports from London, Liverpool and Glasgow. A few days ago the newspaper in question received a telegraphic message from the latter city, the time occupied in the transmission of which was no less than 3½ hours. The blame is being laid on the English authorities, and the German Government is being urged to take steps to improve or extend the telegraph facilities between the two countries, with the view of obviating these delays.

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EXPERIMENTS ON THE TRANSFER OF HEAT THROUGH PLATES WITH VARIOUSLY ARRANGED SURFACES.*

BY WILLIAM G. WALKER, M.INST.M.E., A.M.INST.C.E.

The object of these experiments is to compare the effect on the transfer of heat of variously arranged surfaces projecting from the primary surface of a plate in contact with steam, air and water.

Two cylindrical smooth vessels were constructed of exactly similar dimensions, cut from the same brass tube, each $6\frac{3}{4}$in. length,

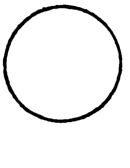

FIG. 1.

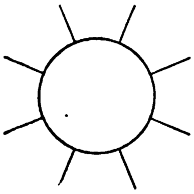

FIG. 2.

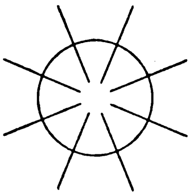

FIG. 3.

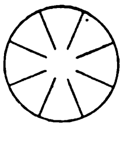

FIG. 4.

$2\frac{1}{16}$in. external diameter and $\frac{1}{32}$in. thick; they were fitted with movable water-tight lids through which thermometers were inserted. When filled with water no difference was found to exist between their respective powers to absorb or discharge heat; this

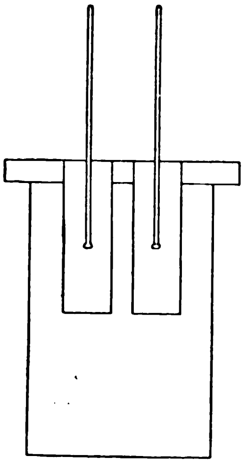

FIG. 5.

was ascertained by heating them together in steam to 212°F. and allowing them to cool either in air or water. Both the thermometers registered the same number of degrees at all points of the scale. One of the cylindrical vessels was then tried with copper ribs $5\frac{1}{2}$in. long, $\frac{3}{4}$in. wide, and 0·012 thick, soldered on

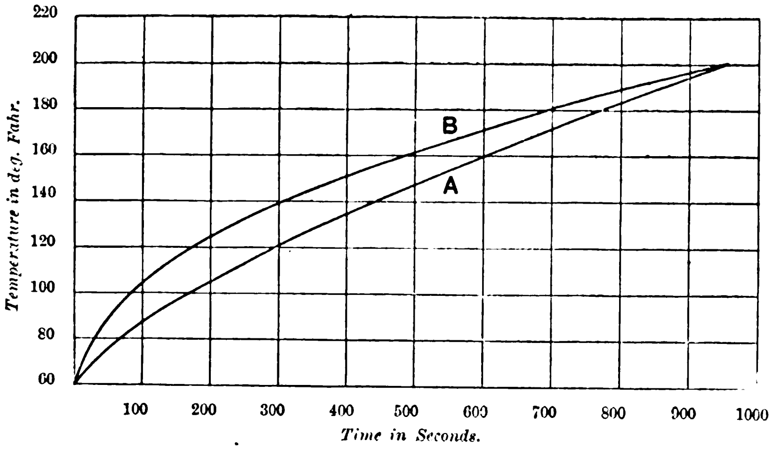

FIG. 6.—Temperature raised by contact with Steam. A, Plain Surface. B, Ribbed Surface.

longitudinally. The ribs were spaced equally and radially round the cylinder, and were tried internally and externally (*see* Figs 1 to 4) as follows: (1) Eight external ribs; (2) sixteen ribs, eight external and eight internal; (3) eight internal ribs.

* Paper read before the British Association at Ipswich, Section G.

When on together the external and internal ribs were in the same plane. The heating of the two vessels was accomplished by suspending them in a tin vessel 12in. high and 8in. in diameter (*see* Fig. 5) having two inches in depth of water kept boiling by a powerful burner. The lid of the tin vessel was a movable one of wood, to which the tops of the cylinders were attached, the thermometers protruding through.

Mode of Experiment.—The two cylinders to be compared were filled with water, and when their temperatures were equal, generally about 65°F., the wooden lid to which they were attached was placed on the vessel containing boiling water; the lid was a good fit, and the metallic surfaces at once commenced to absorb heat. The reading of the thermometers, together with the time,

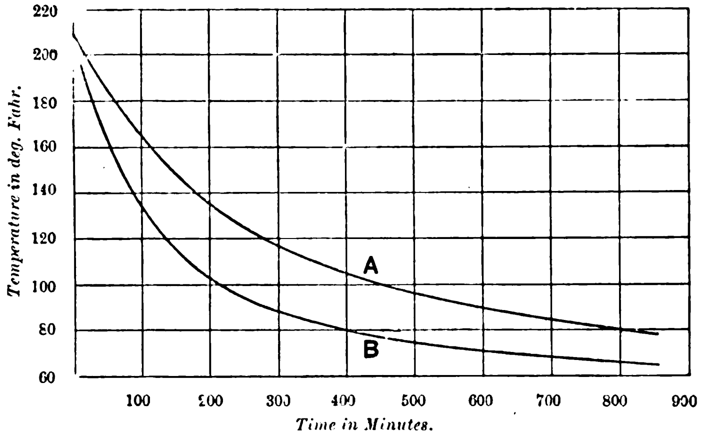

FIG. 7.—Temperature raised by contact with Air. A, Plain surface. B, Ribbed surface.

was noted simultaneously at every 10deg. of the plain cylinder; the time was taken in seconds by a ship's chronometer, and the temperature to one-fifth of a degree; the thermometers became stationary at 210°F. The lid was then, together with the cylinders, lifted off and suspended either in air or water, and allowed to cool down, the respective temperatures and the time being noted simultaneously at every 10deg. It will be understood that contact with steam, air or water always refers to the external surface of the cylinders, the internal surface being, of course, exposed to water only. The difference which arose in the conditions between some of the experiments due to the variation in the supply of heat from the burner, change in the atmosphere, temperature and cooling water, does not affect the value of the comparative nature of the experiments, as any change had the same effect on each cylinder.

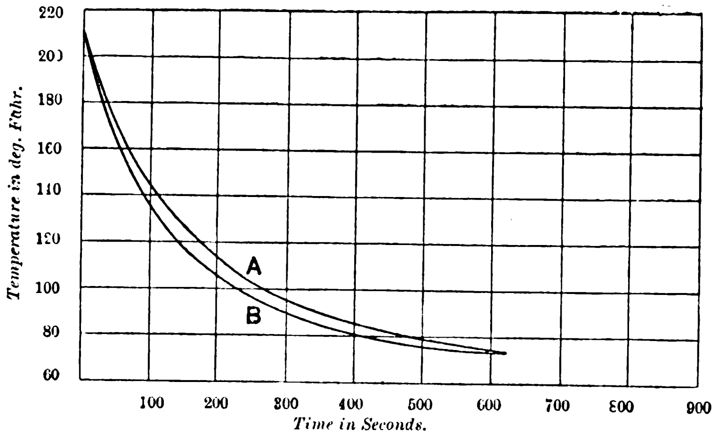

FIG. 8.—Temperature raised by contact with Water. A, Plain surface. B, Ribbed surface.

Examination of Results.—The results of the experiments are given in Tables I. to III.; they are shown plotted for the externally-ribbed cylinder in Figs. 6 to 8. It will be noticed that the difference between the temperature of the corresponding plain and ribbed cylinders increased from zero and reached a maximum after a certain time, after which they again closed to equal degrees of temperature.

The presence of the ribbed surfaces increased to a considerable extent the rapidity of transfer of heat either when absorbing heat from steam or discharging it into air. With the ribbed surface in contact with water, the speed of transfer was also increased, but not nearly to so great an extent. In the case of the externally-ribbed cylinder (Fig. 2), the greatest difference in temperature

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Table I.—*Plain Surface and Surface with External Ribs on.*

Steam.			Air.			Water.		
Plain surface. Temp. Fah.	External ribs. Temp. Fah.	Time in secs.	Plain surface. Temp. Fah.	External ribs. Temp. Fah.	Time in mins.	Plain surface. Temp. Fah.	External ribs. Temp. Fah.	Time in secs.
65	65	0	209	209	0	209	209	0
80	92	35	200	193	3	200	198	10
100	118	167	180	160	16	180	174	30
120	138	295	160	132	30	160	154	65
140	154	430	140	107	53	140	132	110
160	168	590	120	89	84	120	112	170
180	182	757	100	76	132	100	93	254
200	201	950	80	68	255	80	77	480
209	209	...	...	...	...	...	...	...

Table II.—*Plain Surface and Surface with External and Internal Ribs on.*

Steam.			Air.		
Plain surface. Temp. Fah.	External & internal ribs. Temp. Fah.	Time in seconds.	Plain surface. Temp. Fah.	External & internal ribs. Temp. Fah.	Time in minutes.
65	65	0	209	209	0
80	90	35	200	191	5
100	116	115	180	160	17
120	137	220	160	130	34
140	155	325	140	107	57
160	168	430	120	90	88
180	184	560	100	78	138
200	201	690	80	10	260

Table III.—*Plain Surface and Surface with Internal Ribs on.*

Steam.		Air.		Water.		
Plain surface. Temp. Fah.	Internal ribs. Temp. Fah.	Plain surface. Temp. Fah.	Internal ribs. Temp. Fah.	Plain surface. Temp. Fah.	Internal ribs. Temp. Fah.	Time. in seconds.
65	65	209	209	209	209	0
80	80	200	199·5	200	196	13
100	100	180	179	180	174	43
120	120·7	160	159	160	155	72
140	141	140	139	140	134	118
160	161	120	119	120	115	185
180	181	100	101	100	96	295
200	199	80	79	80	79	640
209	209					

between the corresponding plain one was 18°F., 33°F. and 8°F. respectively when in contact with steam, air and water. When exposed for 53min. in the atmosphere, the temperature of the externally-ribbed cylinder had fallen 102°F., whilst the temperature of the plain one had only fallen 69°F. The addition of the internal ribs to the external ones (Fig. 3) appeared to produce little or no effect on the result previously obtained. The temperature of the externally and internally-ribbed cylinders (Fig. 3) showed a maximum difference of 18°F. and 33°F., compared with the plain cylinder, when absorbing and discharging heat in steam and air respectively. In the case of the internally-ribbed cylinder (Fig. 4), the external ribs having been taken off, the maximum difference in temperature over the plain cylinder was 1°F., 1°F. and 6°F. in steam, air and water; their outer or external surfaces were, of course, the same in this case.

It is interesting to notice the greater effect of internal ribs in the case when the cylinder is cooled in water; the comparative slow transfer of heat when in contact with steam or air would allow the temperature of the water in the cylinder to adjust itself. When however, the transfer became comparatively rapid, the ribs became more effectual. The external ribs were more effectual in discharging heat to the atmosphere than in absorbing it from steam; this difference may be due to the condensed layer of steam which was deposited on the surface, and which retarded to some extent the transfer of heat.

The external surface was also increased by coils of copper wire $\frac{1}{16}$in. and $\frac{1}{32}$in. in diameter; with a space between the turns from a mean of nine experiments, the temperature of the coiled cylinder fell faster than the plain one, reaching a maximum difference of 6·7°F.; when, however, absorbing heat from steam, the effect was reversed, the temperature of the plain cylinder rising the fastest and reaching a maximum difference of 4·7°F. This apparent irregularity can be accounted for by the thick layer of steam which was deposited between the wire coils, and could not easily drain off. When cooled in water, the two cylinders, coiled and plain, gave the same results.

In these experiments care was taken that the colour of the respective metallic surfaces was the same.

TELEPHONIC EXPERIMENTS WITH BARE CONDUCTORS LAID ALONG THE GROUND.*

For many years bronze wire has been used by the German Postal Telegraph Administration as a conductor for telephone lines, on account of its conductivity being superior to that of the usual iron or steel wires. Besides bronze wires covered with copper, a number of German makers have also brought out numerous double-metal wires, under the names of compound wire, bi-metallic wire, double-metal wire, double-bronze wire, and patent bronze wire, &c. These wires have a core of steel or aluminium-bronze, with a high tensile strength, and are covered with copper or bronze of a high conductivity. Experiments with these wires were made in order to see if they could compare with bronze wire for telephonic purpose, both in respect to their mechanical and electrical properties. It is claimed for these compound wires that they have important properties. For example, a telephone line with a bimetallic conductor will work much more perfectly than with a conductor of a single metal such as copper. Again, it is claimed that less insulation is needed for such a conductor than for copper or any other material, and hence such wires laid on the earth without special insulation permit of telephonic communication to a much greater distance. The experiments conducted for the German Post Office by its telegraph engineers gave the following results:—

Experiments A.

Experiment 1.—Four wires of different composition and size, and about 0·5 kilometre in length, were laid as shown in Fig. 1 along a ditch 10 metres broad and 0·6 metre deep to be found on either

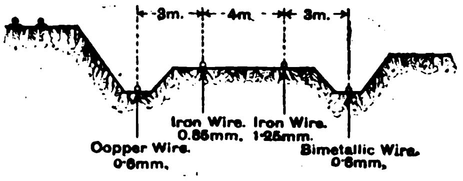

Fig. 1.

of the Grunewald railway station. Although it had rained hard the day before, the ground was only slightly moist, on account of its sandy nature, and the surface was quite dry. There was no difference in the dampness of the ditches and protecting ridge. At each end the wires were connected to a switch which was connected to a telephone, so that by revolving the switch each of the wires in Fig. 1 could be connected at will to the telephone. The other end of the telephone coils was connected to a 6mm. galvanised iron wire, which was driven half a metre into the ground, and served as an earth.

As no difference in the sound could be discovered under these circumstances, the length of the four wires was increased to one kilometre.

Again, no difference was observable even when at about 100 metres from one end. The four wires were laid in a hole 1 metre long and ½ metre deep, and covered with the damp soil dug out of the earth. The transmission was in each case very good, although there was no discernable difference between the four wires.

Tests with longer lengths were not considered necessary, but a further experiment, with part of the wires laid in water, was made.

Experiment 2.—For this purpose a bay of the "Krummen Lanke" was chosen, and about 150 meters of the double metal wire and copper wire laid in it. In this case there was no transmission at all. If the two wires were drawn taut, so that they hung above the water, the transmission was perfect. If both wires were allowed to hang, so that the bend came in contact with the water, then the sound was very feeble, although perfectly distinct, just as though the speakers were at a great distance. Again, if both wires were allowed to dip in the middle several metres into the water, it was still possible to hear that someone was speaking, although it was

* From the *Elektrotechnische Zeitschrift*

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impossible to dis inguish the words. When half the length of the wires, about 75 metres, dipped into the water, it was impossible to hear.

Earth was formed here as before, the iron wire being at one time close to the water's edge, and then further away in a raised part of the ground.

In all these experiments there was no discernable difference between the wires.

In the tests at the railway, Hughes and Morse instruments, as well as buzzers, were used, but in all cases no difference in the wires was noticed.

EXPERIMENTS B.

In order to make the experiments complete a field was chosen which allowed of from 2 to 3 kilometres of wire being laid without any obstruction. This plot of ground is disturbed by no traffic, and the soil is a damp heavy clay. On one side, a stream runs through it. At point A in Fig. 2 a wooden shed was erected; this served as one point to speak from. The earth here consisted partly of a connection to the water mains running under the Zehntstrasse, and partly of a coil of copper wire, let down through an air shaft into the overflow water pipe from the ironworks. At point B a tent was erected, and was used as the second speaking point. The earth here was a large zinc plate soldered to a copper wire and sunk in the stream called the Faulbach. Between points A and B the wire to be tested was laid serpentine fashion in a stubble field and a turnip field. The double-metal wire under examination, of 0·6mm. diameter, was exactly 2½ kilometres in length. All tests were made with this length of wire for all the different wires under examination. Between A and B was laid a direct line of insulated wire to allow of the necessary communications. The apparatus employed was that used by the Post Office for town telephones with dry cells.

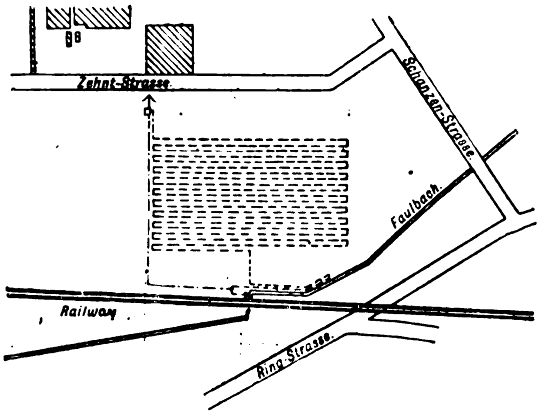

FIG. 2.— — —·—· Insulated Wire. — — — Experimental Wire.

Experiment 1.—A double-metal wire was laid between A and B. In order to keep the wires in their places on the open field, and to provide a means of connection between the wire and damp earth, a number of iron wire staples were driven over the wire and into the ground. Intelligible speech between A and B was impossible. The staples were then removed, but still the result was the same. The portable apparatus at B was then removed to 1 kilometre length of wire from A. (The lengths of 1 kilometre and 2 kilometres were marked by posts driven into the ground.) It was immediately found possible to understand everything. B was then removed to 2 kilometres from A. Here, likewise, speech was possible.

With perfect intelligibility at 1 kilometre and 2 kilometres from A, how was it that only ½ kilometre more should render it impossible to hear anything? This required examination. The last ½ kilometres of wire up to the stream was then carefully examined, when it was found that in this length one of the staples had been left. On removing it speech was possible through the whole 2½ kilometres.

It was then decided to sink a loop of the wire into the Faulbach metre by metre. The very moment the first piece touched the water the loudness of the sound decreased considerably, as if the speakers were at a great distance. Intelligibility, however, remained perfect, although the sound grew weaker as more of the wire was put into the stream, until 4 metres of the wire was in the water, when other noises arose. When 5 metres were in the water intelligible speech became impossible. It had rained hard the day and night before the experiment, so that the ground was completely soaked.

Experiment 2.—Instead of the double-metal wire of 0·6mm. diameter, 2½ kilometres of a double-bronze wire of the same size was laid between A and B, exactly in the same way as in Experiment 1. Speech was perfectly intelligible when 28 metres of the double-bronze wire was in water; numbers spoken could still be understood. When more than 28 metres was in the strength, speech was no longer intelligible.

Experiment 3.—Between A and B was laid 2½ kilometres of pure copper wire of 0·45mm. diameter. Intelligibility was first rate, and the loudness apparently still better than in Experiments 1 and 2. When 50 metres of the wire were laid in water numbers counted could still be heard. The same observation was made in experiments 2 and 3 as in No. 1—namely, that the moment the wire touched the water the loudness diminished considerably. Also, the loudness decreased gradually as more wire was laid in the water.

In Experiments 2 and 3 the weather was continuously rainy, and during the test with the double-bronze wire it poured. In spite of this, intelligibility remained good.

The resistance of the wires employed in Experiments 1, 2 and 3 was about the same in all cases, namely:—

1. 2½ kilometre double-metal wire of 0·6mm. diameter, 270 Siemens units.
2. 2½ kilometre double-bronze wire of 0·6mm. diameter, 261·25 Siemens units.
3. 2½ kilometre copper wire of 0·45mm. diameter, 280 Siemens units.

It was now decided to make tests with wires of much smaller resistance, and two wires used by the Post Office for telephonic purposes were chosen—a copper wire, 4mm. in diameter, and a galvanised iron wire, 3mm. in diameter (a bronze wire 4mm. diameter was not available). The resistances of these wires were as follows:—

4. 2½ kilometre copper wire of 4mm. diameter, 3·75 Siemens units.
5. 2½ kilometre galvanised iron wire, 3mm. diameter, 45 Siemens units.

Experiment 4.—The 2½ kilometre of 4mm. copper wire was connected up between points A and B. There was perfect intelligibility, but the loudness of the sound was much less than in Experiments 1 to 3. When 50 metres of the wire were in water only the faintest sound of the numbers spoken into the telephone was audible.

Experiment 5.—The 2½ kilometre of the galvanised 3mm. iron wire was connected up between A and B. Speech was perfectly intelligible, and the loudness a little better than in Experiment 4, but undoubtedly less than in Experiment 1 and 2. When 5 metres of the wire were in water the result was the same as in Experiment 4.

In Experiments 4 and 5 the weather was fine, but the ground was soaked with rain.

It was only to be expected that the heavy wires would, when lying on the damp earth, give a worse result than the lighter wires, although they would have a better conductivity. This is accounted for by their sinking into the ground, and so presenting opportunities for earth leakage.

In order to test this another experiment was made with a light galvanised 0·2mm. iron wire. The resistance of 2½ kilometres of this was 11,925 Siemens units. This resistance was, therefore, about 44 times that used in Experiments 1 to 3, about 3,180 times that used in Experiment 4, and 265 times that used in Experiment 5.

Experiment 6.—The 2½ kilometre of galvanised 0·2mm. iron wire was connected up between points A and B. The results were very good, and without doubt as good as in Experiments 1 to 3. When 50 metres of wire were in water one could just make out the numbers counted.

In all the tests secondary disturbances occurred from time to time when the wires were in the water. This was found to be due to the acid and chemicals in the water coming from the iron works, which acted upon the wires. Experiment 1, with the double-metal wire, being repeated when the works were stopped, showed that when 50 metres were in water one could still catch the numbers counted. There can be no doubt that if Experiment 2, with the double-bronze wire had been repeated, a similar result would have been obtained.

The results obtained do not show that the double-metal wires are any more valuable than the pure copper wire, but that the distance to which telephonic transmission by bare wires laid upon the earth is possible depends mainly upon the size and weight of the wires, presuming all the conditions are similar.

AN ELECTRIC MINING PLANT.*

BY T. W. SPRAGUE.

A few miles from Pittsburg, at a station on the P. C. and Y. Railway called Hazeltine, is the largest electric power plant for coal mining purposes in the United States, and one of the largest in the world. It is installed to operate No. 2 and No. 3 mines of the Essen Coal Company.

* Abstract from the *Engineering and Mining Journal* of New York.

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Mr. Dysart, the general manager, made a thorough investigation of coal mining machinery plants, and came to the conclusion that where trouble developed with such plants it was nearly always traceable to insufficient power. Accordingly it was decided in laying out this plant to allow an ample margin of initial power.

The power house itself is excellent in material and construction, and in its general design and arrangement. It is a building 130ft. long by 56ft. wide, steel frame with corrugated iron covering. It is set on a 15in. brick foundation, and the ceiling of the dynamo and engine room is sheathed to prevent trouble from the moisture of condensation. The west end of the building contains four Russell tubular boilers, each 60in. in diameter and 18ft. long, and containing 64 tubes 3½in. in diameter. The four are set with full flush fronts, in batteries of two each, but each boiler has its independent firebox and smoke stack, the latter 60ft. high and 32in. in diameter. Each boiler has its independent feed pipe, there being one feed pump for each battery, as well as an injector for each. The injector piping is so arranged that any boiler may be fed by either injector. The injectors are of the "World" type, and the feed pumps are the Hall duplex, 8in. × 5in. × 10in. each. One Cochrane feed-water heater is installed, sufficient in size to supply all four boilers simultaneously. The boiler room extends along nearly 50ft. of the length of the building, occupying the full width. The boilers are set with sufficient space in front for a coal storage supply, coal being thrown in directly from cars on a spur track running parallel with, and close to, the building, and leaving a wide space behind them for the feed pumps, feed-water heater, &c., which are reached through a passageway between the two batteries. In the space behind the boilers is also a pump furnished by the Hall Steam Pump Company for deep well work. The water supply, or a part of it, at present, comes from these wells, one 129ft. deep, one 160ft., and one 180ft. The water is raised on the compressed air system, the pump or compressor being a tandem machine with an 8in. stroke. The water is pumped into two boilers, 3ft. × 22ft., which are used as supply tanks, being placed about 16ft. above the feed pumps. They also serve as settling tanks, and give sufficient head to fill the boilers when no steam is available.

The engine room, which occupies the central portion of the building through its full width, is 63ft. long. It contains three automatic Corliss engines, with cylinders 17in. × 24in., running at a speed of 153 revolutions per minute. They are set on brick foundations, and have 10ft. flywheels. With the steam pressure usually carried, 90lb. to 100lb., these engines will develop something over 200 H.P. each. They drive three 150-kilowatt bi-polar generators of the "Independent" mining type, wound for 275 volts, and running at 510 revolutions per minute. These 200 H.P. generators are probably the largest bi-polar machines in use to-day. They are compound-wound, and provided with self-oiling bearings, ventilated armatures and other improvements. Space is left for a fourth unit of the same size, which may be added when the work is further extended underground. The engines are set at 30ft. centres from the generators, and 18in. double endless belts are used.

The station instruments are mounted on a marble switchboard, furnished by the Link Belt Machinery Company, which Company took the contract for the entire plant, delivered and erected. The switchboard carries two Westinghouse circuit breakers, three Weston round-pattern ammeters, one voltmeter of the same make, together with the field rheostats and usual switches. Wurts's lightning arresters are placed in each of the two mains leading to the two mines, and also at the bank mouths. One set of arresters is also placed on the long stretch of feeders between the power house and No. 2 mine. The trolley line running outside between the two mines is independently controlled by a single-pole switch in the power house. This stretch is comparatively little used, and is normally "dead."

The remainder of the power-house building is divided into three rooms, a blacksmith and machine shop, a locomotive house and a store room, containing a lathe and some other power tools. The locomotive room is large enough to hold on its two spur tracks the two 80 H.P. locomotives now in use. It is provided with pits for getting at the under parts of the machines and an overhead crane for lifting heavy parts.

The electric power generated is used at present for coal under cutting, haulage and lighting. The plant was started in June and is not yet in complete operation. It is intended to run 16 under cutters, all of the "Independent" chain type; two 80 H.P. locomotives, one in each mine, for the main haulage work (mules being employed to do the gathering), and to light the tipples, power house and underground workings as may be necessary.

The coal cutter is driven by a 20 H.P. "Independent" motor wound for 220 to 250 volts, having but one field coil. The machine is 2ft. high, 2ft. 4in. wide, and 10ft. 5in. long when closed. It cuts to a depth of 5ft., making the cut 3ft. 6in. wide and 3½in. high. The frames of the machine are made of wrought iron and steel. The chain is cast steel, as are the sockets and socket pieces. The straps are drop forged and machinery steel pins are used for putting chain together. Cast iron is not used in any part subject to strain. The motor is well protected, except that its commutator and brushes are exposed. This is claimed to be an advantage, but would seem to increase the risk of damage by mechanical injury to a rather sensitive part of the machine. The control of the machine is easily accomplished by the movement of a lever through 180deg. By this means the cutter may be fed forward, stopped feeding, or reversed without stopping the motor. Another good feature is an automatic stop on the withdrawal. Trucks are provided for transporting the machine from room to room.

The section through the vein in which these machines are working shows a little over 5ft. of practically clean coal underlaid by limestone and capped by 10in. of draw slate. On top of this again is 24in. of coal, capped by 22in. more of slate. The cutters are at present working in the bottom of the seam, and the 24in. of coal above the first layer of draw slate forms the roof. This has fallen down or been taken down on a large part of the main haulage ways, but is kept for the roof otherwise.

The power house is located near the bank mouth of No. 3 mine, about 1,400ft. north-west from the bank mouth of No. 2 mine. Later on another opening situated beyond No. 3 will very probably be equipped electrically, hence the placing of the power house in what will be a central location as the work progresses.

The locomotives, 42in. gauge, are single-motor, four-wheeled machines of the "Independent" type. They run under load at about eight miles per hour, exerting nearly 4,000lb. draw-bar pull, and are each capable of hauling 1,200 tons run-of-mine coal per day of 9 hours from the gathering points to the bottom of the slopes in their respective mines. These distances are, in No. 2 mine, 2,000ft., and in No. 3, 3,300ft. The ultimate length of the main haul by the electric locomotive in No. 2 will be 5,300ft., and 8,500ft. in No. 3.

In both mines mules will be employed for the present in gathering trips and distributing empties, and the locomotives deliver the loaded trips at the bottoms of inclines, from which a drum hoist and cable brings them to the tipples. This elevation of the coal is necessary to obtain proper tipple facilities above the level of the railroad, the seam lying some distance below this level.

The coal cutters are evenly divided between No. 2 and No. 3 mines, there being eight in each. In No. 2 mine their average distance from the bank mouth is 2,000ft., making the distance from the power house to the machines 3,400ft. In No. 3 mine the distance to centre of machine distribution is over 4,000ft. At the present time in No. 3 mine seven cutters are at work, four of which run 10 hours per day, the remaining three working double shift. In No. 2 mine, two cutters are running 10 hours per day, two, 15 hours, and a fifth, 20 hours.

The trolley wire is everywhere No. 00 wire, held by special "Independent" mine insulators. The feed wire for coal-cutting machinery is principally No. 0000, while some of the side entry and all the room wiring is No. 3, all bare copper. In No. 2 mine there is installed 14,500ft. of No. 0000, 4,000ft. of No. 00, 1,000ft. of No. 1, 36,400ft. of No. 3, and 2,156 of No. 8 (tie wire), all bare copper wire, while No. 3 mine contains 14,360ft. No. 0000, 8,850ft. No. 00, 500ft. No. 1, 36,000ft. No. 3, and 2,500ft. No. 8, all bare copper. The only insulated wire used is in the leads to and from the switchboard and about the tipples and station, where lights are used. A ground return is used throughout, the coal cutters being operated on the grounded circuit. The rails are all 40lb. per yard, with fish-plates heavily bonded and cross-bonded at suitable intervals. The return is reinforced from the bank mouths to the power house by three No. 0000 aerial wires from each.

The lighting of this plant is an especial feature. In each tipple and at all switches, &c., in the mine where a light is advisable, the special "Independent" mining arc light has been placed.

In and about the power house, shops, &c., 50 incandescent lamps of 16 c.p. each furnish illumination, run three in series. The locomotives are furnished with arc headlights with powerful reflectors.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *September 28, 1895.*

Electricity on Steam Railways.—During the past few weeks a number of tests of the electric locomotive now in use on the Baltimore tunnel road have been made, all of which have resulted very successfully. Much interest has been taken by steam railway men in the results reached at Baltimore and on the Nantasket road, and this has probably been the origin of several recent announcements concerning the introduction of electric power on steam roads. The Illinois Central Railway proposes to use electric locomotives on its terminal lines and

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short branches, and eventually for passenger traffic on all of its interurban lines in the vicinity of Chicago.

Phase Transformers.—At the September meeting of the American Institute of Electrical Engineers, on Wednesday, Mr. Charles S. Bradley read a Paper on "Phasing Transformers" for obtaining two and three-phased currents from a single alternating current. The principle consists in the employment of capacities and inductances, the idea having been reduced to a very practical shape. The parts of the apparatus consist of a condenser and of a transformer having two distinct primary windings. One of these windings is as in the usual transformer, one end being connected with the source of current, and the other leading to the middle of the second or compound transformer winding; one end of the compound winding is connected to line and the other to a condenser, the other terminal of the latter being connected to line. This disposition produces a difference of phase between the split currents flowing in the two primaries of the transformer, and the secondaries are so arranged as to produce three-phased currents by a method which seems to be the same as that devised by Mr. Scott. Mr. Bradley favours the use of three-phase motors with his transformers, for the reason that he thinks that type of induction motor gives better results than the two-phase type. He states that a condenser such as he has designed for use with his phase transformers occupies a space of a cube of 4in. on each side for a ½ H.P. motor, and will stand 3,000 volts. Mr. Bradley also described a three-phase motor of his design, which was employed in the lecture room to illustrate his Paper. The armature consists of practically two armatures end to end upon the same shaft, one having a low resistance winding and the other a comparatively high resistance; the field is placed over the high resistance for starting, and is shifted by means of a lever over the low resistance when the motor has nearly attained speed. In the discussion of the Paper Dr. Duncan pointed out that with such an arrangement the difference of phase at light load would be very small, which Mr. Bradley said was true. Dr. Hutchinson thought that the principle of the transformer, as far as transforming two and three phases was concerned, was identical in principle with the arrangement of Mr. Scott.

CORRESPONDENCE.

MAGNETIC UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the recent correspondence on the subject of magnetic units few practical engineers were found to favour any alteration or addition to the accepted system of electric and magnetic units. Whilst agreeing that those who are daily engaged in practical calculations do not feel any supreme need for new units or names, may I express my belief in the ultimate and perhaps not far distant victory of Mr. Heaviside's "radical cure"? In a letter published in *Nature*, July 28, 1892, Mr. Heaviside advocated two reforms—viz., (1) the elimination of 4π from all cases which have no immediate reference to circles or spheres, and (2) the use of a single multiplier, such as 10^8, in passing from absolute to practical units. While the second of these appears to me of doubtful advantage in our present practical state (since it involves the alteration of the watt), the case of the first stands on a different footing; it is not a question of mere convenience, but of whether its adoption leads to truer views and a greater logical simplicity. If it does, should we not be confident that our successors will reap the reward of our self-denying efforts in the more rapid advancement of our science? Probably few will dispute that on scientific and logical grounds Mr. Heaviside has entirely the best of the argument; in fact, nothing requires to be added to the reasons adduced by the author in favour of his scheme. As a practical measure, however, there are two grounds on which at present it is rejected.

In the first place, how are we to know that in a few years the whole system of units will not again have to be cast into the melting pot and further refined? To this there can be no categorical answer; the question of sufficient finality must be left for decision to our best thinkers, who have the clearest insight into the future course of electrical science.

The second objection is the great difficulty of altering the volt, ampere and ohm as the legalised basis of a most important industry. It is this objection which seems to require fuller discussion, and to admit of an a swer, for is it not the case that we are apt to overrate the difficulty of the change? Of course, the starting point must be international agreement; but, this secured, how would the reform work itself out? The rational system could at once form the basis of every new text-book, and be assimilated by the students of our technical institutes. It would then spread to the instrument factory; ammeters and voltmeters calibrated in the new units would be in request for laboratories, and thence would gradually spread to central stations and workshops. Lastly, it would reach the "final consumer" in the shape of the engineer buying a dynamo or motor, or the householder replenishing his stock of lamps. In the transition stage glow lamps can easily be marked with both the old and new voltage. Probably the majority of purchasers of dynamos and motors gauge them by their horse-power of input or output, or by their capacity in number of lights, seldom by their volts and amperes; and if the second reform of Mr. Heaviside be vetoed, the old and new watt or the rated output of any machine in kilowatts remain unchanged. Parliamentary sanction would in the end complete the change, and the old system of units would be relegated to the limbo of dogmas and superstitions which we have outgrown. Is, then, the reform of such an heroic nature that we need abandon it as an Utopian dream, less likely to be realised than even the overthrow of the yard, gallon and pound?—Yours, &c.,

October 1, 1895. C. C. HAWKINS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In connection with the recent discussion in *The Electrician* on magnetic units, the following may be of some little interest.

If m and m', q and q' be point charges of magnetism and electricity respectively, and μ and k the magnetic and electric constants of the medium, the forces between the charges when at distances r apart are

$$F = \frac{1}{\mu} \cdot \frac{m m'}{r^2}, \qquad F = \frac{1}{k} \cdot \frac{q q'}{r^2}.$$

In these equations, μ and k are undirected or scalar quantities if the medium is isotropic; the products $m m'$ and $q q'$ are also scalar, whatever the nature of m and q may be, and r^2 is scalar. The right-hand member of each equation is, therefore, a *scalar*; but the left-hand member is a *vector*, since F is directed. We thus see that the right-hand member is incomplete as it stands, since it fails to specify or to indicate the directional nature of the vector on the left.

This incompleteness would seem to arise from the fact that 4π, the surface of unit sphere, is omitted on the right. Thus, proceeding according to Mr. Heaviside, if H and E be the intensities of the fields produced by m and q at a distance r from either charge, we have

$$H = \frac{1}{\mu} \cdot \frac{m}{4\pi r^2}, \qquad E = \frac{1}{k} \cdot \frac{q}{4\pi r^2}.$$

The right-hand members of these equations correctly specify the nature of the vectors H and E on the left. They are vectors of the "flux" type, the field due to m or q at any point distant r away being normal to the element of the surface $4\pi r^2$ taken at that point, and estimated with respect to it. In other words, every element of the surface $4\pi r^2$ which appears on the right is directed along the radius from the centre, and it is the presence of this factor in the relation that endows it with its true directional character.

Since the mechanical forces experienced by m' and q' when placed in fields of intensities H and E are m' H and q' E respectively, we get for the fundamental equations

$$F = \frac{1}{\mu} \cdot \frac{m m'}{4\pi r^2}, \qquad F = \frac{1}{k} \cdot \frac{q q'}{4\pi r^2},$$

equations which are now *directionally* true.

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This, in addition to other considerations, would seem to point to the superior consistency and rationality of the system of units proposed by Mr. Heaviside.—Yours, &c.,

W. Williams.

Royal College of Science, London, Oct. 7, 1895.

"INERT" IRON.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have to record an experience which occurred here to-day, and it may prove of service to others if published. All the arrangements of my installation are autom tic, and no failure has been observed during the past eight years—*i.e.*, since the start of this method.

To-day the engine driver could not commence charging, the cut-outs "went off" with great violence. I made a careful examination all round, and nothing wrong could be discovered. The manner in which the cut-outs "went" indicated a "reversal." I therefore tested the dynamo, which was to be used, more closely, and found the iron of the magnets *absolutely* inert; hence no E.M.F. could be produced when set in motion. Such an occurrence is very remarkable, the iron, very soft, weighing probably over one ton. This dynamo is one of Crompton's, and was started January, 1886. It is a beautiful machine, having done good work, and showing no sign of wear. Of course, the iron was soon magnetised by turning on the accumulators when the brushes were raised. Whether magnetic earth storms were the cause of the trouble or not, it would be interesting to know; but as such a failure is always possible, though rare, with efficient dynamos, I would suggest a simple remedy. A flat plate of hard steel placed at the side of the iron core would be an effectual cure, and not alter the virtues of the apparatus.—Yours, &c., David Salomons.

[If the machine be shunt wound it is possible the "inert" iron effect was due to starting on such a low resistance that the shunt-coil was practically short-circuited. At any rate we prefer this hypothesis to that of "magnetic earth storms."—Ed. *E.*]

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s.

The Edition for 1896 is in active preparation, and orders for Advertisements and Subscriptions can now be sent in.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "The Electrician" Series can be obtained of the Booksellers or direct from the Publishing Offices:—

Laboratory Notes and Forms.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett *(now ready)*. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"The Work of Hertz."—By Dr. O. J. Lodge, with many original illustrations, price 2s. 6d. nett, is now ready.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A Large-Sheet Table, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s.—each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

A Sheet Table showing Total Capital Outlay and Receipts and Expenditure for the year 1894 of the Statutory Electric Supply Undertakings of the Metropolis is now ready, printed on thick paper, price 6d.

A Sheet Table giving similar particulars in relation to Provincial Statutory Electric Supply Undertakings is now ready, printed on thick paper, price 6d.

Tenders Invited.—Tenders are being invited by the Postmaster-General for (*a*) the supply of red fir telegraph poles, and (*b*) for creosoting the poles with 10lb. or 12lb. of creosote to the cubic foot. Forms of tenders may be obtained on application to Charles E. Stuart, Controller of Stores, General Post Office, E.C., and tenders must be in by noon on Monday, the 28th inst. Further particulars appear in our advertisement columns.

——— Tenders for the supply of a quantity of telegraph cable and copper wire, in two lots, are being invited by the Direction-Générale des Chemins de Fer, Postes et des Telegraphes, Brussels. Tenders by the 16th instant.

——— Tenders are required for the wiring of the Waverley Market, Edinburgh. Tenders to Mr. Thomas Hunter, W.S., Town Clerk, City-chambers, Edinburgh, by tomorrow, Saturday.

——— The Director of Public Works, Madrid, invites tenders for the concession for the construction and working of a tramway from Madrid to Colmevar Viejo, Chamartin and Rosa. Tenders by the 15th prox. to the Direccion General de Obras Publicas, Madrid.

——— The Municipal Authorities of Loria are inviting tenders for a 20-years concession for the electric lighting of the public streets. Tenders to be sent to the Ayuntamiento de Loria, Spain, by the 15th inst.

——— The Dutch Colonial Minister requires tenders for the supply of cast and rolled iron, iron and steel wire, white sheets, zinc, tools, &c. Tenders to the Ministry for the Colonies, The Hague, by the 16th instant.

——— Tenders are required for the installation of the electric light at the Poor Law Offices, Mawdsley-street, Bolton. Tenders must be sent in to the clerk (Mr. Simpson Cooper) not later than 12 o'clock on Tuesday next, the 15th inst.

——— The Saltash Town Council invite tenders for lighting the district by electricity, gas, or otherwise, from the 4th January next. Particulars of the Chairman of the Works Committee, Mr. W. Alford, 3, Springfield-terrace, Saltash, to whom tenders should be sent not later than Saturday, the 25th inst.

Tenders Accepted.—The Farnworth and Kearsley Co-operative Society have accepted the tender of Mr. R. S. Blackburn, of Hebden Bridge, for putting their central premises in Market-street, Farnworth, in telephonic communication with their outlying branches.

——— We learn that the tender of Messrs. B. Verity and Sons, of London and Manchester, has been accepted by the Blackpool Town Council for the wiring, &c., of the Town Hall.

——— The Sunderland Town Council have accepted the tender of the Electric Construction Company (Limited) for the supply of transformers for their electricity works.

——— The South Molton Shirt and Collar Manufacturing Company (Limited) have received twenty tenders for supplying generating plant, wiring their premises for the electric light, &c. The figures varied from £715 to £198, and the tender of Messrs. Newton and Hawkins, of Taunton, which amounted to £282, has been accepted.

——— The Oswestry Town Council have accepted the tender of Mr. Reakes, Shrewsbury, for wiring the Cross Market for the electric light for the sum of £62.

——— The Asylums Committee of the Portsmouth Town Council have accepted the tender of Mr. J. Southey, of King's-road, Southsea, for wiring the building for the electric light.

Tenders Received.—The Bedford Urban Sanitary Authority have received the following tenders for the supply and delivery of 200 cast-iron lamp columns, carriers, and globes:—

	Cast-iron Tops.			Sheet-copper Tops.		
Bradley, W., Brighouse (*accepted*)	£449	0	0	£519	0	0
Mackenzie Bros., Edinburgh	—			1,350	0	0
Smith (Geo.) and Co., Glasgow	1,050	0	0	1,050	0	0
Hart, Son, Peard and Co., Birmingham	960	0	0	—		
Goddard, Massey and Warner, Nottingham	850	0	0	910	0	0
Ashmore, Benson, Pease and Co., Stockton	—			739	0	0
Lloyd's Works, Abercarn	—			563	6	8
Macfarlane and Co., Glasgow	811	13	4	830	0	0
Pontifex and Co., London	700	0	0	950	0	0
Kilpin and Billson, Bedford	653	0	0	765	0	0
Newton, Chambers and Co., Sheffield	650	0	0	800	0	0
Sharpe and Co., Lancaster	632	0	0	782	0	0
Cochrane and Co., Dudley	—			650	0	0
Ulverston Shutter and Lift Co., Ulverston	625	0	0	—		
Alloa Iron Company, Alloa	620	0	0	715	0	0
Phœnix Foundry Company, Derby	579	0	0	—		
Hollam and Co., London	540	0	0	660	0	0

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TENDERS RECEIVED.—The following tenders have been received for the installation of the electric light at the New Theatre, Cambridge :—

Rashleigh, Phipps and Co., London	£893
Strode and Co., London	555
Crampton (W. J.) and Co., Cambridge	479
Wenham and Waters, London	449
Baily, Grundy and Barrett, Cambridge	330

SALE BY AUCTION.—From our advertisement columns this week it will be seen that Messrs. Wheatley Kirk, Price and Goulty, in compliance with instructions from Mr. D. Ellis, the receiver and manager in the liquidation of Poole and White (Limited), will sell by public auction at an early date that Company's electrical engineering works, together with the valuable and modern fixed and loose plant, &c. Plans and particulars can shortly be obtained gratis from Messrs. Steavenson and Couldwell, 93, Gracechurch-street, E.C., or from the auctioneers, 49, Queen Victoria-street, London, E.C., and Albert-chambers, Albert-square, Manchester.

PLANT FOR SALE.—Particulars are given in our advertisement columns of some plant which Messrs. Henry Lea and Thornbery, 38, Bennett's-hill, Birmingham, have for sale. The plant includes four gas engines, three Elwell-Parker dynamos, switchboard and instruments, shafting, pulleys, leather belting, &c.

——— Our advertisement columns contain particulars of some plant for which the Brighton Grand Hotel Company invite tenders. The plant includes three boilers, one 25-kilowatt "Oerlikon" dynamo, one 13-kilowatt "Victoria" dynamo, a battery of accumulators, switchboards, instruments, &c.

APPOINTMENT.—The Hull Town Council have appointed Mr. A. S. Barnard electrical engineer at their electricity works. The salary is £250 per annum. Mr. Barnard has been in the service of the Lancaster Corporation as borough electrical engineer since 1893.

APPOINTMENT VACANT.—At their meeting on the 29th inst. the Dundalk Town Commissioners notify that they will appoint an electrical engineer for the purpose of reporting on the electric lighting question.

REMOVALS.—The Epstein Accumulator Company (Limited) inform us that owing to the great increase in their business they have been compelled to remove their head offices to more commodious premises at Victoria Mansions, 28, Victoria-street, Westminster, S.W., where all communications should in future be addressed.

——— MM. E. H. Cadiot et Cie., electrical engineers and agents, inform us that they have removed their offices to 12, Rue St. Georges, Paris, where future correspondence should be addressed.

——— M. Lucien Espir notifies that, owing to increase of business, he has been compelled to remove his offices and show rooms to 11 bis, Rue de Maubeuge, Paris.

DISSOLUTIONS OF PARTNERSHIP.—Messrs. C. H. Smeeton and H. Page, hitherto carrying on business as electrical engineers, under the style of Smeeton and Page, at 63, Queen Victoria-street, London, E.C., have dissolved partnership.

——— The partnership business of electrical engineers hitherto carried on by Messrs. F. Woolstone and W. Nottingham, under the style of Woolstone and Nottingham, Leeds, has been dissolved.

——— Notice is given that the partnership business of engineers and merchants hitherto carried on under the style of Bagshawe Bros. and Co., at Upper Thames-street, London, E.C., and at Paris, has been dissolved. Messrs. W. H. W. Bagshawe, of London, and A. Bagshawe, of Paris, retire.

BANKRUPTCIES.—The adjourned meeting of creditors under the failure of Ronald A. Scott (Limited), lately carrying on business as electrical engineers at Acton Hill, W., was held at the offices of the Official Receiver for the Brentford district, Temple-avenue, E.C., under the presidency of the Senior Official Receiver (Mr. Cecil Mercer), yesterday. The statement of affairs as regards creditors showed gross liabilities amounting to £5,967. 10s. 4d., of which £927. 8s. 8d. was due to unsecured creditors. The assets, consisting of stock-in-trade, machinery, &c., were estimated to produce £1,000. The statement of affairs as regards contributories showed total liabilities, which are expected to rank for dividend, amounting to £5,934. 8s. 8d., and assets *nil*. The Official Receiver reported that the winding-up order was made on July 30 last, and a statement of affairs has been submitted by Mr. Ronald A. Scott, the late manager of the Company. The Company was formed in June, 1894, to purchase the business, goodwill, &c., of Ronald A. Scott, of Acton Hill, W., and to carry on the business of electricians, engineers, electrical engineers, and general contractors. The nominal capital was £10,000, in 10,000 £1 shares. No allotment took place, except the £1 paid by each of the seven signatories to the Memorandum and Articles of Association. No other shares were issued to the public, and Mr. Scott was practically the Company. As the consideration for the sale of the business £5,000 fully paid-up debentures were allotted, to Mr. Scott and he subsequently transferred these debentures to certain creditors. On December 6th last, on the application of the debenture-holders, Mr. P. T. Travers, of Ryder-street, S.W., was appointed receiver, and he carried on the business until May last, since which time the business has been practically closed. The cause of failure is attributed to want of capital. Assuming that the validity of the debentures cannot be impeached, the value of the business and other assets is of no practical interest to the creditors, as there will not be sufficient to pay the debenture-holders. Mr. Scott was questioned with regard to certain French patents, and he stated that these patents had been worked by a Mr. Starkey on royalty. He could not remember the terms of the agreement, but he thought Mr. Starkey had power to return the machines, and give up the work at any time. He also thought the debenture-holders had a prior claim over those patents, as they were included amongst the assets of the Company when it was formed. The debtor further referred to his advertising patent, and said that owing to the outcry raised against throwing advertisements on Nelson's column and the National Gallery, Trafalgar-square, he was compelled to give up experimenting under the patent. Eventually the estate was left in the hands of the Official Receiver. A list of the creditors under this failure has been published, and we give below the principal of these :

	£	s.	d.
Wells Bros. (Sandiacre)	£145	0	0
Wilkes, Sons and Mapplebeck (Birmingham)	78	0	4
Nitsche and Gunther (London)	68	8	0
Pattison and Co. (Leicester)	42	0	0
Highton and Co. (London)	38	0	4
Schultz and Co. (London)	36	5	3
W. T. Glover and Co. (Salford)	35	0	0
Williams, Foster and Co. (London)	23	10	6
Sankey and Sons (Bilston)	23	6	7
Spencer and Sons (Newcastle)	21	13	6
Irvine and Sellars (Preston)	20	6	6
Colver Bros. (Sheffield)	17	19	5
Mosses and Mitchell (London)	16	9	2
C. Atkins and Nisbet (London)	15	8	5

BANKRUPTCIES.—The statutory meeting of creditors under the bankruptcy of D. J. Whatmough, lately carrying on business as an electrical engineer at the Market Place, Oldham, under the styles of D. J. Whatmough, and J. and P. Dyer, and formerly as W. Mason, took place at the offices of the Official Receiver, Oldham, on the 3rd inst. The district Official Receiver presided, and after some discussion Mr. J. Jones, accountant (Messrs. Mountain, Jones and Co.), Manchester, was appointed to act as trustee, with a committee of inspection.

——— The adjourned public examination of Mr. E. H. Berry, formerly carrying on business as an electrical engineer and contractor at Burnley, took place at the Burnley Bankruptcy Court on the 3rd instant. Mr. Price, who appeared for the trustee, pointed out that the examination had been adjourned once or twice in order that the debtor might furnish an amended statement of accounts, but he had only furnished one similar to the other, except he had put in an item for travelling expenses amounting to £240. The statement was not verified by affidavit, and Mr. Price stated that he found the debtor had omitted various items. He therefore asked that the debtor's examination be adjourned. The bankrupt, in reply, said that he had not understood how the account should be made out, and that he was being misrepresented. Since the first occasion he had taken some trouble to make the account out, but he might have forgotten some items. The examination was adjourned *sine die*.

LIQUIDATIONS.—A petition has been presented by Messrs. C. A. Parsons and Co., of Newcastle and Leeds, for the winding up of the British Steam Generator and Refuse Utilisation Company (Limited), and will be heard on the 30th inst. at the Royal Courts of Justice, Strand, London, W.C. Messrs. Wrensted and Sharp, of Ormond House, Great Trinity-lane, London, E.C. (agents for Messrs. Robinson, Scott and Holmes, of Bradford), are solicitors for the petitioners.

——— At a meeting of the proprietors of the Railway Automatic Electric Syndicate (Limited) on the 19th ult., it was resolved to wind up the Company voluntarily. Mr. John M. Tourtel, of the Depôt, Mill Hill Park Station, Acton, Middlesex, was appointed liquidator.

——— At a meeting on the 25th ult. it was decided that Baird, Thompson and Co. (Limited), heating and ventilating engineers, Charlton Works, Charlton Place, London, N., and Glasgow, be wound up voluntarily. Mr. J. Coop, of the firm of Davies, Tait and Co., 46, Queen Victoria-street, E.C., was appointed liquidator.

——— At a meeting on the 26th ult. it was resolved to wind up voluntarily Hargreaves and Shaw (Limited), electrical and mechanical engineers, Atlas Works, Ashton-under-Lyne. Mr. J. C. Atkins, C.A., Oldham, was appointed liquidator.

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ELECTRIC LIGHTING SCHEMES INVITED.—The Battersea Vestry offer premiums of £50, £30 and £15 for the best three schemes, reports, designs and estimates for a system of electric lighting for the parish of Battersea. Schemes must be delivered to Mr. W. Marcus Wilkins, the Vestry Clerk, before 12 o'clock (noon) on Thursday, December 12th next. Further particulars are given in our advertisement columns.

ELECTRIC HAIR CURLERS.—Miss Elizabeth L. Banks writes to the *Daily News*, *apropos* of the "Iona" disaster, calling attention to the danger of the ordinary hair curler when used on board ship, and suggesting that liners should be fitted with electric hair curlers.

AGENCY.—Mr. F. W. Ostermann, of 27, Leadenhall-street, E.C., has been appointed sole British agent for the Boeddinghaus double-spiralled plug. A description of this screw plug appeared in our issue of July 26th last.

ELECTROTHERM.—We have received of Messrs. Witty and Wyatt (Limited) their small catalogue of an electric heating and warming pad, which goes by the name of "Electrotherm." It consists of a flexible sheet or pad composed of asbestos, with embedded wires, which, when connected by a length of flexible wire and a socket, to an electric light circuit, develops a uniform and constant temperature. There is in the catalogue a list of ailments from which the electrotherm is designed to afford relief; and, in the event of the purchaser or his friends not suffering from any one or more of these, the instrument may be used as a convenient foot-warmer. Messrs. Witty and Wyatt are the sole European and colonial agents of the H. W. Johns' Manufacturing Company, of New York.

ELECTRIC CONSTRUCTION COMPANY (LIMITED).—We have just received a copy of the new catalogue of standard size continuous current dynamos issued by this Company. The tables in this publication state the output, speed, price, &c., of the machines, for various standard voltages, ranging from 50 to 135 volts. There are also a list of prices for accessories, and a table of the dimensions of the standard machines.

CATALOGUES.—The United Asbestos Company (Limited), Dock House, Billiter-street, E.C., forward us a copy of their new illustrated catalogue. Particulars are given of the Company's "Victor" jointing materials, which, it is stated, are now used in 120 ships of H.M. Navy, in about 500 merchant steamers and by many engineering firms. Details are given of the "Salamander" joints, the "A" brand of which is recommended for high pressures, and for wet steam, water and other joints, while the "B" brand is recommended for dry steam. The Company also draw special attention to their new patent "Salamander" embossed decorations. These decorations are a novel adaptation of asbestos, and the Company claim that they are very efficacious in preventing the inception or spread of fire wherever used, either in saloons of vessels or in buildings. Particulars and prices are also given of the Company's fireproof paints, non-conducting coverings, cements, &c., pipe and flange jointing materials, "Gladiator" and other packing, belting, "Rubesto" sheeting, tape joints, &c. The catalogue is furnished with an index, is well printed, and is undoubtedly one of the completest of the kind we have seen for some time.——Messrs. C. H. Cathcart and Co., 3, Dorset-buildings, Salisbury-square, E.C., forward us circulars containing prices and particulars of their mill and factory electric light fittings. The firm also send us particulars of their table standards. These standards are suitable for use in office or library, and as the bases are being heavily weighted, are not easily overturned.

ABERDEEN.—At the last meeting of the Town Council a letter was read from the Building Committee of the Free Bon-Accord Church, stating that they had been considering the propriety of lighting the new church on the Viaduct by electricity, and asking if the Council would be prepared to extend their mains so far. The letter was referred to the Gas and Electric Lighting Committee.

ALDERLEY EDGE (CHESHIRE).—At their meeting on Tuesday the District Council considered the question of the purchase of the Council's Provisional Order by Mr. S. V. Clirehugh, consulting engineer, Manchester, who is acting on behalf of a Company about to be formed for the purpose of supplying the district with electric current. The terms of the agreement were discussed at great length, but it was eventually decided to call another meeting of the Council to further consider the question.

BANGOR.—At the meeting of the City Council on Wednesday it was decided, on the recommendation of the Electric Lighting Committee, to apply for a Provisional Order. The Committee also recommended that Mr. F. H. Medhurst be engaged as consulting electrical engineer (provided the Council obtain the necessary powers to proceed with their scheme) at a remuneration of £650; if, however, the Council did not proceed further with the matter, Mr. Medhurst's fee would be £50. This recommendation was also adopted.

BELFAST.—At the last meeting of the Electric Light Committee the electrical engineer (Mr. V. A. H. M'Cowen) submitted his report on the proposed extension of the electric light mains in Arthur-street, Howard-street, College-square North, College-square East and Wellington-place, together with an estimate of the probable cost, and he was authorised to proceed with the work. The tenders recently received by the Committee for the supply of additional engines and dynamos were referred to the engineer for analysis and report.

BLACKBURN.—The Markets Committee's recommendation that the Market House and the Fish Market be lighted by electricity was adopted at the last meeting of the Town Council. The Gas Committee has decided to reduce the charge for electric current for motive-power purposes to 4d. per unit.

BLACKPOOL.—At the meeting of the Town Council on Friday last Councillor Pearson, in presenting the Electric Lighting and Tramways Committee's report, spoke in glowing terms of the great success of their electric light undertaking. He also reported that the Board of Trade had granted a licence to work the Lytham-road tramways, and they had decided to adopt electric traction on the section between the Carriage Drive and the South Shore Railway Station. The minutes were duly approved.

BRADFORD.—At the meeting of the County Council on Tuesday, the Chairman of the Gas and Electricity Committee (Mr. Dixon) presented his statement of the income and expenditure of the Electricity and Gas Departments for the year ended June 30th last. Referring to the Electricity Department, Mr. Dixon said the capital outlay had been £67,111, the income amounted to £6,185, and the expenditure to £3,008, or a gross profit of £3,177. After deducting £2,190. 5s. 9d. for interest and sinking fund, there remained a net profit of £986. He said they were at present renovating their plant, and, owing to certain machinery not having been delivered to time, they were compelled to refuse some customers. In conclusion, Mr. Dixon referred to the progress the Department had already made, and said that, properly managed, there was a great future before their electricity works.

BRIERLEY HILL (STAFFS.).—The District Council are greatly dissatisfied with their present system of gas lighting, and the clerk has been instructed to ascertain the cost of lighting the district by electricity.

BRIGHTON.—At a recent meeting of the Works Committee a letter was received from Mr. Magnus Volk, Managing Director of the Brighton and Rottingdean Seashore Electric Tramroad Company, requesting permission to erect some poles on the foreshore for the purpose of carrying electric wires. The Committee informed Mr. Volk that the Council could not sanction the erection of these overhead electric wires, but would grant permission to lay them underground, subject to the work being approved by the Borough Surveyor. On the motion for the approval of the minutes of the Committee at the last meeting of the Town Council, it was decided to refer the matter back for further consideration.

BRISTOL.—It is announced that the formal opening of the electric tramway between Old Market-street and Kingswood will take place on Monday next.

BUENOS AYRES.—It is reported that an underground electric tramway will shortly be constructed in this city.

BURY.—The Town Council at their last meeting appointed a Committee to consider the question of lighting the town by electricity.

CHELTENHAM.—At each successive meeting of the Town Council the Electric Lighting Committee have to report an increased demand for electric current. According to the statement of Alderman Norman (Chairman of the Electric Lighting Committee) at the last meeting of the Council, the Committee had applications for 4,270 lamps, and 3,040 of these had already been connected up.

DOCK LIGHTING.—The quay wall between the Trafford-road swing bridge and the entrance to the Pomona Docks is to be lighted by electricity. To persons who have to navigate craft after nightfall in this crooked part of the canal, the electric light will be a decided advantage.

DOVER.—At the meeting of the Town Council on Wednesday Mr. G. Fry introduced the question of the construction of a system of electric tramways in the town, and, after considerable discussion, it was decided to apply for Parliamentary powers to carry out the proposal forthwith. The estimated cost of constructing and equipping between three and four miles of tramway, erecting a generating station, &c., was put at £50,000.

DUNDEE.—The accounts of the electricity department of the Town Council for the five months ended September 30th have just been published. The electricity rental for this period amounted to £907. 3s. 4d., an increase of £189. 3s. 4d. as compared with the same period of last year.

ECCLES.—At the meeting of the Town Council on Tuesday last the Electric Lighting Committee presented their report on the tenders recently received by the Council for carrying out the proposed electric lighting scheme of the Council. The scheme was prepared by Mr. S. V. Clirehugh, of Manchester, and provided

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for the lighting of the whole of the district at present lighted by gas, and also for the supply of current for private lighting. After very careful consideration of the whole of the tenders sent in, the Committee recommended the adoption of the tender of the Manchester Edison-Swan Company, which amounted to £13,792, and the Committee further recommended that application be made to the Local Government Board for sanction to borrow £20,000 for the purpose of carrying out the scheme. Mr. Alderman Kendall moved the adoption of the Committee's report, but Mr. F. Smith moved an amendment that the question be postponed till after the November elections, and after a long discussion the amendment was carried.

EDINBURGH.—At the meeting of the Town Council on Tuesday the Cleaning and Lighting Committee recommended that the Grassmarket and West Bow should be lighted electrically at a cost of £140, and that an arc lamp be erected at the corner of Picardy-place and another at the corner of London-road, at a cost of £40. After some discussion the proposals were referred back to the Committees for further consideration. The Town Council also discussed the bill which is being promoted for the extension of the city boundaries. In the bill is a clause providing for the extension of the present electric lighting area.

ENFIELD (MIDDLESEX).—The Town and Village Electric Light and Power Company have written to the District Council offering to submit a tender for the lighting of the district by electricity. The letter was referred to the General Purposes Committee.

ELECTRIC LIGHTING LOAN.—At the weekly meeting of the London County Council on Tuesday the Finance Committee reported that they had considered an application from the Vestry of Islington for a loan of £5,150 for the purchase of land for electric lighting purposes. The Vestry found it necessary to extend their electric lighting station, and for that purpose purchased certain property in Burnard-place, Eden-grove, adjoining the existing station. The Council's valuer reported that under the exceptional circumstances of the case the price paid was not unreasonable, and the Committee therefore recommended that the loan be granted on condition that it was taken up at once, interest being charged thereon at the rate of £3 per cent. per annum, and the entire sum to be repaid within a period of 53 years. The recommendation was agreed to.

EXHIBITIONS.—The Leeds International Exhibition was opened on Wednesday last. The Exhibition, which was promoted by the General Trades and Industrial Exhibition Company, is being held in the Engineers' Drill Hall, Camp-road, and will remain open until November 1st. There are about 200 exhibitors, and the building will be lighted throughout by electricity, the work of installation having been placed in the hands of Mr. F. J. Borland, electrical engineer, of Leeds; 18 1,000 c.p. arcs and a large number of incandescents will be employed. Power for driving the dynamo is being supplied by Messrs. Robey and Co., the well-known steam engine makers, of Lincoln, who are exhibiting some of their steam and gas engines. Mr. F. J. Borland also exhibits various electrical appliances, and has constructed a short electric railway in the grounds.

——— It is stated that though the time fixed for sending in applications for space in the Industrial Exhibition which is to be held next year in the Treptow Park, Berlin, many applications are still being received by the administration. It has therefore been found necessary to enlarge the original plans, and the principal building, to which a space of 40,000 square metres had originally been allotted, will now cover 53,000 square metres, and some of the subsidiary groups which were intended to form part of the main building will now occupy a separate hall.

FACTORY LIGHTING.—The new co-operative clothing factory at Kettering, which was formally opened on Tuesday last, is lighted throughout by electricity. The installation was carried out by Messrs. Lee and Warren, of Kettering.

FULHAM (LONDON, S.W.).—At the last meeting of the Vestry the Special Electric Lighting Committee reported that they had received answers to the queries they had addressed to the various local authorities who possessed electric lighting powers. Mr. Sayer moved the confirmation of the report, which was, after some discussion, agreed to, as was also a resolution that an electrical expert be employed by the Committee at a cost not exceeding £50.

GODALMING.—The Special Lighting Committee presented their report at the last meeting of the Town Council. The report stated that the Highways, Footways and Lighting Committee had handed over to them the tenders received for the electric lighting of the district. Seventeen schemes had been received, but not one of the firms who tendered would undertake to establish electric lighting works at their own risk. As a result of the consideration of the schemes the Committee had instructed their surveyor to enter into negotiations with Messrs. J. Fowler and Co., Leeds, and to canvass a specified area of the borough with a view to finding out how many lights were likely to be required. They recommended that they be empowered to obtain a Provisional Order, provided the cost did not exceed £250. The Chairman of the Committee (Mr. Girdlestone), in moving the adoption of the report, said it had been found impossible to attempt the lighting of the whole of the borough electrically at first, and they had determined to take a limited area in which the houses were closed together as an experiment. The result of their canvass was fairly satisfactory, and the headmaster of Charterhouse was anxious to have the electric light introduced into the school, and, taking the whole aspect of the case, there was a very general and strong desire for the electric light in the borough. The report was carried unanimously.

GREAT YARMOUTH.—The Town Council have decided to put the Town Hall in telephonic communication with the Sanatorium and the Corporation stables at a cost of £68. 10s. At the last meeting of the Council the surveyor stated that there were at present 5,495 lamps connected up to the electric light mains, and that the profit on the electricity department for the month of September was £88. 5s. 8d., while the profits for the months of August and September amounted to £142. 4s. 7d., which, the surveyor states, just covers the loss on the first seven months' working.

HAMPSTEAD (LONDON, N.W.).—It appears that the Vestry are at present paying interest to the London County Council on their electric lighting and other loans at the rate of 3½ per cent. per annum, and they are naturally anxious to obtain a reduction on this excessive rate. The Finance Committee have, therefore, been commissioned to consider and report on the question of obtaining better terms from the Council.

HANLEY.—On the recommendation of the Parks Sub-Committee the borough surveyor has been instructed to prepare and submit a scheme for lighting the boathouse and lake in Hanley Park by electricity.

ISLINGTON (LONDON, N.).—The Electric Lighting Committee of the Vestry require an additional £25,000 to complete their electric light undertaking. This additional expenditure is partly caused by under-estimates, and the balance is required for the purchase of more property in Eden-grove for extending the generating station.

LAMBETH (LONDON, S.E.).—Although the members of this Vestry have had, during the past two or three years, several discussions on the subject of introducing the electric light into the parish, they do not appear to have made much progress with the matter. At the last sitting Mr. Bennetts moved that a special committee be appointed to collect information, and to consider and report upon the whole question, but the Vestry adjourned without coming to a decision.

LONDON, E.C.—It is stated that arrangements are being made for the introduction of the electric light into the London Commercial Sale Rooms, Mincing-lane, E.C.

MILE END (LONDON, E.)—The Vestry have appointed a Committee to consider the question of lighting the district by electricity.

MONMOUTH.—At the meeting of the Town Council on Monday the Mayor (Councillor W. Honeyfield) stated, in reply to a request for information as to the suggested refuse destructor and electric lighting scheme, that the engineers (Messrs. Bramwell and Harris) had reported that the combined scheme would cost £20,000.

NEW MALDEN (SURREY).—Some time ago the Kingston Corporation suggested to the District Council the advisability of introducing the electric light into the Coombe district, and at the last meeting of the Council the Highways Committee reported that they had fully considered the question, but they recommended that the Kingston Corporation be informed that the suggestion cannot be entertained at present.

NEWPORT (MON.).—The formal opening of the electricity works takes place on Monday next, the 14th inst.

OLDHAM.—At the last meeting of the Electric Lighting Committee it was decided to recommend the Council to adopt the Brighton system of charging for current. The Council have received the formal sanction of the Local Government Board to borrow £15,000 additional for electric lighting purposes, the loan to be repaid in 25 years.

OSWESTRY.—At the last meeting of the Council it was stated that the Oswestry Electric Light Company were prepared to supply current to six 500 c.p. lamps for lighting the Cross Market for £60 per annum. The present gas lighting costs £42. 3s. 6d. The Company's proposal was accepted.

OXFORD.—At the last meeting of the City Council the Streets, Roads and Lighting Committee reported that they had received certain proposals from Mr. J. Hardie McLean, managing engineer of the Oxford Electric Company, for lighting certain portions of the city by electricity. These proposals provided for the erection of 32 arc lamps in some of the principal thoroughfares, and the cost of supplying current would be £688 per annum. Eight were to be all-night lamps, while current would be cut off from the remaining 24 at midnight; but on each of these 24 lamp-posts a double bracket would be placed about half-way up each post, carrying a 32 c.p. incandescent lamp, which would be lighted at midnight. The all-night lamps would cost £26 each per annum, and the combination lamps would cost £20 each. If, however, the Committee considered that two 16 c.p. incandescents

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would be sufficient for each of the 24 combination lamps, the cost would be reduced to £652 per annum. The Committee recommended that the latter proposal be accepted, and that a contract be entered into for a term of six years with the Company, the contract to be determinable at the end of the first three years at the option of the Corporation. Mr. Kingerlee moved the adoption of the report, and said that about three years ago they lighted a small area of the town by electricity, and the Committee had unanimously decided that it should be continued. The cost of the original scheme was £380 a year. The entire cost of laying down mains and providing and fixing lamp-posts was to be borne by the Company, and the whole of the 32 lamps would be 2,000 c.p. each. These 32 lamps would displace gas lamps of the equivalent of 834 c.p. The matter was discussed at great length, several of the members complaining of the inadequate illuminating power of the existing gas lamps. The report was adopted, with only one dissentient.

Poplar (London, E.).—On the recommendation of the Works Committee, the Board of Works have decided to discharge the reference of the notice of the Capital and Counties Electricity Supply Company (Limited) of their intention to apply for a Provisional Order.

Runcorn.—At the last meeting of the District Council the electric light question was discussed. The Rev. Dr. Gastoldi moved a resolution in favour of the introduction of the electric light and of the appointment of a committee to consider the subject. He said that the town was an exceptionally suitable one for the introduction of the electric light, as he thought that they would be able to obtain sufficient power from the waterworks and from the refuse destructor works which they would be shortly compelled to erect. The motion was amended so as to include the consideration of other methods of illumination by the committee, and was passed in this form.

Shoreditch (London, E.).—Progress with the erection of the electricity generating station has been barred for some time, owing to certain demands on the part of the London County Council that the building line in Bowling Green-walk should be placed further back than originally agreed to. At the last meeting of the Vestry it was stated that this obstacle had been overcome, and that the amended plans had been sanctioned by the Council. The work will now be proceeded with as speedily as possible.

St. James's (London, S.W.).—At the last meeting of the Vestry the Works Committee presented a report on the question of lighting the principal streets of the parish by electricity. The Committee had before them schemes submitted by the St. James's and Pall Mall Electric Light Company and the London Electric Supply Corporation. As the Committee wished to obtain further particulars of the St. James's and Pall Mall Company's scheme, the general manager of the Company (Mr. F. J. Walker) subsequently submitted a modified plan showing the positions of the 69 arc lamps which the scheme provided for. If the Company undertook the laying of mains a sum of £5,000 would be required for that purpose, and, subject to a satisfactory arrangement as regards the period of the contract to enable the Company to make provision for this outlay, they would be willing to supply current, and to maintain in full running order each of the lamps requiring a current of 10 amperes, for the sum of £30 per annum. The Vestry would have to supply and erect the lamp-posts complete with lamps, and the Company would supply all mains, connections, switches, &c. The Committee recommended that experiments be made with incandescent gas burners in Regent-street before they proceed further in the matter. A discussion arose on the motion for the confirmation of the Committee's report, and Mr. Jenkins moved that it be an instruction to the Committee that an arc lamp be erected over one of the refuges in Regent-street while their lighting experiments were being made. They would then be able to compare the difference between the two methods of illumination. The instruction having been carried, the Committee's report was adopted.

Swansea.—In our last issue we mentioned that the Town Council had adopted the report of the Electric Lighting Committee, recommending the introduction of the electric light into Swansea and the adoption of a high-tension alternating-current system of electric supply. Notice of motion has been given by Councillor Viner Leeder for the next meeting of the Council that the principle of the electric light be adopted, but that the system to be employed shall be further considered.

Tottenham (Middlesex).—At the last meeting of the District Council a letter was read from the Town and Village Electric Light Company drawing attention to the advantages to be derived from the adoption of the Parfitt system of electric lighting. After some discussion the matter was referred to the General Purposes Committee for consideration and report.

Wakefield.—The Electric Lighting Committee reported at the meeting of the City Council on Tuesday last that they were making satisfactory progress with the electric lighting scheme, and that they were now awaiting the sanction of the Local Government Board to borrow the necessary money. Councillor Lee, in moving the adoption of the report, urged the importance of pushing on with the work, as some large customers were anxious to light their premises electrically, and unless current were available within a reasonable time they would probably put down their own generating plant.

Wells.—Dr. John Hopkinson has presented his report on the electric lighting question. The City Council intend to apply for a Provisional Electric Lighting Order.

Weybridge.—The District Council have now obtained counsel's opinion as to the validity of the contract recently entered into by them with the gas company. The opinion is to the effect that the contract could not be enforced. At the last meeting of the Council, Mr. Bilney severely criticised the action of the Council in so hastily entering into the contract. They had paid an exorbitant price for the gas—£2. 2s. a light. They had, therefore, lost £100 over the transaction. The Council should have accepted the Electric Light Company's offer to continue the lighting for another three months, and in the meantime they could have negotiated with them for better terms; but the Council had never negotiated with the Company at all. It was eventually decided to instruct the clerk to submit to the gas company the terms upon which the Council are prepared to enter into a fresh contract, and a special meeting of the Council to consider the matter will be held on the 16th inst.

Wigan.—At the last meeting of the Town Council the report of the Electric Lighting Committee was presented. The report recommended the adoption of an electric lighting scheme, which would involve an initial expenditure of about £16,000. After an amendment that the advice of an electrical expert be obtained before proceeding further with the matter had been rejected, the Committee's report was adopted.

Worcester.—The City Council intend to apply to the Local Government Board for sanction to borrow £1,300 for wiring the Guildhall and the Public Hall for the electric light.

Workhouse Lighting.—At a meeting of the Lighting Committee of the Newcastle Guardians last week it was decided to engage the services of Mr. D. Selby Bigge and Mr. John Thompson to report on the lighting of the workhouse by electricity and the probable cost thereof.

Works Lighting.—Messrs. A. J. King and Co., proprietors of the Ingersley Vale Bleach Works, Bollington, near Macclesfield, intend to light the whole of their premises electrically. The work has been placed with Messrs. Mather and Platt, of Salford, who have also received an order for the supply of an electric motor for driving machinery in the firm's new shed.——The whole of the Conisborough Glass Works are to be lighted electrically. The contract for supplying the necessary generating plant, wiring and fitting has been placed with Mr. J. A. Edmondson, of Leeds.

COMPANIES' MEETINGS AND REPORTS.

Willans and Robinson (Limited).

The ordinary general meeting of the shareholders in this Company was held at the City Terminus Hotel, Cannon-street, on Tuesday, under the presidency of Mr. Mark Robinson, M.Inst.C.E.

The Secretary (Mr. C. S. Essex) read the notice calling the meeting, and the report of the Directors was taken as read.

The Chairman then said: In rising to move the adoption of the report and accounts I can again congratulate you, on behalf of the Directors, upon a prosperous and encouraging half-year. We have had, as the report points out, something of a windfall, but even without this the results would have been better than last half-year. It is true that we do not show a profit exceeding that of last half-year by quite the amount of the windfall, but that is only because we have already applied a portion of our windfall to increasing an already liberal rate of depreciation before the calculation of profit is arrived at. To write down one's assets faster than ordinary prudent book-keeping requires, is but another way of carrying to reserve, so that the handsome reserve fund of £5,146 to which we now attain as the result of our first eighteen months' work, is by no means the total measure of our savings. That we have done better than last half-year is important for two reasons. First, we have had to bear the burden of much idle capital intended for the Rugby extension, which obliges us to earn more dividend without helping us to earn it. So far we have met the obligation—and a little more—even without our windfall. Do not forget, however, that for the next half-year or two, until Rugby is fairly at work, this is an evil which must tend to increase. Secondly, the first half of the year is usually our worst half, a fact which should give us anticipatory comfort for the half-year which is now passing. As regards dividend, we hope our action in continuing it at 7 per cent. will meet your approval. It would be easy to divide more; we could pay 12 per cent. if we were so ill-advised, but it would not be prudent, and after all 7 per cent. is more than a good many things yield. If we can keep up that interest in a time of transition, while continuing to build up a large reserve, we shall feel that we have fulfilled our promises in the present, and have given you good hope of surpassing them in the future. Increasing orders must be, of course, a

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ground for congratulation. Yet it is difficult to express how this increase adds to the labours and the anxieties of the management, and how seriously it upsets the smooth working of the business. We cannot greatly increase our output until Rugby is ready, and therefore to encourage the same rate of increase of orders through the present half-year would be unwise, since the figures of the second half of 1894 were swelled by one exceptional order, the execution of which is responsible for much of the congestion in the half-year now under review. You will naturally wish to know something of the steps we are taking to remedy this state of things, and to bring us fairly in line with the business which waits for us. As regards time, we shall not, I am sorry to say, achieve our original aim of having the new works in operation by Christmas. The new foundry may give us help at an earlier date, but the machine shop cannot aid us much until the spring is well advanced. With regard to the scope and magnitude of the new works, the original intention was to start in some suitable place with a considerable foundry, and with a small machine shop, the latter being wholly an adjunct to Thames Ditton, where only repetition work—*i.e.*, standard parts of engines made to gauge, and requiring little other than a foreman's supervision—should be carried out; it should thus act only as a feeder to Thames Ditton, where the parts made elsewhere would be examined and passed, and where the engines would still be put together and afterwards tested. We contemplated from the first that this arrangement could be only a temporary one, and that eventually the northern works must be the larger of the two, and must become the headquarters of the business. However, by the time the Rugby site was decided upon it had become evident that before the contracts could be placed this subject might be found ripe for decision, and it has in fact become so. It was simply a question of the rate of the increase of our business, and that rate has so accelerated of late that our decision could not be in doubt. The least extension which could reasonably be made involved the practical doubling of the present machine-shop floor space—that is, we had to build at Rugby a machine shop as large as the one at Ditton. Since we contemplate larger and heavier engines than can be properly made at Ditton, the new machine shop must be fitted with heavier tools and heavier travelling cranes than the present one; it must, in fact, be a better and more important shop. Obviously the engines should be erected, and of course tested where the heaviest work is done. At Thames Ditton we are terribly cramped in the erecting shop, and the testing department is perhaps, through want of room, the weakest spot of all. The time, then, has therefore come to move these departments to Rugby, and with them such subsidiary departments as the pattern shop and the stores, as well as the staff and the head offices, must be moved. In other words, Rugby must be the headquarters from the first, and Thames Ditton the adjunct. Given a sufficiency of orders, which does not seem doubtful, there is evident advantage in making the change at once, rather than piecemeal, and so we trust that before our next October meeting we shall date our letters from Rugby, and shall be able to feel that we are doing our constructive work under far more favourable conditions than at present, while still enjoying the advantages of concentration. As regards the works at Thames Ditton, these are well adapted for just that class of standard light work which it was at first intended to begin with in the North. The heavier tools at Ditton will be removed to Rugby, but the lighter standard parts, which are made to invariable gauges and templates, can continue to be made at Ditton with but small intervention on the part of the superior staff. In order to save time, only the principal and most urgent buildings have, so far, been put in hand at Rugby; but plans for the remainder are in preparation, and, with the exception of the offices, they should be ready at about the same time as the other buildings already under construction. It is thus premature to speak definitely of the cost of the buildings, or of the new tools required; but the Directors are satisfied, from the contracts now placed, that very substantial and efficient shops will be obtained at a cost which will compare favourably with that of the shops at Thames Ditton. It may be of interest to the shareholders to know that the machine shop now building (including under the same roof a large erecting shop and ample stores) measures about 300ft. by 100ft., or 30,000 sq. ft. of floor space, against about 20,000 sq. ft. in the Thames Ditton machine and erecting shops. At Ditton the testing department occupies a small corner of the machine shop; at Rugby, the testing department is a separate building. The Rugby foundry will be of considerable size, covering, with its dependent buildings, some 20,000 sq. ft., and it will have available floor space some five or six times greater than that of the foundry at Ditton. The latter, it should be remembered, supplies only a small part of the castings we use; at Rugby we hope to make all ourselves. Some of the new tools for Rugby have been purchased already, and are doing us excellent service in a temporary shop not far from the works at Ditton. We hope soon to add to the number of tools so employed. The debenture debt has been paid off, and it may be added that we have given notice to pay off the mortgage on the Thames Ditton freehold, so as to set our hands completely free against the time when an issue of debentures may be found necessary. The extension of our foreign licence business is of good augury in every way. Continental work is not easily carried on from here, as in most European countries there is prejudice against engines not of home manufacture, while the cost of sending over to erect, as well as to explain and instruct, makes such business relatively unprofitable. It is better to receive a reasonable royalty upon engines made by licensees, and to keep one's capital and appliances for the more remunerative home and colonial business. It is as important as it is difficult to secure licensees both able and eager to do thorough justice to the engine, but we believe that, as the outcome of long and patient negotiations, the Willans engine will now be made abroad by firms whose capacity and position is thoroughly satisfactory, so that we may look forward with some confidence to the receipt of a substantial income from royalties. I regret to say that the question of the Stock Exchange quotation is still unsettled, though I believe there is no doubt about its being granted. We were last half-year under the impression that if we issued the remainder of the capital whose issue has already been authorised, we should be able to comply with the Stock Exchange requirements as to the relative proportions of capital offered and not offered to the public. The issue was made without difficulty, and we supposed that the quotation would follow. But it seems that it cannot be given until the shares are not only issued, but paid up in full, and not only paid up in full, but paid up so long since that the next dividend to accrue shall be a *full* dividend upon every share. Unfortunately, since the money was obviously not wanted at once, we arranged with some of the shareholders to make their payments over a long period, in some few cases extending beyond the current half-year. These we shall endeavour to get in before the half-year closes, and then, though the dividend upon these shares payable next spring will be for only part of a half-year, as soon as that dividend is paid a full dividend will be accruing for next time. According to this we must renew our application in just six months time. He concluded by moving the adoption of the report and accounts.

Mr. ERSKINE (a shareholder) seconded the motion.

A short discussion followed, in which Messrs. ROSE, BRYAN DONKIN, ANDERSON, and G. B. CLIFTON took part.

The CHAIRMAN, in reply, stated that no arrangement had been made by the Company with their licensees as to the price at which engines made by the latter might be sold. They had granted licences in certain foreign countries because they believed that their engines could be made cheaper there than by the Company here, the Company being shut out from those countries by high tariffs. The foreign manufacturers, however, would pay this Company a royalty. They could compete with the Company in far-off corners of the world, as, for instance, Japan or South America, but he could see no harm in such competition. If foreign makers sold the engines in those places they would not sell them instead of the Company doing so, but in addition to the Company's sales, and pay a royalty to them. They could not compete in England, or in countries in which the Company were really interested. With regard to the increase of £1,379 in the item of patents in the half-year, the bulk of this addition was in the gas engine patent account. They had for the time concluded their experiments with the gas engine under test for a couple of years. He thought that all it would be wise for him to say at the present time on this matter was that they believed they had acquired very valuable information upon the subject for the amount they had expended on the tests, and that as soon as they had time and space at Rugby to think of the matter, they would be able to go on with gas and oil engines, and with greater advantage in consequence of the experiments in question. The particular engine which they had had in view they did not like, and they had come to the conclusion that it would not be wise to pay the high price asked for it, and they believed that they would go on just as well without having to make the payment. The sum paid by them for the patent for the Niclausse boiler was included last half-year, or the half-year before that, in their patents account. He might say that this boiler promised very well indeed, but it was useless for them to ask for orders for it, because they had not at present the means to execute them. They could have taken plenty of orders for the boiler if they had been in a position to execute them. The principal boiler which would be used at the Company's new works would be the Niclausse. He had been glad to hear the encouraging remarks of Mr. Bryan Donkin regarding the reserve fund, which he hoped they would be able to build up very quickly. The sum they received for their grant of a sub-licence for the Niclausse boiler was included last time under the foreign licences account. The two engines which were under construction for Heilmann locomotives were not completed; in fact, the locomotives themselves were not ready for the engines. The dividend recommended would be paid on the following day. They only got 1 per cent. interest on their money at the bank. They had invested a sum of nearly £10,000 for the debenture sinking fund, and when the debentures were paid off they still retained those investments, so that a part of their surplus cash was now invested in addition to the reserve fund.

The motion was then unanimously adopted.

The CHAIRMAN afterwards proposed a resolution declaring a dividend for the half-year ended June 28th last at the rate of 6 per cent. per annum on the capital paid up on the Preference shares, and at the rate of 7 per cent. per annum on the capital paid up on the Ordinary shares.

Mr. ANDERSON seconded the resolution, which was unanimously adopted.

On the motion of Mr. ANDERSON, seconded by Mr. BRYAN DONKIN, a cordial vote of thanks was passed to the Chairman and Directors for the able way in which they had conducted the affairs of the Company.

The CHAIRMAN, in acknowledging the vote, remarked that the Directors did their best to obtain the shareholders' approval. He hoped that they would be able to show in the future that they had acted wisely in what they had done so far.

The proceedings then terminated.

Westinghouse Electric Company (Limited).

The following is the report of the Directors of this Company for the year ended September 30, 1894, to be presented at the fifth annual general meeting of shareholders, to be held at the offices, 4, Victoria-mansions, 32, Victoria-street, S.W., on Tuesday next, 15th instant, at four o'clock:—

The agreement between the English and American Companies, referred to in the last report and approved by the shareholders at the last general meeting, has been carried out. After providing for all expenses of management, Directors' fees, depreciation, patent taxes, and other expenses connected with the maintenance of the various English and foreign patents owned by the Company, there is a net profit for the year amounting to £7,725. 1s. 11d., which, added to the sum brought forward from the

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previous accounts, makes a total of £20,739. 18s. 7d. to the credit of profit and loss, which the Directors propose to carry forward.

Owing to the continued increase in the sales of the Shallenberger meter, the Directors have found it necessary to provide more extensive laboratory accommodation for the purpose of ensuring careful tests and adjustments of the meters being made before despatching them to purchasers. The Directors have secured this accommodation at their Chelsea warehouse, and they have now a laboratory complete with the very best instruments and apparatus necessary for testing purposes. The sales of meters during 1894 have been satisfactory, and orders for transformers and other apparatus were also in excess of those of previous years.

Mr. Oscar H. Baldwin, who was previously associated with the English Company, has, on the recommendation of Mr. Westinghouse, been appointed manager of the Company with a seat on the Board. The Directors have purchased a controlling interest in the European patents, covering a new system of electric traction, in which the conductors are placed underground, and which they believe will prove to be a very valuable asset. They have also agreed with the American Company on a new and more favourable basis of prices for all apparatus manufactured by that Company, which they think should prove advantageous and lead to increased business.

The retiring Director is Mr. Albert Kapteyn, who, being eligible, offers himself for re-election, as do also the auditors, Messrs. Price, Waterhouse and Co.

NEW COMPANIES, STATUTORY RETURNS, &c.

In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1895, pages *304-332, &c., &c.*

HEADLAND'S PATENT ELECTRIC STORAGE BATTERY COMPANY (LTD.). This Company was registered on October 5th with a capital of £15,000, in £1 shares, to purchase or otherwise acquire and take over as a going concern the business of electricians at present carried on under the style of "H. and E. Headland," at Leyton, Essex, to enter into an agreement for the acquisition of same, and to carry on the business of electricians, electrical apparatus manufacturers, &c. The subscribers, with one share each, are: E. E. Cronk, J. H. Oxley, F. Cronk, P. J. McManus, T. Byron, H. W. Headland, electrician, and A. F. White. Mr. H. W. Headland is to act as works manager of the Company.

CROMPTON AND CO. (LIMITED).—The annual return to August 23rd has been filed. The capital is £280,000, in 30,000 Preference and 26,000 Ordinary shares of £5 each. 28,180 of the former and 5,928 of the latter have been taken up, and 4,000 Ordinary have been issued as fully paid. The full amount has been called on the Preference, and one pound per share on 1,928 Ordinary shares.

CITY NOTES.

MEMORANDA.—Bank rate, 2 per cent. (Feb. 22, 1894). Price of silver, 31d. per oz. (Oct. 10th). Consols (2¾ per cent.) 107⅜—107⅝ for money, 107 7/16—107 9/16 for account (Oct. 10th); 2½ per cent. 105¾—106¼. Stock Exchange Settling Days: Consols, Nov. 6th; Stocks and Shares Continuation Day, Oct. 14th; Ticket Day, Oct. 15th; Pay Day, Oct. 16th; Mining Shares Carry-over Day, Oct. 12th.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).—The Board of Directors have resolved, after placing £6,000 to the credit of the Renewal Fund, to declare an interim dividend for the quarter ended September 30th of 10s. per cent. on the Ordinary stock and 20s. per cent. on the Preferred stock, less income tax. The dividend is payable on November 1st.

BERLINER ELEKTRICITATS-WERKE.—The report for the year 1894-95, just issued by this Company, shows a profit of £79,822, as compared with £64,652 in the preceding year. It is proposed to declare a dividend of 12½ per cent., as against 10½ per cent. for the year 1893-94.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended October 6th were £887, against £892 in the corresponding week of 1894, a decrease of £5. The total receipts for the half-year amount to £11,858, against £12,011 for the corresponding period of 1894, or a decrease of £153.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of September amounted to £62,586, against £57,368 in the corresponding period last year, an increase of £5,218.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of September amounted to £52,678, and to £40,178 in the corresponding period of 1894, or an increase of £12,500.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of September amounted to £28,400. The traffics from January 1st to September 30th amounted to £231,200, and for the corresponding months in 1894 and 1893, £207,400 and £203,600 respectively

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 6th inst. amounted to £1,088. The amount for the corresponding week last year was £908; increase, £180.

LUGANO ELECTRIC TRAMWAY COMPANY.—A Company has recently been formed at Lugano, with a capital of £8,000, to be known as the Tramvie Elettriche à Lugano, to construct and operate an electric tramway from the Paradiso in Lugano to Cassarate, with a branch to Moule-Nunif.

SALT LAKE AND OGDEN GAS AND ELECTRIC LIGHT COMPANY (LIMITED).—During the week this Company issued a prospectus inviting subscriptions for 100,000 Five per Cent. Accumulative Preference Shares of £1 each, payable 5s. on application, 5s. on allotment, and 10s. on 31st inst. The Ordinary share capital of the Company is £300,000, £260,000 whereof has been issued. The shares now offered to the public are redeemable at any time after January 1, 1905, at 105 per cent. The Salt Lake and Ogden Gas and Electric Light Company of Utah (U.S.A.) was formed in 1893, with a capital of $1,500,000, for the purpose of acquiring the franchises extending to the year 1919, and consolidating the several undertakings previously carried on in Salt Lake City and Ogden for the supply of electric light, gas, and power. That Company created an issue of $1,500,000 (£300,000) Six per Cent. First Mortgage Gold Bonds, and $1,250,000 (£250,000) of these have been issued. The whole of the shares and the entire management of the Utah Company are under the control of the English Company, which was formed in 1893. The proceeds of the present issue will be applied to the purchase of an equal amount of bonds of the Utah Company. The offices of the Company are 251, Winchester House, Old Broad-street, E.C., and the Secretary is Mr. J. N. Kelman. The lists opened on Wednesday last, and close to-day (Friday) at 4 p.m. for both town and country.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Tuesday next, October 15th, a settling day in 9,104 fully-paid £10 shares and 207,649 £10 shares (£2-paid) of the Central London Railway Company (Limited), and have also ordered the same, together with the further issue of 3,498 Seven per Cent. Cumulative Preference shares (Nos. 12,846 to 16,343) of the Electric Construction Company (Limited), and the further issue of 3,163 Ordinary shares (Nos. 1 to 601, 1,092 to 1,181 and 7,529 to 10,000) of W. T. Henley's Telegraph Works Company (Limited), to be quoted in the Official List.

SUBMARINE CABLES TRUST.—Notice is given that on and after the 15th inst. the sum of £1. 15s. on account of the coupon due 15th inst. will be paid by Messrs. Glyn, Mills and Co., 67, Lombard-street, London, E.C., between the hours of 10 a.m. and 2 p.m. Coupons should be left four clear days for examination.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended October 4th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,071.

WESTERN UNION TELEGRAPH COMPANY.—This Company have issued their report for the quarter ended September 30, 1895:—The following statement, dated September 11th, exhibits the condition of the Company at the close of the quarter ended June 30, 1895:—

Surplus April 1, 1895, as per last quarterly report......		$7,260,082. 75
Net revenues, quarter ended June 30, 1895..............		1,583,048. 80
		$8,843,131. 55
From which deducting for—		
Dividend of 1¼ per cent. paid July 15	$1,191,941. 25	
Interest on bonded debt	223,713. 95	
Sinking funds........................	20,000. 00	
	$1,435,655. 20	
Less—		
Portion of Sinking Fund for the bonds of 1900 (which were set aside previously) returned to the Company by the Sinking Fund Trustees, because of the drawn bonds not being presented for redemption...	$40,000. 00	
		1,395,655. 20
Left a surplus July 1st, as above		$7,447,476. 35
The net revenues of the quarter ended September 30th, based upon nearly completed returns for July, partial returns for August, and estimating the business for September, would be about..............		1,850,000. 00
		$9,297,476. 35
From which appropriating for—		
Interest on bonds	$223,500. 00	
Sinking funds	20,000. 00	
		243,500. 00
		$9,053,976. 35
It requires for a dividend of 1¼ per cent. on capital stock issued, about		1,191,945. 00
Deducting which leaves a surplus, after paying dividend, of		$7,862,031. 35

In view of the preceding statements, the Committee recommend that a dividend of 1¼ per cent. on the capital stock of this Company be declared payable on and after the 15th instant. The stock books of the Company are closed from September 20th to 15th instant.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the half-month ended September 30th were £1,703, as compared with £2,679 in the corresponding period of 1894. The June receipts, estimated at £3,939, realised £3,958

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Divi-dend.	Name	Previous Week's Price, Oct. 2.		Price Wednesday. Oct 9.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Oct. 5. Highest	Lowest
			TELEGRAPHS.								
£1,012,880	Stock	11/0	Anglo-American	48	50	47	49	4 11 10	Jan., Apr., July, Oct.	50	..
£2,993,560	Stock	22/0	Do. Preferred	89	90	87½	88½	5 1 8	" "	90	88⅝
£2,993,560	Stock	5/0	Do. Deferred	8½	9	7¾	8¼	..		8¾	..
£173,400	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 16 11	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	14	14½	14	14½	4 9 8	Mar., June, Oct., Dec.	14½	14 1/16
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 7 11	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock xd	160	165	161	168	4 3 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20	21	20½	21½	4 13 0	" "	..	..
12,931	5	2/0	Direct Spanish (fully paid) xd	4	5	4	5	4 0 0	April and October	..	—
6,000	5	10%	Do. Preference 10 per Cent. xd	9½	10	9¾	10½	4 7 7	" "	..	—
£30,000	Stock	4½%	Do. 4½% Debentures of £50 each	103%	106%	104%	107%	4 4 11	..	..	—
60,710	20	2/0	Direct United States Cable, 1877	9	9½	8¾	9½	4 6 6	Jan., Apr., July, Oct.	9 1/16	—
400,000	10	5/6	Eastern	17⅛	17⅝	17¼	17½	3 14 4	" "	17⅝	17 3/16
70,000	10	6%	Do. 6 per Cent. Preference	18	18½	18	18½	3 4 10	" "	18¼	18⅛
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	129	132	129	132	3 1 5	May and November	131½	130¼
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	107	110	107	110	4 11 9	February & August	..	..
250,000	10	2/6	Eastern Extension	18	18½	18	18½	4 1 1	Jan., Apr., July, Oct.	18⅜	18⅛
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	128	131	128	131	3 1 4	February & August	..	..
£54,100	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	107	103	107	4 14 7	January and July	105½	..
£80,600	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	107	103	107	4 14 7	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	108	111	108	111	3 12 5	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	114%	117%	114%	117%	3 9 5	May and November	—	..
180,227	10	3/3	Globe Telegraph and Trust	10⅛	10⅜	10⅛	10⅜	3 19 6	Jan., Apr., July, Oct.	10⅜	10 3/16
180,042	10	6%	Do. 6 per Cent. Preference	17	17¼	17	17½	3 9 7	" "	17 5/16	17 1/16
150,000	10	5/0	Great Northern	21¾	22¼	21¾	22¼	3 16 3	Jan., April, and July	..	..
£180,000	100	5%	* Do. 5 per Cent. Debentures, 1883 issue	103	106	103	106	4 14 9	March & September	104	..
17,000	25	37/6	Indo-European	50	53	50	53	4 14 4	May and November	52½	51⅛
37,548	10	2/6	London Platino-Brazilian	..		..		..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	105	109	106	110	5 9 7	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	108	111	109	112	3 12 1	..	..	..
11,839	8	4/0	Reuter's	5	6	5½	6½	..	April and October	..	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent.	128	133	128	133	4 12 4	" "	131	130½
15,609	10	2/0	West African Telegraph	5½	6½	5½	6½	..	January and July	..	—
£233,300	100	5%	* Do. 5 per Cent. Debentures (red.)	104	107	104	107	4 13 11	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2	1½	2	..	January and July	1½	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	100	105	100	105	7 15 4	June and December	101	..
88,321	10	6d.	West India and Panama	¾	1	¾	1	..	..	15/16	¾
34,563	10	6%	Do. 6 per Cent. 1st Preference	10½	10¾	10½	10¾	5 14 3	May and November	10½	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	6 13 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	110	113	111	114	4 8 8	June and December	..	..
64,242	15	6/0	Western and Brazilian	10	10½	10	10½	4 5 9	May and November	10⅜	10¼
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	—	..	..
33,129	7½	1/6	Do. 5 per Cent. Deferred	4	4½	3¾	4½	..	—	..	..
£165,200	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	103	107	104	108	5 12 2	February & August	—	..
£206,400	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	103	107	104	108	5 12 2	" "	..	..
$1,177,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	6 1 9	May and November	..	..
£164,300	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	103	100	103	5 17 1	March & September	..	..
			TELEPHONES.								
44,000	5	2/6	Chili Telephone (fully paid)	3½	4	3½	4	..	..	..	..
224,850	10/0	1¼d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	—
171,504	£1	8¼d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	—	..
484,597	5	2/6	National	6⅛	6⅜	6⅛	6⅜	3 18 5	June and December	6 5/16	6⅛
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	16	18	16	18	3 6 8	" "	16¼	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	" "	15¾	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	6¼	6½	6¼	6½	3 16 11	—	6 7/16	6½
1,100,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	106	108	106	108	3 5 5	January and July	106⅜	106½
58,000	5	3/0	United River Plate	2¾	3¼	2¾	3¼	..	" "	..	..
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	93	98	93	98	5 3 4	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	13	14	13½	14½	1 14 6	—	14 1/16	13⅝
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	14½	15½	14½	15½	3 17 5	—	15⅜	15
£100,000	Stock	5%	* Do. 5% Debenture Stock (red.)	133	137	133	137	3 13 8	June and December	135¼	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	—	..	—
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	—		—		..	—	..	—
8,322	£5	..	House-to-House Electric	—		—		..	—	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	—		—		..	—	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	..	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7⅞	8⅛	7⅞	8⅛	..	—	..	..
111,000	5	..	London Electric Supply	..		..		..	—	..	—
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	11¾	12¼	11½	12	2 10 0	..	11¾	—
150,000	Stock	4½%	* Do. 4½% Debs.	117	119	117	119	3 16 5	June and December	..	..
6,452	£10	2/0	Notting Hill Electric	8½	9½	8½	9½	..	—	..	..
..	..	..	Rand Electric	7/16	9/16 prem.	⅜	½ prem	..	—	8½	..
19,980	£5	2/0	St. James and Pall Mall	8	8½	8¼	8¾	..	—	..	..
20,000	£5	7%	Do. 7 per Cent. Preference	9	9½	9	9½	3 13 8	—	..	..
59,900	5	2/6	Westminster Electric Supply (fully paid)	8½	9	8½	9	3 1 1	..	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	8	1/6	Brush Electrical Engineering	1½	1¾	1½	1¾	3 11 8	—	1¾	1⅝
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	1⅞	2¼	2	2¼	5 6 8	—	2 3/16	2
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	112	115	112	115	3 18 7	March & September	..	..
20,000	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1	2	1½	2	..	January and July	..	..
12,139	5	1/6	Edison and Swan United	2	2½	1¾	2¼	..	..	..	—
£100,000	Stock	4½%	Do. 4% Mortgage Debenture Stock	104	107	104	107	4 5 1	..	—	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		—		..	..	—	..
120,000	2	..	Electric Construction	⅝	⅞	⅝	⅞	..	..	⅞	..
12,845	2	2/9¾	Do. 7 per Cent. Cumulative Pref. xd	2	2½	2	2½	5 11 0	..	2¼	..
91,195	2	10/0	Elmore's Patent Copper Depositing	¾	1	¾	1	..	—	..	—
20,000	5	..	Fowler-Waring Cables (fully paid)	¼	¾	¼	¾	..	..	..	..
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	19	21	19	21	4 15 3	February & August	..	..
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896 xd	100	102	100	102	4 8 3	March & September	..	..
15,995	£10	..	International Okonite Ordinary	..		..		..	—	—	..
16,000	£10	..	Do. 8 per Cent. Preference	..		—		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	⅛	⅜	⅛	⅜	..	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	43	45	43	45	4 0 0	March and July	44½	43
£150,000	100	5%	* Do. 5 per Cent. Bonds	104	107	104	107	4 14 7	January and July	..	—
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	—
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	..	—
£100,000	10	6/0	W. T. Henley's Telegraph Works Ordinary	12½	13	13½	14	4 5 9	..	13½	13
£30,000	10	7/0	Do. 7 per Cent. Preference xd	15½	16½	15½	16½	4 4 10	..	..	..
£[illegible]0,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock	104	107	105	108	4 3 9	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1½%	City and South London Railway	38	40	38	40	3 2 6	May and November	40	..
7,000	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 4 9	..	—	..
£67,130	Stock	4%	Do. 4% Perpetual Debenture	134	136	134	136	2 19 9	May and November	..	..
87,500	£10	2½%	Liverpool Overhead Railway	12⅛	12⅜	11⅞	12½	1 17 6	—	—	—
6,295	10	5%	Do. 5% Preference	15	15½	15	15½	3 4 9	..	..	—
25,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but not f redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 909. [No. 25. Vol. XXXV.] FRIDAY, OCTOBER 18, 1895. PRICE SIXPENCE.

NOTES.

When municipalities acquire tramways, they cannot do better than work them to the best advantage. One means to this end is careful administration; but no amount of good management will make amends for a radically defective system of haulage. At the same time municipalities cannot be too cautious in adventuring the ratepayers' money in untried schemes. It is possible, however, to handle a matter of this kind in an over-timorous manner. Between enthusiastically adopting every untried novelty emanating from fertile engineering brains, and never adopting anything new for fear that it may be out of date before it is paid for, there is a golden mean. This golden mean, it seems to us, has been admirably attained by the Leeds City Council, which recently took over a more or less worn-out tramway network. The good people of Leeds immediately clamoured for lower fares and better service, and the merits of half-a-dozen different systems of traction were incontinently thrust upon the attention of the city fathers; not only so, but, as Alderman Ward somewhat bluntly remarked, "so many experts offered their services that the Committee found them a nuisance." Under these circumstances the City Council wisely appointed a special committee to deal with the entire question, and it is the exhaustive report compiled by this Committee and Mr. Hewson, the borough engineer, that the Leeds City Council adopted on Tuesday last by 40 votes to 11. Electric traction has triumphed over all its competitors. Steam haulage, it was felt, "ought not to be tolerated" any longer. Gas and oil cars, the Committee were unanimously of opinion, "would not do for Leeds." The choice lay between cable and electric cars, a combination of the two being dismissed as impracticable. The borough engineer's estimate of the initial cost of the cable system and the electric system was £428,922 and £378,499 respectively, the respective annual working costs being estimated at £111,819 and £90,072. The eloquence of this estimate, added to American *facts*, carried the day, and the principle of electric traction was adopted for Leeds, though before the City commits itself definitely to the large expenditure indicated, the overhead trolley and the underground conduit system are to be pitted against each other. We can only hope that those who have sown the seed will reap their fair share of the harvest now evidently ready for the sickle. The success of the Roundhay Park line was the last straw that broke the back of the opposition at Leeds.

In an article, copiously illustrated by diagrams, which will be found in our columns this week, Mr. Clarence P. Feldmann discusses "The Influence of the Shape of the E.M.F. Curve upon the Iron Losses of Alternating-Current Transformers," and adds one further contribution to the controversial literature of the "true sine curve." American manufacturers, we fear, will believe that Mr. Feldmann gives himself and his plea away at the outset, where he talks of "the legendary ground of the pure sine curve." To their manner of thinking the true simple harmonic curve of electromotive force is anything but legendary. However, the interesting series of curves which Mr. Feldmann has carefully compiled teaches us that, whether legendary or not, the pure sine curve need not worry the practical engineer. Rather than strive to impart its simplified purity to his alternate-current machinery, which a benevolent Providence has wisely made it extremely difficult for him to do, the designer or the constructor of such plant should hold this form of curve in taboo. We do not now desire to resuscitate the controversial side of an inquiry, one of the useful effects of which has been to stimulate widespread research into the comparative values for various purposes of waves of different type. The controversial side of the matter has, we believe, long since been set at rest by the dead-weight of an immense mass of experimental and practical evidence. Mr. Feldmann does but add one more to the large number of facts which tell in favour of the flatter type of curve of electromotive force.

While perusing an article on "The Kinetic Theory of Gases, regarded as Illustrating Nature," in the current number of the *Philosophical Magazine*, we noticed that the introductory part furnished a most lucid and interesting summary of the metaphysical connection between phenomena and the logic of research. We have therefore taken the liberty to clip off the introduction to Dr. Johnstone Stoney's article on the kinetic theory, and to publish this under the new title, "Phenomena and Research"; for this delightful exposition of the underlying connection between what we see, what is, and what we may deduce, is worthy of the attention of all who seek to wrest her secrets from Nature's hidden recesses, whether in connection with electrical or any other phenomena. Particularly useful i

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that part of his introduction, in which Dr. Stoney shows the true logical importance of mechanical illustrations of phenomena. In such cases it is not Nature herself that is under examination and study, but a simplified and partial representation of Nature. The value of all such illustrations depends upon the success with which the observer takes proper note of the modifying influence which the characteristics that are absent from the illustration exert in the actual real phenomena. It is to the neglect of this precaution that the innumerable short-lived and erroneous hypotheses of this, that and the other branch of physical science are chiefly due.

In our "American Notes" this week will be found a detailed account of the "latest" phase of the Niagara-Buffalo franchise negotiations. At first it would seem that the Buffalo municipal authorities, thinking they had the whip hand of the Niagara Falls Power Company, devoted themselves to the pleasant task of exacting the maximum possible profit out of that concern. Now, however, our New York correspondent tells us that "the attitude of the Niagara Company is considered by many people to confirm their belief that the talk of transmitting the power of Niagara to a distance was a mere blind, the Niagara enterprise being primarily a land-jobbing scheme, which expects to derive profit, not from the electrical plant in itself, but in leases and rentals from the vast landed property which it possesses in the immediate vicinity of the power house, and now being developed as a manufacturing centre." If this be so, the social millenium would seem to be nearly as far off as ever, and Messrs. Houston and Kennelly's calculations as to the exact cost at x miles from the Falls of an electrically transmitted Horse-Power Hour, x being any number from 0 up to 500, have been more or less wasted. The true inwardness of things American is always to be found very deep down, and we are not, therefore, prepared to accept the latest explanation of the why and wherefore of the Niagara power plant as the last.

The idea of building up a complete collection of catalogues which, as Messrs. Johnson and Phillips point out in our "Correspondence" columns this week, has found favour in the eyes of the officials of the United States Patent Office, is, commercially, technically, and historically speaking, an altogether admirable one, the only drawback that occurs to us being the possibility that the world may not prove big enough to contain a complete file of this unrecorded "literature." This, however, is a remote contingency which may safely be left to posterity to deal with. As the circular-letter of the United States Patent Office points out, a file of this kind will prove invaluable in patent cases in determining the exact meaning assigned in any particular industry at any particular time to recondite technical terms. But the file is to be kept for "other purposes." What may these be? Perchance they may have something to do with imitation, plagiarism, and the posting-up of the acute American in the latest foreign manufacturing developments. Now we have it on the authority of no less a personage than John Stuart Mill—and on that of common sense—that no one can reasonably be expected to be indifferent to his own immediate interests unless other people are made to follow his example. That being so, the plan of the United States Patent Office may very possibly not be supported by foreigners unless there is reciprocity, unless American manufacturers show *their* readiness to aid the good work, and unless the English, French, and German Patent Offices also keep a file of catalogues.

The cool courage of those unfortunate individuals who are afflicted with the inventive mania is a somewhat well-worn theme; but, notwithstanding, we must be allowed to record an instance of it which recently came to our notice. For years men trained in the glow-lamp industry—one of the few still surviving in which secret processes are the order of the day—have been at work, endeavouring to improve the efficiency of glow-lamp filaments by using refractory oxides, and at the present moment a company is, we believe, about to be brought out in this country to exploit the Langhens patents. Nevertheless, an individual has been found brave enough to devote his time and his money to laborious experimenting in this direction, and in order that he may not be biassed by an undue knowledge of what others have done or are doing, he has taken the precaution of ignoring all patent and technical literature on the subject, feeling, of course, quite sure that *his* idea is quite new. Valour of this kind surely merits the Victoria Cross.

A correspondent says that "already we have a circle of polytechnics girdling London." The effect of this belt of learning is, we are told, "the rapid democratisation of the present age." We also note that at some of the points in this largely invisible girdle classes are specially held for "formula-using students"—a most objectionable type of seeker after knowledge. We hope the object of these special classes is the utter extermination of the species.

Cable Interruptions and Repairs :—

	Date of Interruption.
Cadiz-Teneriffe	Sept. 25, 1895.
Maranharn-Para	Oct. 10, 1895.

Clerk Maxwell Scholarship.—The Clerk Maxwell Scholarship is vacant by the resignation of Mr. W. C. D. Whetham, M.A., of Trinity College. Candidates must send their applications to Prof. Thomson, Cavendish Laboratory, on or before November 1st.

International Telephonic Communication.—Belgium and Germany are now in direct telephonic communication with each other. Antwerp and Cologne are the extreme points between which conversations can be carried on, and the price for three minutes' use of the line varies from 1fr. 25c. to 2fr., according to the distance. The new Copenhagen-Hamburg-Berlin telephone trunk line came into operation on the 9th inst.

Finsbury Technical College.—We see by the programme recently issued in connection with the City and Guilds Technical College, Finsbury, that there are at present in attendance 200 day students, ranging from 15 to 19 years of age, and about 1,000 evening students, whose ages vary between 14 and 40 years. Besides the usual courses of lectures and laboratory instruction in pure and applied science, the forthcoming winter session will include a number of short courses of lectures on special subjects, notices of which will appear in our columns from time to time.

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Holophane Globes.—Notice is given that Spiridion Psaroudaki, of 96, Boulevard de Grevelle, and André Blondel, of 2, Boulevard Raspail, both of Paris, have applied for leave to amend the specification of the Letters Patent No. 19,185, of 1893, for improvements in the diffusion and distribution of light. Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents) issued on October 2, 1895. Any person or persons may give notice of opposition to the amendment (on Form G) at the Patent Office, 25, Southampton-buildings, London, W.C., within one calendar month from the date of the said journal.

The United States-Haiti Cable.—The *New York Herald* of September 24th announces simultaneously the formation of the United States-Haiti Cable Company and the laying of the New York shore-end of the projected cable by the s.s. "Mackay Bennett." The shore-end at New York is 10 miles long, and terminates close to the Commercial Cable station at Coney island. In Haiti the landing place will be Puerto Plata. There the Company will connect direct with the French system of cables, and will collect for them at New York traffic for Venezuela, Dutch and French Guiana, Brazil, and the West Indies generally. The Directors of the United States-Haiti Cable Company are John W. Mackay, George W. Ward, J. W. Mackay, jun., A. B. Chandler and Albert Beck.

Search Lights and Strikers.—We have received the following from Messrs. Baxendale and Co., of Manchester :—

"We would like to bring before your notice rather a novel use of the search light in connection with the strike and riots at Messrs. Gartside's works, near Stalybridge. We received instructions from this firm to fix one of our "ship canal" search-light plants at their works, with the idea of preventing the strikers from maliciously setting fire to the temporary sheds erected for the protection of the men at present employed. A few hours after the receipt of their order we had this plant running on the top of the works, and it is now being used nightly, in conjunction with the police force established at the works, to scour the surrounding country, and for illuminating the various parts where pickets are placed. We are informed that the light used for this purpose is a perfect success, and enables them to dispense with a considerable number of temporary police. We think that perhaps this description may be of interest to some of your readers, as it is, so far as we are aware, the first time a projector has been used for this purpose."

Obituary.—It is with deep regret that we have to announce the sad death on Sunday last of Mr. Franklin Leonard Pope, one of the best known and most popular men in the American electrical world. According to a cablegram received from New York as we go to press the circumstances of Mr. Pope's death were as follows :—On Sunday evening, as darkness approached, it was found that the glow lamps in Mr. Pope's house would not light up properly. Mr. Pope thereupon went down to the cellar to examine the transformer. Not long after, members of the family heard a thud and an explosion. On going down to see what was wrong Mr. Pope was found lifeless, his body lying beside the transformer. The exact manner in which the fatality occurred has not yet been ascertained—Mr. Pope began life as a telegraphist, and after doing duty with several pioneer companies, joined the service of the Western Union Company, which he left about 1880, to practise as a consulting electrical engineer and patent expert. Latterly he became connected with the Westinghouse Company, acting as their expert in connection with their Tesla patent litigation. Mr. Pope has been President of the American Institute of Electrical Engineers, and was the original proprietor and editor of our esteemed contemporary, the *Electrical Engineer* of New York. He was a frequent and valued contributor to the technical journals and the author of several works, one of which was a small and capital book on the evolution of the incandescent lamp. Mr. Pope was a frequent visitor to this country, and endeared himself to a large circle of friends by his kindly manner. He was about 60 years of age.

Inverted Arcs in a Worsted Mill.—An article in the *Electrical Engineer* of New York describes the use of inverted arc lamps in a worsted mill in America, and gives some data for a comparison between the cost of this and of other methods of illumination. The tests were made during the month of January in the present year, and the first room to be subjected to experiment was the braiding room, 136ft. long, 66ft. wide and 12ft. high. The machinery consists of 420 machines, arranged in 14 parallel rows. Formerly the room had been lit by 84 gas jets; but eight inverted arcs replace these, the arc lamps being placed in two parallel rows at 17ft. distance from the side walls. Nine-ampere lamps were used. When lit by gas (6s. per thousand) the cost of a 2½-hours evening run was 9·32 shillings; but when the arcs were used the cost (current at 7½d. per kilowatt hour) was reduced to 5·92 shillings, showing a saving of 47 per cent. in favour of the arc lighting. Next an experiment was made in the worsted spinning room, which had the same dimensions as the other room, and which was furnished with 24 spinning frames, 12 twisters, and three spooling machines. Here 10 inverted arcs replaced and gave a better light than 82 gas jets, the actual saving in the cost of a 2½-hours evening run being 33·3 per cent. in favour of the arc lamps.

Power Required for Electric Traction.—In the early days of mechanical traction for street cars, says *Engineering*, "the estimates of the power requisite were frequently ludicrously low. As a couple of not very powerful horses could draw a heavy tramcar without much difficulty, it was argued that two or three horse-power applied mechanically should do the same thing, it being notorious that Watt's estimate of the number of foot-pounds in a horse-power was excessive. There should, therefore, have been a good margin in favour of the mechanical system. Experience proved the reverse to be the case, the reason being that though no ordinary horse can do 33,000 foot-pounds of work per minute continuously, he can for a small fraction of time do very much more, which is not usually the case with a mechanical motor. Hence the horse-power required for mechanical traction can only be determined by experiment and experience. In an article in the *Sibley Journal of Engineering*, Mr. James Lyman gives the results of a number of tests made in different American cities of the power required for electric traction. At Rochester, where the first of Mr. Lyman's records were obtained, there are about 20 miles of track which was in good condition at the time of the test. The number of cars on the road was 40, each weighing about eight tons and provided with a 15 H.P. geared motor. In general the road was level, but in the heart of the town there were some gradients of from 3 to 4·7 per cent. Moving on the level the necessary tractive power averaged 38lb. per ton of car, and for the whole run over the four principal routes at 6·5 miles per hour, the average horse-power was 1·4 per car, and the maximum 6 H.P., this latter being used only momentarily. At Buffalo the same average power was required, but the maximum was 6·6 H.P. In a large western city a car with the axles coupled direct to the motor, without the intervention of gearing, took 0·92 H.P. per car on the average, with a maximum of 4·7 H.P. In wet weather the tractive power required is reduced, the rain acting as a lubricant. Wetting of the rails round curves is particularly effective, the requisite tractive power being thereby reduced by one-third."

The Electric Light and Power Equipment of the Birmingham Technical School.—The electric lighting of this School was carried out by Messrs. B. Verity and Sons according to the plans and specifications of Messrs. Henry Lea and Thornbery. The generating plant consists of three 53 B.H.P. Tangye gas engines running at 160 revolutions. The three compound-wound Parker dynamos run at 900 revolutions, and are belt-driven. The engine room also contains a small Tangye gas engine, used for compressing a mixture of gas and air for starting the main engines. Instead of the usual cylindrical vessels a large cast-iron tank, 24ft. by 16ft. by 3ft. deep, holding 6,000 gallons of water, is placed above the battery room, of which it forms the roof. The dynamos, by aid of a "booster," are able to charge a 58-cell battery of E.P.S. storage cells. The Principal of the School (Dr. W. E. Sumpner) has, in conference with the engineers, given special consideration to the character of the lighting of the rooms throughout the building, so as to adapt it as much as possible to the various wants of the classes. In some rooms the usual 16 c.p. glow lamps are used, in others a smaller number of 50 c.p. glow lamps are found to be more suitable, in others Crompton arc lamps are used of the ordinary pattern, while in others again inverted arc lamps are employed. In the mechanical drawing office particularly this method of lighting is much appreciated, and in many of the workshops, where the shadows cast by ordinary

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lights are objectionable, the inverted arc system has proved a great success. Electricity is freely used in the school for motive-power purposes. Thus there are 15 motors in the building, of a total of 46 H.P., varying from one to 7 H.P. each. The manufacture and fixing of the machinery and apparatus and the wiring of the building have proceeded very expeditiously and smoothly, no hitches of any kind having occurred. The first instructions were given to the contractors on May 23rd last, and the light was used for school purposes on September 16th, and has since then been nightly in use without interruption. There are in all about 806 glow lamps, 80 arc lamps, 13 miles of insulated copper conductors, and 30,000ft. of wood casing.

Newport.—The Newport municipal electric supply station was formally opened on Monday last, though current has been supplied for some time past from a temporary plant. The system employed is that of alternate-current transformer sub-stations. The transformers are placed in boxes in various parts of the town, and at a distance of about 200 yards from each other. The generating plant at present consists of four 75-kilowatt alternators of the Hall type by Messrs. Fowler and Co., cotton-rope coupled to four horizontal compound condensing engines of 150 I.H.P., manufactured by the Uskside Engineering Company of Newport. The steam plant comprises four Lancashire boilers fitted with Proctor's mechanical stokers. Meldrum's system of forced draught is also fitted to the boilers, being arranged for easy disconnection when the boilers are required to work with natural draught. The engines are run at a speed of 110 revolutions, and are fitted with Hartnell's vertical high-speed governors. Heavy flywheels of eight tons weight and 12ft. diameter are provided. They are grooved for eight ropes of 1¼in. diameter. The alternators run at a speed of 525 revolutions, and have a periodicity of 87 and an E.M.F. of 2,000 volts. The switch board is so arranged that all the alternators can be run in parallel. An emergency shunt is also fitted, so that any circuit can be run direct from any dynamo without the intervention of the omnibus bars. In a separate building a day load plant is erected. It consists of a semi-portable under-type engine and boiler for 50 I.H.P., driving a Hall alternator. The switch-board of this plant is connected with the main switch-board, and so arranged that the dynamo can be controlled at either board. The distribution is effected by a network of armoured cables of the Siemens type, laid direct in the ground. The high-pressure cables are of the vulcanised india-rubber class, and are drawn into cast-iron culverts and boxes laid chiefly under the pavement. The transformers are of the Lowrie-Hall type. There is also some street lighting, which is carried out by 40 Lewis alternating-current lamps of 500 watts. They are fed by separate high-pressure mains connected to the omnibus bars. The current is transformed in the base of the lamp-post, where small converters of special type are fixed. The pillars are of cast iron, fitted with ornamental brackets, from which the lamps suspend at a height of 18ft. above the ground. The whole plant was designed by Mr. Robert Hammond, who acted also as consulting engineer to the Corporation.

The Boston Electric Subway.—There are more suburban street railway lines converged into a few streets in Boston (Mass.), it is said, than are to be found in any other city in the States, and the problem of disposing of this enormous traffic was an intricate one, which was made more difficult by the narrowness of the streets. To dispose of this traffic a subway scheme has been adopted. The idea is that by having a tunnel devoted to the cars alone, and free from all interference by vehicles or pedestrians, schedule time will be made by the cars, which can naturally be run at much higher speed than on a crowded street. The general character of the subway differs from the type of tunnel hitherto employed for such structures. It is an object to have it near the surface, and to have it independent of lateral ground support, in the sense that it can stand by itself, if earth is removed from about it. This makes it secure from disturbance by excavations in the street. Hence, for the top, steel beams, with brick or concrete arches turned between them, are employed. For the bottom, two inverts of brick or concrete are to be used, the side walls rising from which are of masonry. A central row of pillars supporting a longitudinal girder is provided to support the centre of the roof in the four-track structure. The entire structure is to be made as waterproof as possible, and electric pumps are to be installed for the drainage of water that may collect in the sumps. Its standard height is 14ft., its standard width for two tracks is 24ft., and for four tracks 48ft. This will bring the top of the rail 17ft. below the surface of the street level, giving a descent of 16ft. for the passenger—a descent less than the average ascent required by the New York Elevated Railway system. The stations are all to be underground, and only the stairways will be seen above ground. There will be about five miles of single track. A special lighting plant will furnish electric lights for the entire length of the tunnel, the power being entirely distinct from that for running the cars. These will be incandescent lights carried on brackets. For ventilating the subway large electric fans will be used, discharging the air through ducts. Work is now in progress on the first section. The entire operations are in the hands of the Boston Transit Commission, which consists of five members, and which has power to establish rentals for the use of the structure by the street railway companies when completed. To force the companies to use the subway, the Commission is empowered to remove the tracks from the streets above the subway after its completion. The work will be done by the City and State authorities, and the expense is to be borne from a fund furnished by the city treasurer from the sale of bonds, and the public is to be freed by the rentals from extra taxation. The Commission will repave the streets, move sewers or pipes, strengthen foundations and conduct the entire work of construction, having also the management of the structure in charge, after completion.

Current Electrical Science.—The *Philosophical Magazine* contains a Paper by Dr. L. T. More, investigating the true causes of the change of length in soft iron bars produced by MAGNETISATION. It appears that there is a contractive force which opposes (unsuccessfully) the lengthening due to the new orientation of the molecules. The net effect is a gradual elongation, which becomes more and more rapid, and reaches a maximum at a field intensity of 1,200, and then suddenly falls. Hardening the wire diminishes the elongation, and the maximum sets in sooner. Stretching has the same effect; but allowance must be made for a change in elasticity produced by magnetisation. There is a thoughtful article by Dr. Johnstone Stoney on the kinetic theory of gases, of which we reprint an abstract this week. He shows how the vast multitude of molecular events, in an almost infinitesimal time, affords opportunity for accomplishing work which requires rare collocations of conditions. The future development of physical science will require more pioneers among the arcana of nature like Dr. Stoney.——Wiedemann's *Beiblätter*, No. 9, contains some capital abstracts of inaccessible electrical papers. There is a new form of ELECTRIC MACHINE by F. Busch, consisting of a paper band travelling round rollers and rubbed by rabbit skin, giving sparks 20cm. long! Two Russian physicists, with unprintable names, give their experiences of currents produced by water trickling through earthy material, and build a theory of EARTH CURRENTS upon their results. A. Abt describes the process of MAGNETISATION BY RUPTURE of iron bars. A characteristic German Paper by Prof. Ostwald is also abstracted, in which he explains the action of mind upon matter as something in the nature of catalysis. ——Our new English abstracts of physical papers, published by the Physical Society, form a perfect mine of electrical science. Among abstracts of comparatively inaccessible electrical Papers we notice one of M. Blondel's experiments with ALTERNATE CURRENT ARCS, in which he discovered a slight lag of the current behind the potential difference. This he attributes to a thermo-electromotive force produced at the positive carbon when at the temperature of volatilisation.——In the *American Journal of Science*, Dr. M. I. Pupin, in the first of a series of "Studies in the Electromagnetic Theory," discusses in an admirably clear manner the exact position of the law of ELECTRO-MAGNETIC FLUX in Maxwell's theory, and promises a more general form of this law. Dr. Pupin evidently intends to fight like another Heaviside, but without Mr. Heaviside's weapons, and 4π's are ominously frequent.

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ELECTROMAGNETIC THEORY.—LXXVI.*

BY OLIVER HEAVISIDE.

(*Continued from page 741.*)

§ 298. When a cable is earthed at its ends the type of the normal function for the potential is $\sin sx$, vanishing terminally, s being fixed by $\sin sl = 0$. Left to itself, a distribution of potential of this type becomes reduced to $\sin sx \cdot \epsilon^{pt}$ at time t later, p being negative, fixed by $RSp = -s^2$. If the ends are both insulated, the normal function is $\cos sx$ for the potential, but with the same series of values of s, with the addition of a zero value, making 1 a special normal function. The roots of the determinantal equation are equally spaced.

Now, if one end be earthed and the other insulated, the normal functions are $\sin sx$ or $\cos sx$, as the case may be, with $sl = (n - \frac{1}{2})\pi$, n being integral. The roots of the determinantal equation are equally spaced in this case also.

In all other cases whatsoever, so far as I know, of real practical problems, the series of s's in the general normal function $\cos sx + a \sin sx$, where a is a constant, which are permissible and necessary in order that real and practical terminal conditions may be satisfied, differ from those given by $\sin sl = 0$ or $\cos sl = 0$, and are unequally spaced. It does not seem to be possible for any two arrangements of real condensers, resistances, and coils, acting at the terminals, to act in concert in such a way as to bring the determinantal equation back to the original simple type. It is perhaps for this reason, or rather for similar reasons in other physical problems involving Fourier series, that it has apparently escaped notice that Fourier's theorem, in which the s in the normal functions is $n\pi x/l$, n being integral, does not uniquely determine expansions of functions. It is, indeed, said to do so, but that is another story. It seems natural, for the above-stated reason, that mathematical physicists should not come across exceptions. On the other hand, pure mathematicians would, perhaps, not arrive at them, owing to the peculiar way they have of regarding the subject of the expansion of functions. They would be concerned with professedly rigorous proofs of Fourier's theorem, and of the convergency, rather than with the discovery of exceptions.

Guided, however, by physical ideas, though applied to entirely unpractical arrangements, involving instability, to be produced by latent impressed forces, set going by the real electrical mechanism, it is quite easy to adjust matters so that the terminal arrangement at one end of the cable shall combine with that at the other in such a way as to bring the roots of the determinantal equation back to the original simple kind. We come back to $sl = n\pi$, or $(n - \frac{1}{2})\pi$, with, however, the important and essential fact that there are extra normal functions of an abnormal kind. And so we come to violations of Fourier's theorem regarded as a unique expansion.

Thus, equation (85) shows the potential at x on the right side of y, due to Q initially at y, subject to the terminal conditions $V = -Z_0C$ at A, and $V = Z_1C$ at B. We may write it

$$V_1 = \frac{(Z_0 s\cos + R\sin)sy \cdot (Z_1 s\cos + R\sin)s(l-x)}{(Z_0Z_1s^2 - R^2)\sin sl + Rs(Z_0 + Z_1)\cos sl}\frac{sQ}{S}. \qquad (100)$$

In general, with practical resistance operators, the denominator only vanishes by the sum of the terms in it vanishing; then we have the determinantal equation (75), with unequally spaced roots, save in the limiting cases of terminal earth or disconnection.

But let $$Z_0 + Z_1 = 0. \qquad (101)$$
Then $$(Z_0Z_1s^2 - R^2)\sin sl = 0 \qquad (102)$$
is the determinantal equation. So $\sin sl = 0$, giving $sl = n\pi$, n being integral; and also,

$$Z_0^2 q^2 = R^2, \qquad (103)$$

where $q^2 = -s^2 = RSp$. Here, when Z_0 is a real resistance operator, the left member is an odd function of p. So there is an odd number of extra special normal functions.

Thus, in case of a resistance R_0 at A, we get

$$R^2 = R_0^2 RSp, \qquad (104)$$

showing one root, positive. In case of a condenser at A, or $Z_0 = -(S_0p)^{-1}$, we get

$$R^2 S_0^2 p = RS; \qquad (105)$$

again one root, positive. In case of a coil at A, with $Z_0 = R_0 + L_0 p$, we get

$$R^2 = (R_0 + L_0 p)^2 RSp. \qquad (106)$$

There are now three roots, and three extra normal functions. But two of them combine to make an oscillatory function. In general, the number of extras is unlimited. The physical interpretation will be considered a little later.

If, instead of (101) as the fundamental relation connecting the Z's, we substitute

$$Z_0Z_1s^2 = R^2, \quad \text{or} \quad Z_1 = -\frac{R^2}{q^2 Z_0}, \qquad (107)$$

the determinantal equation becomes

$$\left(Z_0 - \frac{R^2}{q^2 Z_0}\right)\cos sl = 0. \qquad (108)$$

So $\cos sl = 0$, or $sl = (n - \frac{1}{2})\pi$ for the regulars, just as if one end of the cable were earthed and the other insulated; and, in addition,

$$Z_0^2 q^2 = R^2 \qquad (109)$$

for the extras. So, with the same Z_0, there are the same extras as in the former case. But now, if Z_0 is a resistance, Z_1 is a negative permittance, and if Z_0 is a permittance, Z_1 is a negative resistance.

§ 299. We cannot consider both cases at once very well. Therefore first examine the case $Z_0 = -Z_1$. Equation (100) reduces to

$$V_1 = \frac{(R\sin + Z_0 s\cos)sy \cdot (R\sin - Z_0 s\cos)s(l-x)}{(Z_0^2 q^2 - R^2)\sin sl}\frac{sQ}{S}. \qquad (110)$$

Apply the expansion theorem. This had better be done separately for the regulars and the extras. Say $V = v_1 + v_2$, where v_1 is for the regulars, and v_2 for the extras. Then, working as in many previous cases, we find

$$v_1 = \frac{Q}{Sl} + \frac{2Q}{Sl}\Sigma\frac{(R\sin + Z_0 s\cos)sy \cdot (R\sin + Z_0 s\cos)sx}{R^2 + Z_0^2 s^2}\epsilon^{pt}, \qquad (111)$$

where $sl = n\pi$. The outside term represents the mean potential—that is, $Q/(Sl + S_0^1 + S_1^1)$, where S_0^1 and S_1^1 are the effective terminal permittances, which, however, cancel one another. But the outside term is only required when the terminal resistance is infinite at A, or $x = 0$.

For the extra terms, we may transform (110) to

$$V_1 = \frac{(R\,\mathrm{shin} + Z_0 q\cosh)qy \cdot (R\,\mathrm{shin} - Z_0 q\cosh)q(l-x)}{(R^2 - Z_0^2 q^2)\,\mathrm{shin}\, ql}\frac{qQ}{S}, \qquad (112)$$

in which it is to be noted that the p's determine the normal systems. We have

$$p\frac{d}{dp}(Z_0^2 q^2 - R^2) = R^2\left(1 + \frac{2p}{Z_0}\frac{dZ_0}{dp}\right), \qquad (113)$$

when $R^2 = Z_0^2 q^2$. Hence, using (113), and putting $R = Z_0 q$ in the numerator of (112), it, so far as the extras are involved, expands to

$$v_2 = \frac{Q}{S}\Sigma\frac{q\epsilon^{q(x+y-l)}\epsilon^{pt}}{R\,\mathrm{shin}\, ql \cdot \left(1 + \frac{2p}{Z_0}\frac{dZ_0}{dp}\right)}, \qquad (114)$$

ranging over the roots of $Z_0^2 q^2 = R^2$.

Finally, as before said, $V = v_1 + v_2$ is the complete expansion. The unit impulsive function is got by dividing by Q/S, and omitting the time factor, making

$$u = \frac{1}{l} + \frac{2}{l}\Sigma\frac{(R\sin + Z_0 s\cos)sy \cdot (R\sin + Z_0 s\cos)sx}{R^2 + Z_0^2 s^2}$$
$$+ \Sigma\frac{q\epsilon^{q(x+y-l)}}{\mathrm{shin}\, ql \cdot \left(1 + \frac{2p}{Z_0}\frac{dZ_0}{dp}\right)}, \qquad (115)$$

where the extras are in the second line alone. Herein Z_0 may be any rational resistance operator. It follows that

$$f(x) = \int_0^l uf(y)\,dy \qquad (116)$$

is the expansion of an arbitrary function $f(x)$.

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Equation (115) being general, has the failings as well as the merits of general results. But we can easily interpret specially simplified cases.

§ 300. The simplest case of all is that of a positive resistance at A, and an equal negative resistance (to be interpreted later) at B. There is but one extra, as per (104). Denote the extra q by h for distinctness. Then $h=R/R_0$, the reciprocal of the effective length of the terminal resistance R_0 in terms of the cable. Therefore, since $dZ_0/dp=0$,

$$u=\frac{h\epsilon^{h(x+y-l)}}{\sinh hl}+\frac{2}{l}\Sigma\frac{(h\sin+s\cos)sy\,.\,(h\sin+s\cos)sx}{h^2+s^2} \tag{117}$$

expresses the unit impulsive function.

Let $f(x)=1$ for example; that is, start with a uniform potential in the cable. Thus an easy integration gives us the following expansion:—

$$1=\frac{2\epsilon^{hx}}{1+\epsilon^{hl}}+\frac{2}{l}\Sigma\frac{h}{s}\frac{(h\sin+s\cos)sx}{h^2+s^2}(1-\cos sl), \tag{118}$$

where $sl=\pi$, 2π, 3π, &c., the terms with even multiples having zero coefficients. The introduction of the time factor to each normal function shows the result later as usual. The summational part ultimately vanishes. The outside extra term increases with the time.

We may write (118) thus, if sl is confined to the odd integers:—

$$\frac{2\epsilon^{hx}}{1+\epsilon^{hl}}=1-\frac{4}{l}\Sigma\frac{h^2\sin sx}{s(h^2+s^2)}-\frac{4}{l}\Sigma\frac{hs\cos sx}{s(h^2+s^2)}. \tag{119}$$

The function on the left side is apparently expanded in a Fourier series. But it is *not* a Fourier series in the ordinary sense. It absolutely violates the conditions settling the size of the coefficients according to Fourier's theorem. It is only one example in a million, however. It illustrates a property of the wonderful function ϵ^x.

We may verify (118) by the conjugate property of normal systems. This is an absolutely sound method, provided we have *all* the normal functions at command. One normal function is ϵ^{hx}, the type of the rest is $(h\sin+s\cos)sx$. That the extra one is conjugate to the rest we see thus:—

$$\int_0^l\epsilon^{hx}(h\sin+s\cos)sx\,.\,dx=\int_0\frac{d}{dx}(\epsilon^{hx}\sin sx)dx=0. \tag{120}$$

Also, if w_1 and w_2 denote any two of the regulars, we may verify that

$$\int_0^l w_1w_2dx=0. \tag{121}$$

If, therefore, we assume that

$$f(x)=1=A_0\epsilon^{hx}+\Sigma A_nw_n, \tag{122}$$

we can isolate any coefficient by quadratures. Thus

$$A_0=\frac{\int_0^l f(x)\epsilon^{hx}dx}{\int\epsilon^{2hx}dx}=\frac{2}{1+\epsilon^{hl}} \tag{123}$$

finds A_0, and any one of the rest is found by

$$A=\frac{\int_0^l wf(x)dx}{\int_0^l w^2dx}=\frac{2h}{sl(h^2+s^2)}(1-\cos sl). \tag{124}$$

Comparing with (118), we verify that result. The quantity h may be positive or negative. Changing its sign merely makes the positive and negative resistances change places. Between the two, with $h=0$, we have the case of terminal disconnection. The conjugate property may be readily applied to the unit impulsive function (117) itself, so as to verify that formula.

As regards the expansion of the left member of (119), if done according to Fourier's theorem, the physical assumption would be such as to make the normal systems be $\cos sx$ and $\sin sx$, and this would correspond to an entirely different state of things. Out of physics came the subject of expansion in normal functions. Unto physics should we return for fresh inspiration.

§ 301. The next simplest case is that of a terminal condenser. Say that $Z_0=(S_0p)^{-1}$ at A. There is but one extra q. Denoting it by h, its value is S/S_0. Also, by using the new Z_0 in (113), we see that the result is $-R^2$ instead of $+R^2$, as in the last case. So, by (111) and (114), we find that the new unit impulsive function is

$$u=\frac{1}{l}+\frac{2}{l}\Sigma\frac{(R\sin+Z_0s\cos)sy\,.\,(R\sin+Z_0s\cos)sx}{R^2+Z_0^2s^2}-h\frac{\epsilon^{h(x+y-l)}}{\sinh hl}, \tag{125}$$

where the extra function is in the second line. Here $sZ_0/R=-h/s$, and we may write (125) more simply,

$$u=\frac{1}{l}+\frac{2}{l}\Sigma\frac{(s\sin-h\cos)sy\,.\,(s\sin-h\cos)sx}{h^2+s^2}-\frac{h\epsilon^{(hx+y-l)}}{\sinh hl}. \tag{126}$$

Applying this u to the special initial state $f(x)=1$, we obtain

$$f(x)=1=1-\frac{2\epsilon^{hx}}{1+\epsilon^{hl}}+\frac{2}{l}\Sigma\frac{(s\sin-h\cos)sx}{h^2+s^2}(1-\cos sl), \tag{127}$$

which gives another expansion of ϵ^{hx} not conforming with Fourier's theorem. In (127) sl has the values π, 2π, 3π, &c.; and the coefficients of the terms belonging to 2π, 4π, &c., vanish as before. The formula fails at the terminals, on account o the condensers.

The normal functions are now ϵ^{hx}, the sole extra function, and an infinite series of the type $(s\sin-h\cos)sx$, including the case $s=0$, or a constant term. But to verify (127) by the conjugate property, we must take count of the terminal condensers. Thus, if

$$w=(s\sin-h\cos)sx \tag{128}$$

be taken as the normal function along the cable it must be supplemented by

$$w_0=-h,\qquad w_1=-h\cos sl, \tag{129}$$

at the terminals. Similarly, the normal function ϵ^{hx} must be supplemented by 1 at A and ϵ^{hl} at B. The mutual energy of ϵ^{hx}, &c., and w, &c., is therefore

$$S_0w_0+\int_0^l S\epsilon^{hx}w\,dx+S_1\epsilon^{hl}w_1, \tag{130}$$

which, by the previous two equations, may be seen to vanish, thus proving the independence of the system ϵ^{hx}, &c., and any one of the w systems.

Similarly, we may show that the mutual energy of two w systems is zero. That is,

$$0=S_0\underset{(x=0)}{w_mw_n}+\int_0^l Sw_mw_n\,dx+S_1\underset{(x=l)}{w_mw_n}, \tag{131}$$

if w_m and w_n are any two different regular normal functions. I have not done it, but have no reason to doubt it. Then, all the normal systems being proved to be independent, quadratures find the coefficients when we assume

$$f(x)=A_0+\Sigma A_nw_n+B\epsilon^{hx}. \tag{132}$$

But there are different ways of doing it, according to whether $f(x)$ is the complete initial state, or whether the condensers are initially charged as well. In the latter case, if V_0 and V_1 are their initial potentials, we find the coefficient of any normal system by forming the expression for the mutual energy of the initial state and the particular normal state, using (130) or (131) to isolate the coefficient. Thus

$$A_n=\frac{S_0V_0w_{0n}+\int_0^l Sw_nf(x)dx+S_1V_1w_{1n}}{S_0w_{0n}^2+\int_0^l Sw_n^2dx+S_1w_{1n}^2} \tag{133}$$

finds A_n, if w_{0n} and w_{1n} are the terminal values of w_n. And

$$B=\frac{S_0V_0+\int_0^l Sf(x)\epsilon^{hx}dx+S_1V_1\epsilon^{hl}}{S_0+\int_0^l S\epsilon^{2hx}dx+S_1\epsilon^{2hl}} \tag{134}$$

finds B. The formula for A_n also answers for A_0, if it be taken to mean the coefficient of $-h$, which is what w reduces to when $s=0$.

Now, in the case of (127), $f(x)$ alone is existent, and we must make V_0 and V_1 zero in (133), (134). Doing this, and developing the results, we shall arrive at (127), and verify it. We may also use (133) to obtain the effects due to V_0 and V_1. Initially we must have zero expansions—that is to say, expansions which represent zero, except at the terminals. To find the proper expansion to represent V in the cable due to the initial charge S_0V_0 of the real condenser at A, and

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the charge S_1V_1 at B, put $f(x)=0$ in (133), (134), and evaluate. The results are

$$A=\frac{2}{l}\frac{V_1\cos sl - V_0}{s^2+h^2}, \quad A_0=\frac{V_0-V_1}{hl}, \quad B=2\frac{V_0-V_1\epsilon^{hl}}{1-\epsilon^{2hl}}, \quad (135)$$

to be used in (132). The result is therefore

$$0=2\frac{V_0-V_1\epsilon^{hl}}{1-\epsilon^{2hl}}\epsilon^{hx}+\frac{V_0-V_1}{hl}+\frac{2}{l}\Sigma(V_1\cos sl - V_0)\frac{(s\sin - h\cos)sx}{s^2+h^2}. \quad (136)$$

The 0 on the left side expresses $f(x)$, the potential of the cable everywhere, except at the terminals, where, on account of the condensers, special interpretation is needed.

If we assume $V_0=V_1$, the mean term disappears, and we reduce the last result to

$$0=\frac{2V_0\epsilon^{hx}}{1+\epsilon^{hl}}-\frac{2V_0}{l}\Sigma\frac{(s\sin - h\cos)sx}{s^2+h^2}(1-\cos sl), \quad (137)$$

where only the odd values of n in $s=n\pi/l$ are effective. This corroborates (127).

If we multiply (127) by V_0, it expresses V_0 all along the cable. Adding the result to (137), we obtain $1=1$. This is obvious by arithmetic. But it means more than that here—namely, that if the initial state is V_0 constant in the cable and both condensers as well it will remain constant, because there is nothing to disturb it.

§ 302. If we say that the equation to be obeyed at one end of the cable, say at B, is $V=R_1C$, and further say that R_1 is a positive constant, the most obvious interpretation is that R_1 is a mere resistance. The equation then asserts Ohm's law simply. But this is not necessarily the interpretation. What the equation asserts is that the ratio of V to C is positive and constant. There may therefore be any electrical arrangement that will produce this result. A distortionless circuit will do it, and in many ways. Electric and magnetic energy are then involved, either with or without waste of energy by conductive resistance. The distortionless circuit will behave to an impressed force precisely like a resistance.

Similarly, if we say that the terminal condition is $V=-R_1C$, where R_1 is still a positive constant, we do not assert that $-R_1$ stands for a negative resistance. That would make nonsense, according to the commonly understood electrical law. Any arrangement that will, when acted upon by an impressed voltage, compel the current to obey the law $V=-R_1C$, is what is implied by that equation of condition. We are not obliged to enter any further into detail as to how it is to be done. A source of energy is involved, of course, which, however, does not require any specialisation, since the resultant effect is embodied in the law.

To save circumlocution, it is obviously convenient to speak of a negative resistance, to be understood as above. Now put a positive resistance at one end of a cable, say at A, and an equal negative resistance at B, and let the cable be initially charged at one place, say with a charge Q at y. This charge instantly begins to spread, and raises the potentials at A and B slightly. There is, therefore, a current *from* the cable at A, but *into* the cable at B. The former is normal, the latter abnormal, due to the terminal resistance being negative at B. The B end of the cable therefore becomes charged faster than the A end, and the higher its potential is raised the stronger becomes the current into the cable. At the A end, on the other hand, where things are normal, the current due to the initial charge would first rise to a maximum and then fall slowly to zero. But the continuous entry of fresh charge at B alters matters. It spreads all along the cable, from B to A, raising the potential of the whole cable. The ultimate result, therefore, when the normal effects due to the initial charge have subsided, is a state of positive charge increasing continuously with the distance from the A end, and increasing continuously with the time. This is the meaning of the extra normal function ϵ^{hx} for the potential. The current to match is directed from B to A. Both are associated with the time factor ϵ^{pt}, where $p=h^2/RS$.

The equilibrium state of zero potential is accordingly unstable. An infinitesimal charge arriving at B is sufficient to disturb the equilibrium. Which way the current will set in at B will depend on the sign of the initial point charge. If V becomes positive current will enter the cable, and continue to do so. If negative, current will leave the cable at B, and the cable will become charged negatively.

An arbitrary initial state of electrification in the cable, left to itself, will in time either wholly disappear, or will be replaced by the distribution $\epsilon^{hx}\epsilon^{pt}\times$ constant. Equation (117) determines the behaviour fully, when applied to the initial state. An initial state of the type

$$w=(h\sin + s\cos)sx$$

subsides to equilibrium, as may be readily seen by its satisfying the abnormal terminal condition at B, the current and the potential having opposite signs. Similarly, the sum of any number of such distributions, of any sizes, will subside to equilibrium. But they cannot make up an arbitrary distribution, because the abnormal distribution is left out. An initial distribution of the type ϵ^{hx}, instead of subsiding, increases with the time. In order that no term of this sort should enter, the initial state must be specialised so as to exclude it. Thus, the first equation in (123) settles the coefficient of ϵ^{hx}. It is zero if the integral of the product of the initial state and ϵ^{hx} is zero. This is the case when the initial state is the sum of a number of systems of the regular type w. The simplest case, however, is to have two point charges, one positive, the other negative, with their sizes suited to their distances from B. Thus, if

$$Q_1\epsilon^{hy_1}+Q_2\epsilon^{hy_2}=0,$$

Q_1 and Q_2 being the charges, at y_1 and y_2 respectively, the expression for u in (117) shows that the abnormal term ϵ^{hx} does not exist.

After so much detail concerning this simple abnormal case, others of a similar character may be very briefly treated. As for why they are considered at all, an anecdote about Dr. Elliotson comes in useful. One of his students said he did not see the use of studying morbid physiology; it was so unnatural. The doctor told him he was a blockhead, adding, "It is only by the study of the morbid that the true conditions of health can be ascertained."

(To be continued.)

ELECTRIC TRAVELLING CRANES IN SHIPBUILDING.

A new departure in shipbuilding, calculated to have far-reaching developments, has recently been made by Messrs. Swan and Hunter, of Wallsend-on-Tyne. This consists in carrying on the operations of building beneath a structure provided with travelling cranes so arranged that material may be transported from end to end, overhead, and therefore in no way interfering with the movements of the workmen. This erection, which forms an imposing landmark, is about 500ft. in length, 68ft. wide in the clear between the side frames, and about 80ft. high, and is constructed entirely of steel. At the lower part horizontal girders are introduced to carry one end of the shores, and the lowest tier of these being about 10ft. from the ground level, enables the vessel to be adequately stayed without in any way interfering with free passage.

The most important use of this roof is, of course, to support the travelling cranes above referred to, which are carried on two tracks about 12ft. wide and 22ft. from the centre line of the roof on each side. As the employment of steam cranes at this elevation presented many objections, it was decided to adopt electric power, and for this purpose designs were invited from several of the leading electric crane makers, the design of Messrs. Clarke, Chapman and Co., of Gateshead, being finally adopted. We give illustrations of these (Figs. 1 and 2), showing the general features of their construction, also views taken (Figs. 3 and 4) from the roof showing them in position.

From these illustrations it will be seen that the cranes are suspended on the track, and have a clear run the whole length of the supporting roof. The upper part consists of a square frame formed of steel joists supporting a circular wheel path on which the jib turns, and which allows of a complete revolution being made. The length of the jib from the centre to the rope sheave at the end is 22ft., and a platform is provided on one side and at the end where the motor is placed, rendering

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all parts of the crane accessible. The electric motor is placed at the back end so as to act as a counterpoise, and is capable of giving off 25 B.H.P. at a speed of 700 revolutions per minute. It is shunt wound, and is mounted on a sliding adjustable frame. The current is received through bare conductors fixed on insulators at each side of the crane road, and from the collectors passes to the main switch through contact rings in the upper frame. The various movements are obtained by belts, the reversing being by double clutches and mitre gear. The motor drives by two belts the main countershaft in the centre line of the upper frame, one giving a speed of 400, and the other a speed of 200 revolutions per minute to this shaft, from which all the other movements are derived, the travelling and slewing gear having two definite speeds, which may, however, be modified within certain limits by an adjustable resistance fixed on the jib near the operator,

As the cranes are suspended, great care has been necessary in their construction, and the employment of various safety devices renders them as safe as possible. In the upper frame, to prevent accident caused by the failure of a wheel or shaft, four brackets are provided, which are fixed to the frame very near to the rails, so that under no circumstances could the crane fall more than about ½in.

As the roof is built to a gradient corresponding to that of the ways—viz., 1 in 50—means had also to be provided to render it impossible for the crane to run away; this is accomplished by an electric brake on the upper shaft, which is put in operation by a small switch placed conveniently to the crane man, and which stops the motion in a short distance when descending at the high speed (300ft. per minute) at which the crane travels.

For the travelling motion two mitre wheels are mounted on the central countershaft, having between them a double coupling which can engage with either; these gear into a corresponding wheel on a vertical shaft, which is, of course, in the centre line of the upper frame and the centre of rotation of the jib. A longitudinal shaft on the top serves to transmit the motion by means of two worms and worm wheels to the transverse shafts at each end, on which are fixed the travelling wheels. Two distinct speeds are obtained, 300ft. and 150ft. per minute respectively, though these can, of course—as with the other motions—be modified to a considerable extent by means of the variable resistance. The weight of the crane being about 14 tons, it will be seen that the work done in merely lifting it with its full load of 3 tons up this incline of 1 in 50 is 6 H.P., without allowing for friction in tractive effort.

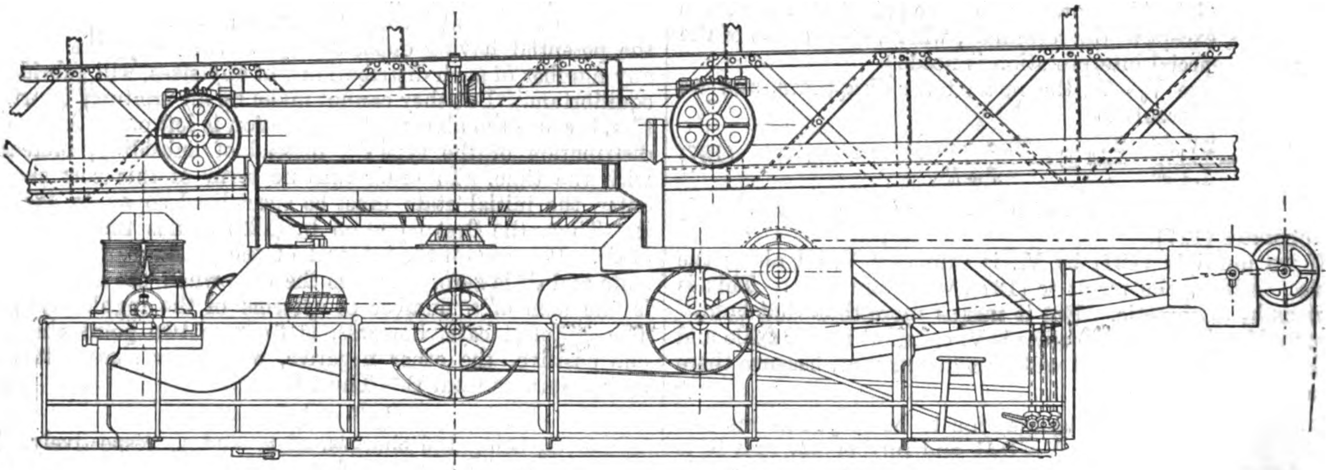

Fig. 1.—Elevation of Crane.

The circular motion of the jib is obtained by a pinion gearing into an internal wheel in the upper frame, and the circumferential velocity at the extremity is, normally, 150ft. and 75ft. per minute.

The hoisting gear is all placed in the jib, and consists of a drum grooved to receive the wire rope, and having secured to it a worm wheel gearing into a worm, which can be driven in either direction by suitable gear. There are two different speeds in this gear independent of those obtained from the countershaft, thus giving four speeds of lift—namely, 100, 65, 50 and 32·5ft. per minute. The two higher speeds are used for light weights up to 30cwts., the slower speeds for lifts exceeding this.

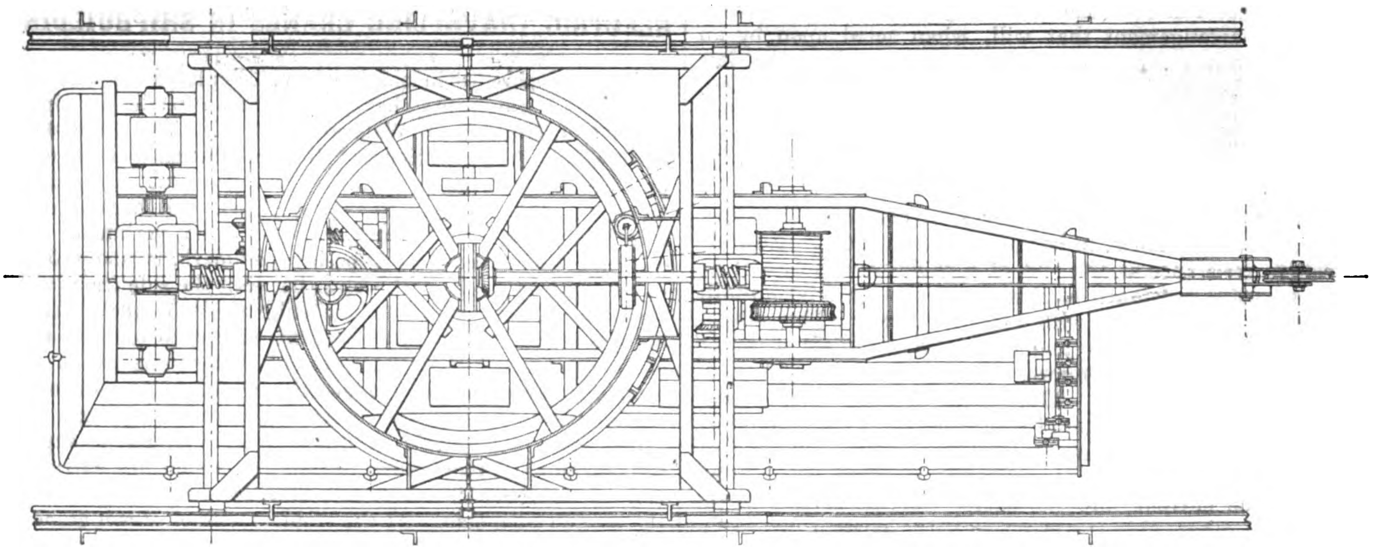

Fig. 2.—Plan of Crane.

An important consideration in this connection was that of providing means whereby the crane could not be overloaded or strained, as, for instance, by a plate catching on the underside of the ship framing. To meet this difficulty, the sheave carrying the wire rope is mounted at the end of a lever having its fulcrum near the sheave. The gudgeon pin is supported on

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a spring, and the sides of the frame are slotted, so as to allow a vertical displacement of about 3in. (*see* Fig. 1). This, therefore, allows the rope sheave to descend 3in. in case of the rope being held in any way. The long end of the lever is held by a spring which can be adjusted to suit any weight the crane is intended to deal with, and should this be exceeded the lever rises, and by so doing operates a trigger switch, which cuts off the current and so stops the motor, and at the same time releases the striking gear bar and throws the belt on the loose pulley. These operations take place so rapidly that it is impossible to strain the crane or to lift more than the weight for which the spring is adjusted.

The switches and levers controlling the several motions are all placed conveniently to the crane man, and sufficient experience has now been gained to prove the satisfactory working of these cranes, and to demonstrate that a decided step forward has been taken in the direction of rapidity and economy in connection with shipbuilding.

In the power house there are at present two shunt-wound dynamos, each capable of generating 60 kilowatts, the speed being 550 revolutions per minute, and an exciter, which also serves to charge the accumulators used for lighting the offices. The dynamos are driven by a Robey compound engine of about 200 H.P. It is intended to have two more generators of the size given above, provision having been made in the foundation to receive them. The generators, exciter, and switchboard were supplied by Messrs. Clarke, Chapman and Co., and are in every respect worthy of that firm.

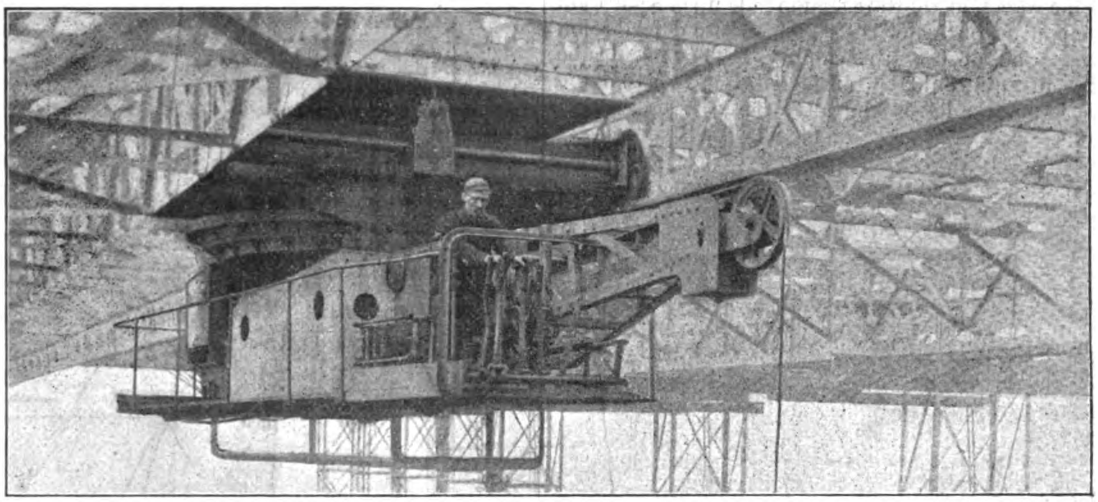

Fig. 3.—View Showing Crane in Position on Roof.

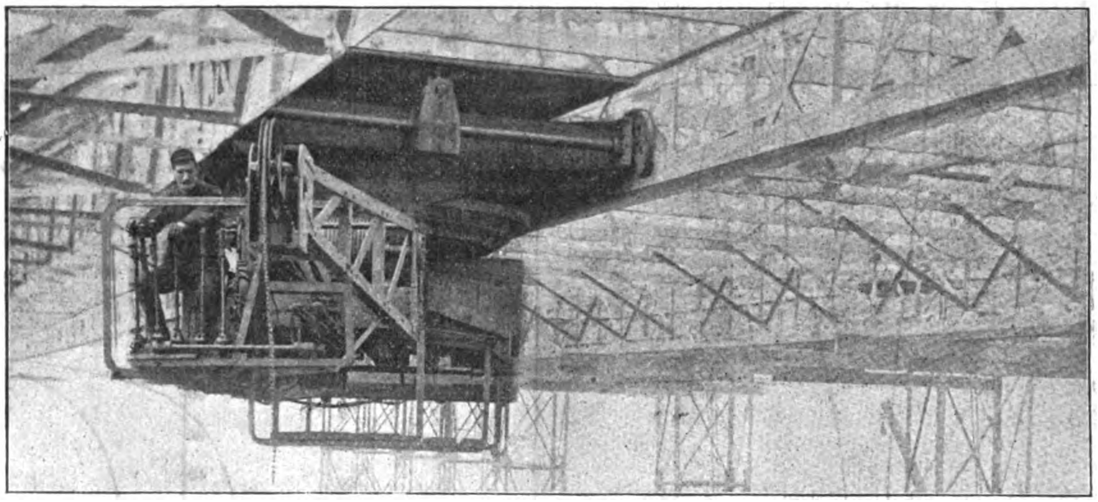

Fig. 4.—View Showing Crane in Position on Roof.

THE INFLUENCE OF THE SHAPE OF THE E.M.F. CURVE UPON THE IRON LOSSES OF ALTERNATING CURRENT TRANSFORMERS.

BY CLARENCE P. FELDMANN.

The step from the legendary ground of the pure sine curve to the real shape of the E.M.F. curve introduces complications, but allows conclusions upon the real working conditions of a transformer. Mr. A. Hill has shown, in Vol. XXXIV. of this journal, how to trace the idle current of a transformer whose hysteresis curve is known. I have gone a step further, and have found a graphical method of showing the differences between the iron losses for peaked and flat curves of E.M.F.

When trying to introduce the real shape of the E.M.F., the first difficulty is offered by the fact that not only the E.M.F., but also the curve of magnetism contains wrinkles due to the existence of the higher harmonics. The iron is thus carried through hysteresis cycles with loops, and as these loops are passed with 3, 5, . . . times the velocity as the main cycle, they must obviously change their position with regard to the main cycle.

This difficulty is overcome as soon as not only the curve of E.M.F., but also that of the corresponding magnetism, is resolved into its components, and treated in Mr. Hill's way for finding the idle current. Each component, e_1, e_3, e_5 of this E.M.F. E is a sine curve; its corresponding curve of magnetism is therefore also a sine curve, whose amplitude,

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n_1, n_3, n_5. corresponds to the maximum value of a hysteresis cycle passed with the velocities p, $3p$, $5p$ . . . respectively. If, now, the behaviour of iron used is known for all the cycles whose maximum values of B are $\frac{n_1}{s}$, $\frac{n_3}{s}$, $\frac{n_5}{s}$ . . . respectively, s being the section of the iron core, the components i_1, i_3, i_5 . . . of the total idle current J_1 may be found. These components are no longer sine waves, as they are again made up of a wattless and a watt-component, but show the characteristic deformation due to the variation of the permeability. They would be altered if eddy currents could be considered, but to avoid too great complications these losses and alterations have been left out of account.

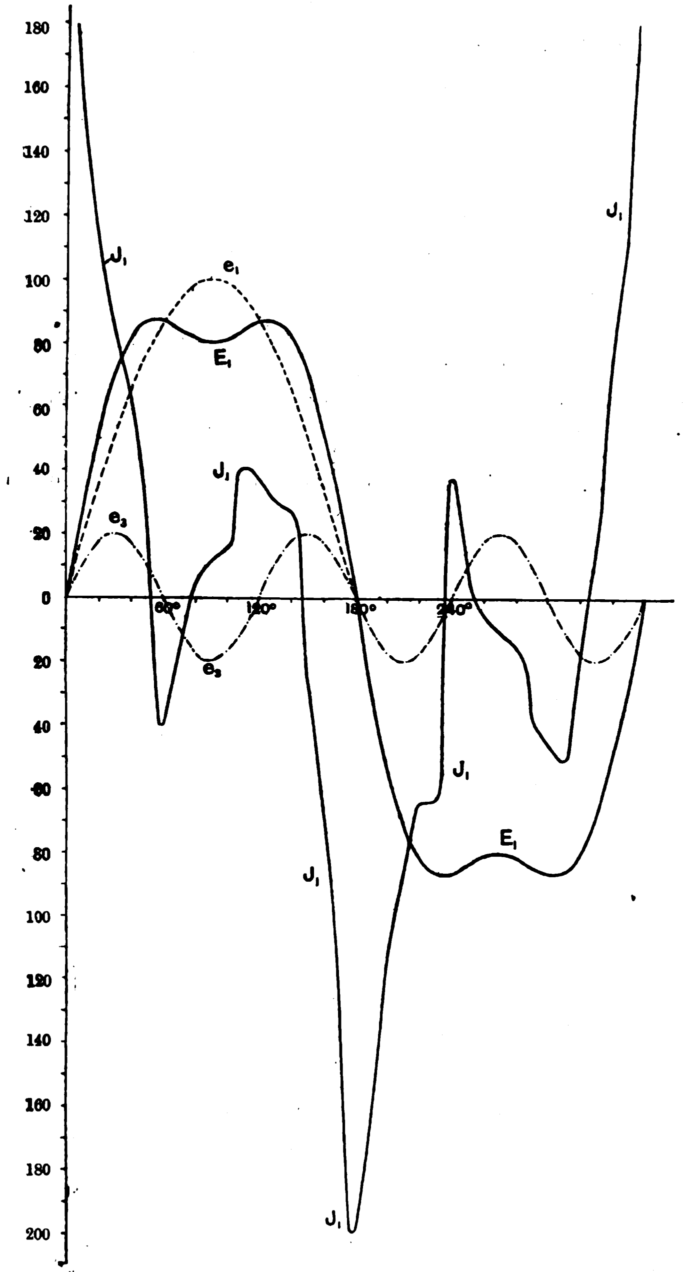

Fig. 1.—Flat Curve of E.M.F., Components of E.M.F., and Total Idle Current.

By gathering all the idle currents i_1, i_3, i_5, whose frequency is p, $3p$, $5p$ respectively, the total idle current J_1 may be obtained—a largely deformed curve with a rather high number of smaller ripples. This curve is displaced in phase with regard to the curve of the total E.M.F. E; but though these curves are both largely deformed, the product of two of their corresponding values gives the power spent in the core of the transformer at the moment regarded, and the arithmetic mean of all these momentaneous values of the power gives the mean value sought for. This value might be found by drawing and planimetering the curve of the power spent, or by multiplying corresponding ordinates of the J_1 and E curve and working out their mean arithmetic value.

Proceeding in this way with the two excessively deformed curves,

$$E_1 = 100 \sin pt + 20 \sin 3pt = e_1 + e_3 \text{ (Fig. 1)},$$

$$\text{and } E_1' = 100 \sin pt - 20 \sin 3pt = e_1' - e_3' \text{ (Fig. 2)}.$$

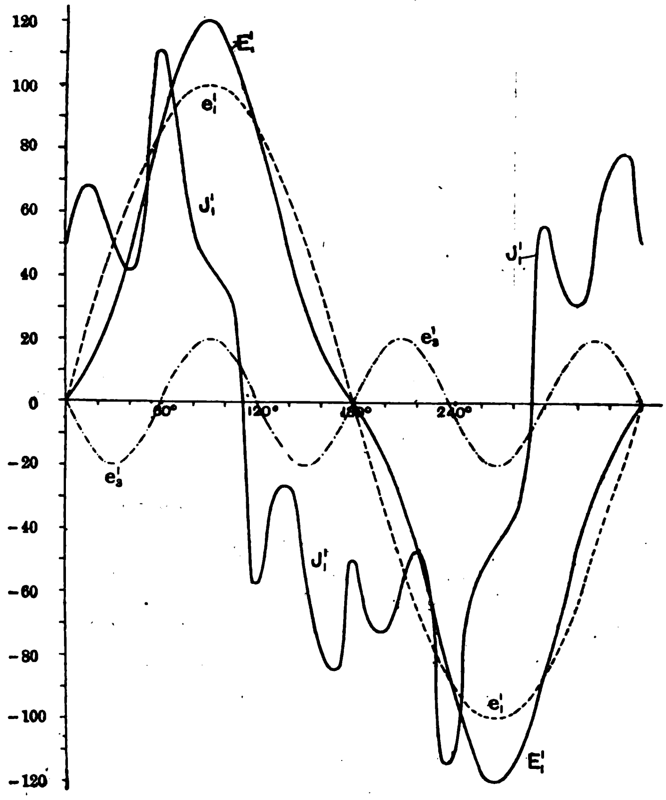

Fig. 2.—Peaked E.M.F., Components of E.M.F., and Total Idle Current.

I first obtained the components n_1, n_3 (Fig. 5) and n_1', n_3' (Fig. 6) of the curves of magnetism N and N_1', by deriving respectively the components e_1, e_3 and e_1', e_3'. Then two modified hysteresis curves (Figs. 3 and 4) were drawn whose

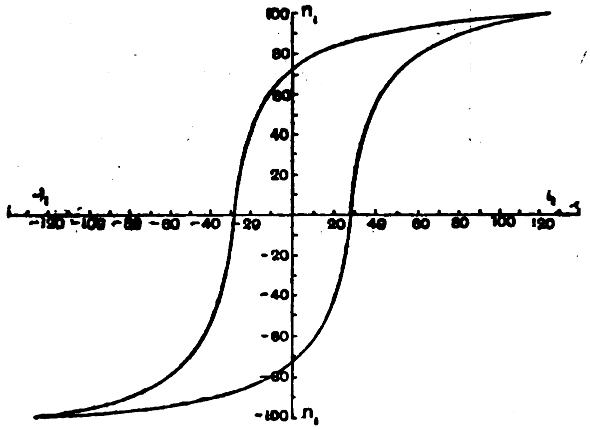

Fig. 3.—Hysteresis Curve for n_1.

maximum ordinates corresponded to $n_1 = n_1'$ and $n_3 = -n_3'$ and whose abscissæ gave directly the idle currents $i_1 = i_1'$ and $i_3 = -i_3'$ (Figs. 3 and 4). The total idle currents J and J_1', which are the sums of i_1 and i_3, i_1' and i_3', were then introduced in Figs. 1 and 2 and from them and the curves of E.M.F. E_1 and E_1', the energy spent in the iron was calculated and found to be, in arbitrary units: 653 for the flat E.M.F. (Fig. 1) and 622·5 for the peaked E.M.F. (Fig. 2), giving a difference of 4·8 per cent. in favour of the latter. These values are directly comparable, as the $\sqrt{\text{mean square}}$ of the two E.M.F.'s, as given

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by a Cardew voltmeter, viz., $\sqrt{e_1^2 + e_3^2}$, and the hysteresis curves, are the same. This result has been calculated, without the use of high mathematics, on p. 430 of my book,* and has been verified by Charles P. Steinmetz in the discussion upon the true or imaginary value of the sine curve.

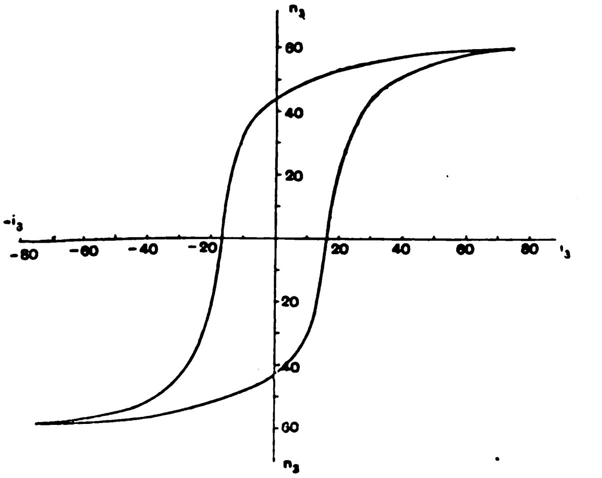

FIG. 4.—Hysteresis Curve for n_3.

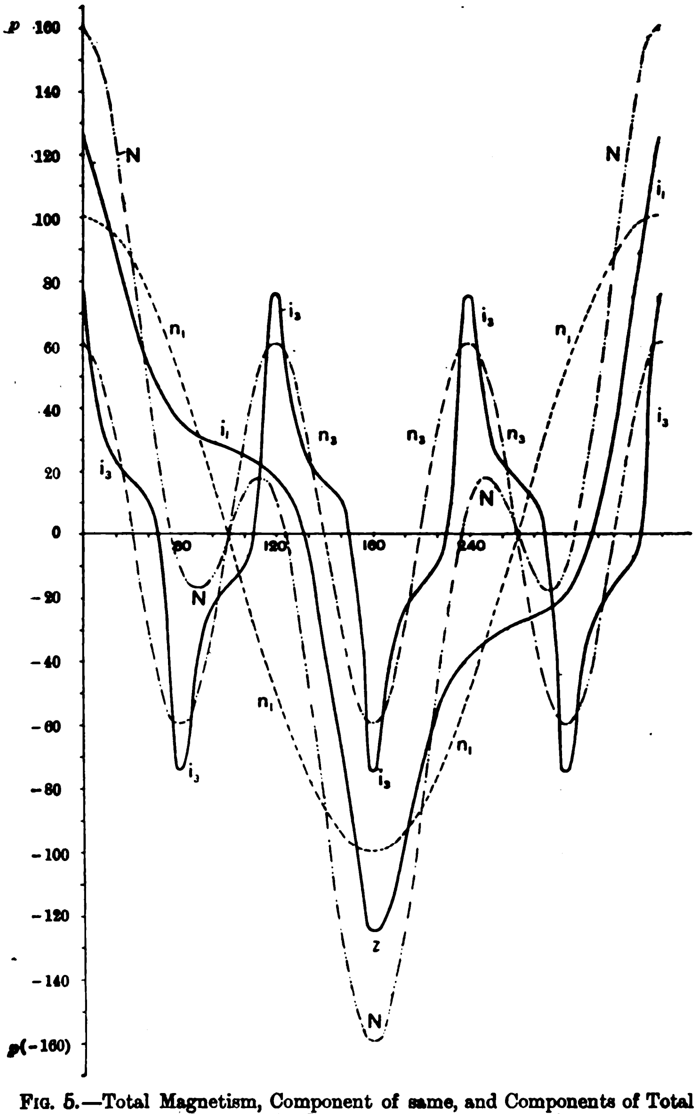

FIG. 5.—Total Magnetism, Component of same, and Components of Total Idle Currents for Flat Curve of E.M.F., Fig. 1.

A new result is obtained if the method described is carried a little further. The curve and components of the magnetism have been obtained by finding graphically the change of the E.M.F. curves. If, now, the change of the curves (N) and components (n_1, n_3) of the magnetism is evaluated, the curves

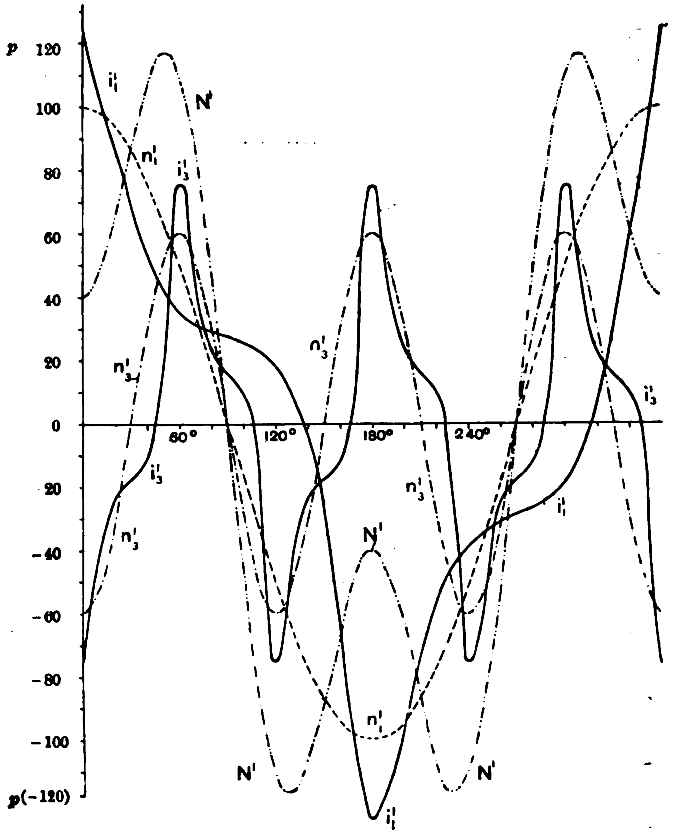

FIG. 6.—Curve and Components of Magnetism and Idle Currents for Peaked Curve of E.M.F., Fig. 1.

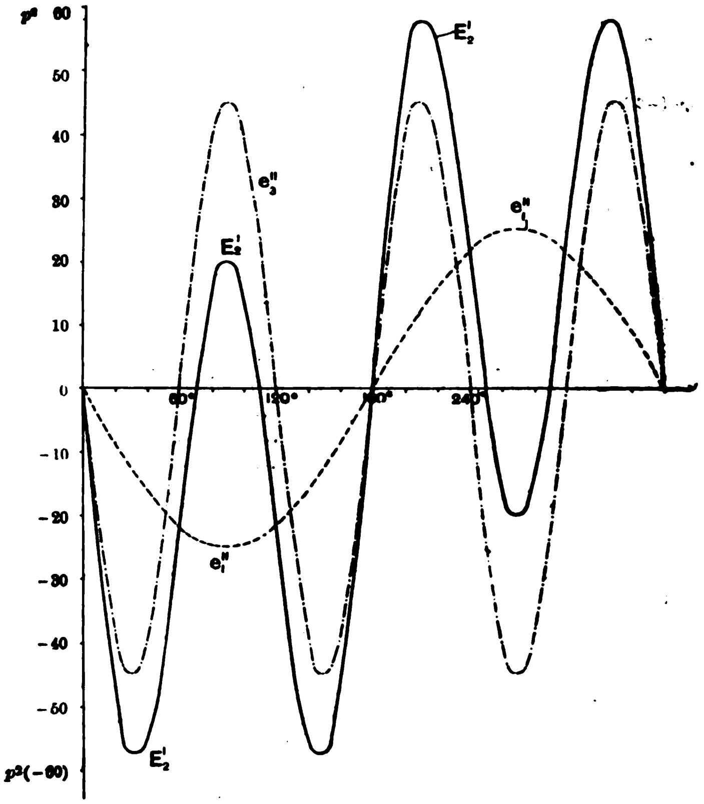

FIG. 7.—Secondary E.M.F. and Components, corresponding to the Primary E.M.F., Fig. 2.

and components of the secondary E.M.F. are obtained. They are represented in Figs. 7 and 8, and clearly show the increased influence of the higher harmonic. If the transformer is supposed to convert in the ratio 1 : 1, and so show but negligible waste field, the total idle current and its components must have

* "Prüfung, Wirkungsweise und Bereichnung der Wechselstrom Transformatoren." (Leipzig: O. Leiner.)

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the same values and opposite phases as before. By multiplying corresponding values of current and secondary E.M.F., and taking the mean value, it may easily be found that with the increased influence of the expression with $3p$ the iron core loss

For the formerly peaked curve has been diminished from 622·5 to 615·5 ...... } In the same arbitrary units as before.
For the formerly flat curve has been increased from 653 to 678 .... }

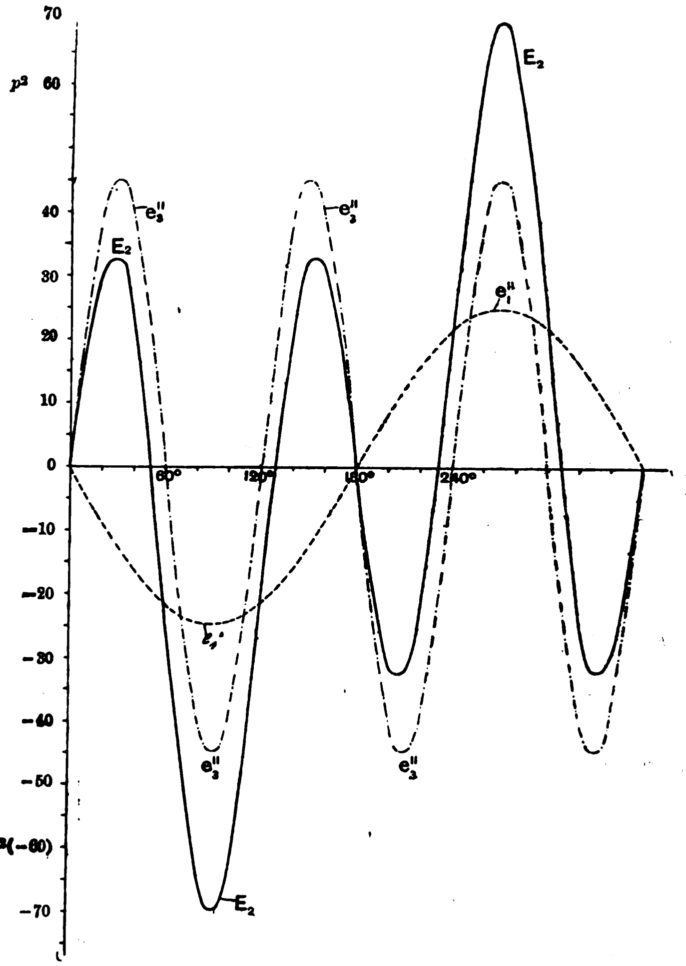

Fig. 8.—Secondary E.M.F. and Components, corresponding to the Primary E.M.F. Fig. 1.

This note has been caused by a letter of Mr. L. Neustadt, of Budapest, who told me in August of last year that one and the same transformer measured at 105 volts with differently-shaped E.M.F.'s, showed the following iron losses :—

With $p = 40$ ∾ and primary current...301 watts } For peaked
With $p = 40$ ∾ and secondary „ ...257 „ } E.M.F.
With $p = 42$ ∾ and primary current...262 „ } For flat
With $p = 42$ ∾ and secondary „ ...296 „ } E.M.F.

These numbers are not directly comparable, because of the different periodicity. But they clearly show the influence of transformation. The method described is, of course, only an approximate one.

AN APPARATUS FOR THE DEMONSTRATION OF THE DEVELOPMENT OF HEAT IN WIRES BY ELECTRIC OSCILLATIONS.*

BY IGNAZ KLEMENCIC.

The theoretical investigation of electrical oscillations tells us that for these the distribution of current over the section of a conductor is different to that which obtains for a steady current. In the case of oscillations, the density of the current is largest near the surface and smallest near the centre of the wire; in fact, with high-frequency oscillations the current is confined to a thin layer at the surface, the thickness of which depends, however, on the nature of the material. In consequence of this peculiar distribution of current, the resistances of wires are different for oscillations and for steady currents. The development of heat in a conductor, when a current is passing through, is fixed by its resistance. In two similar wires, when a steady current is passing through them, the ratios of the heat developed is given by the ratio of their specific resistances. But owing to the circumstances mentioned above the ratio of the developed heats in the case, oscillatory currents will be a different one. The experimental investigations of Bjerknes and of the writer on the absorption of energy in different wires traversed by electrical oscillations have at least qualitatively confirmed theory. It appeared to me desirable to devise an apparatus which would show in a convenient way the ratio of the heat developed by a steady current and by electric oscillations, and which would also be suitable for lecture experiments, and in the following note I propose to describe some apparatus which should fulfil these conditions, at least in a provisional way.

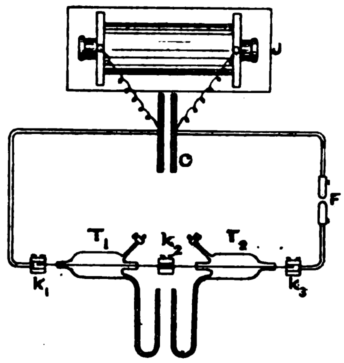

Fig. 1.

The apparatus is shown in Fig. 1. It consists principally of two air thermometers, T_1 and T_2, with the wires to be experimented upon enclosed within them, of a condenser C, and the spark-gap F. Riess, as is well known, has already enclosed a fine wire in an air thermometer for the purpose of studying the development of heat caused by the discharge of a Leyden jar. In this case the air thermometer had to be of a different shape, and the use of a very fine heating wire is out of the question. Fig. 2 shows the thermometer used, half size; *a b* and *c d* are copper wires, 3 mm. thick, to which, between *b* and *c*, the experimental wire, about 0·4 mm. thick, is soldered.) The copper wires are cemented into the

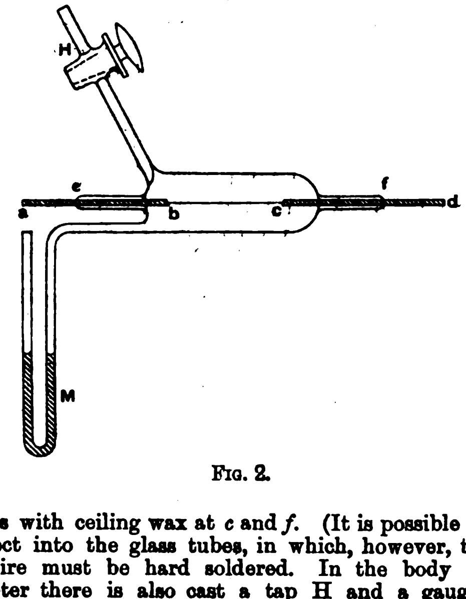

Fig. 2.

glass tubes with ceiling wax at *c* and *f*. (It is possible to cast the same direct into the glass tubes, in which, however, the experimental wire must be hard soldered. In the body of the air thermometer there is also cast a tap H and a gauge tube M. As gauge, liquid coloured alcohol can be used. Two of these air thermometers are used, containing experimental wires of equal length and thickness but of different materials. In demonstrating the development of heat in the wires, one cannot try to show that the resistance for electric oscillations is larger than for a steady current, but one must be satisfied with proving that the ratio of the resistances as judged by the development of heat in the two wires is different for electric oscillations and for steady currents. The two air thermometers are fixed by means of the copper wires to the terminals k_1, k_2, k_3. These are so arranged as to permit of an easy exchange of the air thermometers. The terminal k_1 is connected by a copper wire 3mm. thick to one side of the

* From *Wied. Ann.*, No. 4, 1895.

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condenser C, and k_3 by a similar wire, after passing the spark gap, which is about 3mm., to the other side.

The condenser consists of test tubes filled with mercury, the inner having a diameter of 18mm. A Leyden jar or a Franklin plane would serve the same purpose, only then the connection of the conductor with the plates has to be a fixed one. The two small cylinders between which the spark takes place are rounded at the sparking end and fixed into a metal shell, which again rests on glass supports. The length of the spark gap is adjustable, the most suitable distance being about 3 mm. All parts of the apparatus are fixed on a board and the terminals of the secondary of an induction coil J have only to be connected to the plates of the condenser and the apparatus is complete. It should be mentioned that the gauge glasses of the air thermometer must be vertical, and the conductor circuit horizontally arranged. The Leyden is charged by the induction coil, and as soon as the potential reaches a certain height a spark passes at F. The electricity of the two plates is then equilibrated by an oscillatory discharge, as the experiments of Fedderson and others show. The charge and discharge is repeated several times a second, and a distinct development of heat in the experimental wires is noticed, the liquid in the open ends of the gauge glasses rising. The duration of the oscillations depends, as is known, on the capacity and self-induction of the circuit. Under the conditions which obtained it was very likely less than 10^{-6}sec.

The experiments are carried out as follows :—A steady current from a battery (with a suitable resistance in its circuit) is sent through the experimental wires and the heights of the gauge liquids is observed. The ratio of these heights are the same as the resistances, or, if the experimental wires are of equal length and thickness, as the specific resistances of the wire. The cocks of the air thermometer are now opened for a moment to equalise the pressure, and then the induction coil is excited. The wires are now heated by electric oscillations, and the heights of the gauge columns are different from those observed with the steady current. Especially noticeable is this when an iron wire and a German silver or platinum-iridium wire are used. The following are a few results obtained with two pairs of experimental wires :—

I. German silver and brass wire 6cm. long and 0·37mm. in diameter ; ohmic resistance, brass wire = 0 042, German-silver wire = 0·145. The gauge column rose, with a steady current of 1 ampere, 13mm. in the air thermometer containing the brass wire, and 48mm. with the German-silver wire. When oscillations were taking place the rise was 12mm. and 26mm. respectively. The ratio of the heights for a steady current is 3·7, and is nearly equal to the ratio of the resistances ; for the oscillations it is 2·2. This corresponds with what theory would lead us to expect.

II. Iron and platinum-iridium wires, each 3cm. long and 0·4mm. in diameter ; ohmic resistance, platinum-iridium wire = 0·068, iron wire = 0·037. Rise of the gauge column with steady iron wire = 13mm., platinum-iridium wire = 23mm. When oscillations are going on, iron wire = 35mm., platinum iridium wire = 15mm. The ratio of the rises of the gauge column in the case of a steady current is 1·8, the same as the ratio of the resistances ; but in the case of oscillatory currents the rise is greater for iron than platinum-iridium wire, since the resistance to electric oscillations increases very much with the magnetisibility of the wire.

In connection with the above figures it must be remarked that the absolute values are not great, and to make the relative heat development visible to a larger audience the figures of the two gauge glasses should be thrown into a screen. In using a more powerful source of energy—for instance, an alternator—in connection with a transformer instead of an induction coil, greater rises could be obtained, and the gauge tubes could be lengthened. To protect the air thermometers from illumination it is a good thing to cover them up with paper. Although the apparatus in its present form enables one very well to demonstrate the differences in the heat developed in wires by a steady current and by electric oscillations, there is room for improvements.

PHENOMENA AND RESEARCH.*

BY G. JOHNSTONE STONEY, M.A., D.SC.

Science may be defined as the investigation of how Nature works, of how and why events in Nature occur. This investigation is best carried on by employing the Physical Hypothesis, viz , that the objects of Nature act on one another, either directly (action at a distance), or through intervening media (which by many is supposed to be an essentially different kind of action). Now, the objects of Nature, in the more strict sense of that phrase, are syntheta of human perceptions and ultra-perceptions ; and syntheta of perceptions cannot be what really act. Nevertheless, it is eminently useful to carry on our investigation under the physical hypothesis that it is they which act, and to confine our efforts to tracing out what effects this action must be supposed capable of producing, and under what laws it must operate, in order that it may account for what occurs in Nature. This, however, is felt by many persons to be too abstract an attitude of mind ; and to satisfy them, and create the plausibility which they demand, by relieving the fundamental conceptions of what is oppressively felt as the absurdity of supposing that syntheta of perceptions act, it is usual to supplement these syntheta by piling an aërial Pelion upon this solid Ossa, and by supposing that in addition to the *sensible object* which occupies any portion of space there is what is called *its material substance* occupying the same position, which, partly directly and partly by its motions, acts on other material substances (the ether being one of these material substances). According to this, which is the prevalent hypothesis among both scientific and non-scientific men, it is these substances which travel about through space ; and the sensible objects, which are what we see and feel are supposed to accompany them in their wanderings by reason of the way in which they, the substances, act (usually through intermediate material agencies) upon our organs of sense.*

This is the usual point of view ; but more careful thinkers will do well† to eschew this somewhat convenient, but by no means necessary, encumbrance upon the unadulterated process of physical investigation, which treats the sensible objects themselves, the bare syntheta of perceptions and ultra-perceptions, as though they were what brought about the changes that occur in Nature ; and which exclusively occupies itself in tracing out the laws that must, under this hypothesis, be in operation in order that the effects may be what they are.

Another and a very useful scaffolding, which helps us in building up our investigation, is the introduction of forces between the physical cause (which is always the vicinity of some natural object) and the effect to be attributed to it under the physical hypothesis. We are thus enabled to speak of the acceleration of a stone in its fall towards the earth either as being due to the neighbourhood of the earth, or as being caused by a force of gravitation which acts on it, which force is, in its turn, regarded as brought into existence by the proximity of the earth to the stone. The introduction of this piece of intermediate scaffolding is of great service—

1. Because the force can be represented by a line whose length accurately represents the intensity, and whose direction accurately represents the direction of the effect upon the stone of the vicinity of the earth ;

2. Because the same effect upon the stone might have been due to other physical causes, as, for example, to a spring urging it forward, in which case the same piece of scaffolding, a force represented by the same line in the same position, would occupy its place between the cause and the effect ; and

3. Because the effect might have been different, while the physical cause remained the same—thus, if the stone lay on the ground, what the vicinity of the earth would have occasioned is stress between the stone and the ground.

Accordingly by referring effects in Nature to the operation of forces, we are enabled in each case to indicate with accuracy the intensity and direction of the effect, without having to specify (*a*) which of several possible physical causes is the one in operation, or (*b*) which of the possible kinds of effect is that which is being produced : and this in practice is found to be an immense convenience.

Such is an outline of the principles that underlie the dynamical investigation of Nature, which is the form of investigation that penetrates most deeply into its secrets. The dynamical investigation of nature being the most complete from the physicist's standpoint, is, of course, to be preferred to any other wherever it can be employed. Our present knowledge of astronomy, of rigid dynamics, of elasticity, of hydrodynamics, are among its great achievements But there are other sciences, in which we cannot penetrate so close to the origin of things, but which are, nevertheless, amenable to mathematical treatment onwards from a station less deep-seated. In these we begin with happily chosen equations, the truth of which we have not succeeded in tracing to their dynamical source in Nature, but the consequences of which we can calculate and compare with what we observe to occur. Of this kind are the exquisite theory of light which was developed by M'Cullagh, and the enormous strides which our knowledge of electricity has made within the last half century, culminating in the marvellous electromagnetic theory of light.

In all such sciences we are greatly helped by mechanical illustrations, which may be regarded as working models, that, though they

* Abstract from an article on "The Kinetic Theory of Gases, regarded as Illustrating Nature," in the *Phil. Mag.*, October, 1895.

* The author has endeavoured to trace out what it is that really occurs in all such cases. See his Paper "On the Relation between Natural Science and Ontology," in the *Scientific Proceedings* of the Royal Dublin Society, Vol. VI. (1890), p. 475.

† This course is much to be preferred, because it effectually avoids the risk of throwing dust in our own eyes. The justification of the Physical Hypothesis is its utility, not its truth—its incomparable efficiency as a means of investigating Nature ; and it is better, though not essential, that students of Physics should make no mistake about a matter of this kind.

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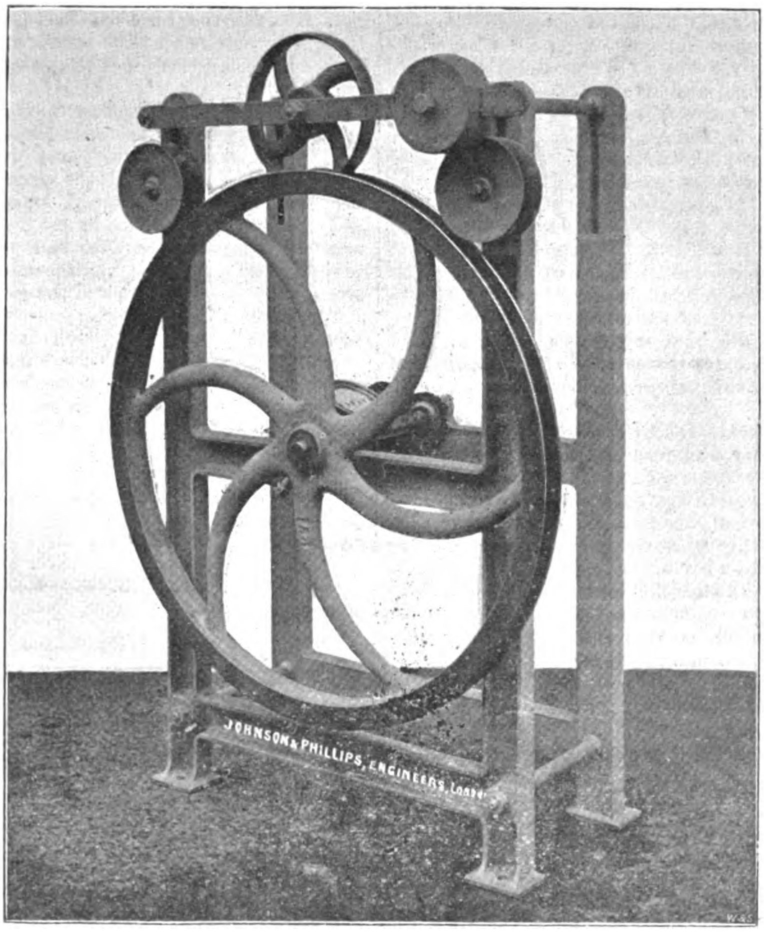
do not in the least profess to represent the unknown dynamical condition which exists in Nature, furnish us with an apparatus which operates in ways that we can both compute and conceive, and which produces results that, in some important respects and within ascertainable limits, follow laws the same as or analogous to those that prevail in the part of Nature which is illustrated by them. Of this kind is that most useful and simplest wave-theory of light which represents it by an undulation of mere transverse vibrations. Of the same kind are the various attempts to represent the "texture," which must prevail in the luminiferous ether. And somewhat akin to these are those instructive analogies which can be traced out between different sciences, wherever in both the same differential equation governs the progress of events. Thus, when a current of electricity is turned on to a circuit, the current penetrates the wire from its surface towards its core, by the same law as that by which heat would, by conduction, be carried inwards from the surrounding dielectric—a process already familiar to us, and which, therefore, makes the sequence of events in the other case easily conceived.

Again it must be remembered that in every dynamical investigation, what the mathematician really investigates is not the problem presented by Nature, but some simplification of it. The legitimacy of this process and its value depend upon the important circumstance that, in dynamics, a slight change in the data leads only, at least for a time, to a slight change in the result. Thus in computing the mutual perturbations of the planets, the planets may be treated as though they were spheres, made up of untextured spherical shells each of a uniform density throughout; and it may be left out of account that they approach to being spheroids, with mountains on their surface, irregularities of a like kind at greater depths, rocks in those mountains, minerals in those rocks, a different molecular texture in each mineral, tidal strains, heat expansions by day, contractions by night, and so on, with numberless other details. Now it is legitimate to omit all these from our calculation, for though every one of them produces its effect in actual Nature, the difference between the outcome of their joint operation and that computed from the greatly simplified data of the mathematician is too small to make any approach to being perceived by any human agency. Hence, for any purpose which is of use to man, the approximation arrived at by the simpler problem is sufficient, wherever the errors are of such a nature that they are not cumulative. Nevertheless, it should be clearly recognised that it is a mechanism illustrating Nature, and not Nature itself, that has been mathematically investigated. So it is with all dynamical investigations: the data of Nature have to be simplified to bring the task within the range of man's power over mathematical analysis; and the result is satisfactory because of the important fundamental principle referred to above, that in dynamics a slight modification of the data furnished by Nature may be safely made, because it leads only to there being a small difference between the calculated result and that which occurs in Nature—of course, care being taken in each case that the approximation of the computed result to what occurs in Nature shall be sufficiently close for the object we have in view.

CABLE-MEASURING WHEEL.

The accompanying illustration represents an apparatus made by Messrs. Johnson and Phillips, intended for measuring lengths of cable. The wheel is usually made two yards in circumference, and the one shown is suitable for measuring either small wires or cables up to 1in. in diameter. The wheel being placed *outside* the framework, the cable can be removed without trouble, either during or on completion of operation. The counting gear is placed *inside* the framework to minimise risk of damage. The counter is fitted as usual with bell to indicate any arranged length. The jockey wheel is of large diameter to give greater gripping surface and to prevent slip. The pressure exerted by it, instead of being adjusted by loose weights, is varied by simply sliding the balance weight up or down the lever on which it is mounted. Adjustable guide wheels are provided on each side to make a large cable take a larger proportion of the circumference of the wheel, and so secure freedom from slip. The counter registers absolute revolutions, the figures on the counter altering their position exactly at the end of each revolution. This the makers find much better than the worm and worm-wheel arrangement, in which, after a little wear, the measuring wheel is liable to make half a revolution without moving the finger on the counter.



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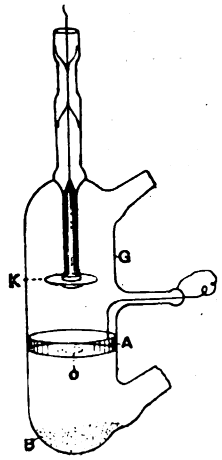
NOTE ON THE EFFECT OF THE GLOW-DISCHARGE ON OXIDE OF LEAD.*

BY E. WARBURG.

1. Oxide of lead absorbs large quantities of gas from the atmosphere and liberates them slowly in a partial vacuum. On heating the oxide these gases are also liberated; heated in the atmosphere and immediately brought into a good vacuum, no appreciable quantity of gas is evolved.

2. Yellow oxide of lead recently heated to a dull red was placed in a glass tube of 20mm. diameter, and was evenly distributed along the tube, which was then filled with oxygen at a pressure of 2·5mm. of mercury. A glow-discharge from a storage battery of 600 cells was then passed between aluminium plates or wires. Very soon the substance near the luminous portions of the discharge, alike at the cathode and anode, became chocolate brown, while the dark parts did not change colour. Rise of temperature of about 100deg. helped to produce the effect, but did not do so by itself. From this it seemed to follow that the oxide of lead, under the influence of the discharge, absorbed oxygen, and was thereby partly transformed into peroxide of lead. Further experiments proved that the phenomenon was accompanied by a reduction in the pressure of the gas, which could be still further reduced by shaking the tube, and thus bringing the unaffected parts of the oxide to the surface (*see* § 5). On the advice of Prof. Elbs a mixture of dilute hydric chloride, potassium iodide solution, and powdered chloride of zinc was made and divided into two equal portions. A piece of the unchanged oxide of lead was now brought into contact with one portion of the mixture, which became at once light blue;



into the other portion was put a piece of lead oxide that had been subjected to the discharge, and this gave the mixture a very dark blue colour. The latter oxide, therefore, contains peroxide of lead.

3. The experimental tube having recently heated oxide of lead evenly distributed in it, was filled with hydrogen at a pressure of $\frac{3}{10}$mm. of mercury. Under the effect of the glow-discharge the substance became intensely black, but again only near the luminous portions; but after a time the oxide near the dark portions were affected. It seems, therefore, that oxide of lead in contact with hydrogen is partly reduced by the glow-discharge.

4. When the experimental tube was filled with rarefied nitrogen there was no visible change of the oxide of lead after the discharge.

5. The question is whether the reactions described in paragraphs 2 and 3 are a direct consequence of chemical transformation produced by the current in the gases, or whether they merely originate from the light or the radiation of the glow-discharge. Several things point to the latter alternative. Firstly, the effect appears to come from the luminous portions of the glow-discharge. Secondly, the effect appears to be confined to the surface of the oxide of lead, as parts directly under the surface show no change of colour. If a tube of larger diameter, 45mm., is used, and the glow-discharge is arranged so that its path is a certain distance from the substance, the effect was found to be the same. If, on the other hand, a continuous current of gas is passed through the discharge tube by means of a Kahlbaum pump, and the gas on leaving this is led straightway to a tube containing oxide of lead, no trace of a change can be discovered. Finally, it can be proved that the cathode rays alone produce the effect.

In the glass tube G (*see* figure) an aluminium disc A is placed, which serves as anode, and has at O a circular opening. Through this come the rays from the cathode K, which consists of an aluminium washer covered on the back with mica, and impinges on the bottom of the tube, which is filled with the oxide of lead, B. Wherever the rays struck the substance the phenomenon occurred with hydrogen as well as with oxygen. The experiment succeeded equally with the current of the accumulator battery and with the induced current from a Ruhmkorff coil; in the first case, however, only with a low gas pressure, as it was only with such that the cathode rays could reach the substance. That rise of temperature plays a substantial part in the influence of the positive portion of the glow-discharge is improbable on account of the low temperature of this portion (paragraphs 2 and 3).

6. Some of the substance was put into a glass tube, one end of which was made tight, and on the other closed by a quartz plate 5mm. thick. After the tube was filled with hydrogen at 33mm. pressure, the rays of an arc lamp were passed through the quartz plate by means of a quartz lens right on to the substance, and after 6min. no trace of change was observed. The effects described in paragraphs 2 and 3 depend, therefore, on rays of very small wave length, since quartz is transparent to ultra-violet rays down to wave-lengths of 0·19μ.* When, however, following G. Salet,† two tinfoil rings were placed at a certain distance in front of one another, and connected with the poles of an induction coil, the phenomenon made its appearance at once.

7. There seem, therefore, to be various reasons for thinking that the rays do not effect the gas, but the oxide of lead, and cause a change in *it*, which makes it susceptible to combination with the oxygen and hydrogen. Upon this supposition it seemed probable that when the glow-discharge operated on the substance in rarefied nitrogen, and hydrogen or oxygen was quickly introduced, an effect would be produced. Experiments were made, but with negative results. Experiments with other metallic oxides have led to no results worth mentioning.

* From *Wied. Ann.*, No. 4, 1895.

* G. G. Stokes, *Phil. Trans.*, p. 605, 1865; J. L. Soret, *Arch. Sc. Phys.* 61, p. 11, 1878.

† G. Salet, *Ann. Chim. et Phys.* (4) XXVIII., p. 20, 1873.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

WEDNESDAY, October 23rd.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Ordinary General Meeting at the Royal United Service Institution, Whitehall. Paper to be read: "The Electric Lighting of Edinburgh," by Henry R. J. Burstall.

THURSDAY, October 24th.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Ordinary General Meeting. Papers to be read: "Report on the Lille Experiments upon the Efficiency of Ropes and Belts for the Transmission of Power," translated by Prof. D. S. Capper. "Observations on the Lille Experiments upon the Efficiency of Ropes and Belts for the Transmission of Power," by Prof. D. S. Capper.

FRIDAY, October 25th.

PHYSICAL SOCIETY.

5 p.m. Meeting at Burlington House. Papers to be read: "The Radial Cursor," by F. W. Lanckester. "The Development of Arbitrary Functions," by Prof. Perry and Mr. Hunt.

*** Particulars of Meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

Thermodynamics.—The following is a syllabus of the special course of four lectures on the "Principles of Thermodynamics, and their Application in Engineering," which will be delivered by Prof. Perry, at Finsbury Technical College, on alternate Thursday evenings, from 7:30 to 9 o'clock, commencing on Thursday, October 24th:—(1) October 24th, "How we Calculate exactly the Heat and Work Changes when any changes of volume pressure or temperature occur in stuff subjected only to Fluid Pressure;" (2) November 7th, "The First and Second Laws of Thermodynamics;" (3) November 21st, "Application to Air Engines and especially to Gas Engines; also to Compressors, Exhausters and Refrigerators;" (4) December 5th, "Application to the Steam Engine." One or more additional lectures may be necessary, and if so, their dates will be announced later.

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HORSELESS CARRIAGES.

It is commonly reported that an eminent lawyer once boasted that he could drive a coach-and-four through any Act of Parliament. The statement did not show much respect for the law itself, nor was it complimentary to the framers of the Acts. Perhaps the gentleman was a Parliamentary whip. We wonder if he would have undertaken to drive the coach without the four horses, which a good many individuals in the present day are wanting to do. The letters and disquisitions that have appeared in the daily papers, trying to find an "open sesame," seem to us somewhat beside the mark. Instead of seeking how far it is possible, in contravention of existing laws, or by misapplied interpretation, to escape from what is generally recognised as the full meaning and intent of the Acts, would it not be better to recognise that the law as it stands plainly and practically prohibits the use of horseless carriages, and instead of cudgelling our brains to find out how we may excuse ourselves for breaking a recognised law, set to work diligently to have the law amended? Is there any good in asking *why* we can do nothing in England without a precedent? Would it not be better to accept as axiomatic the curious fact that, no matter what may originate in the English mind for the public benefit, or to further enterprise, it will, if it involves any deviation from well-known and hard-trodden paths, assuredly have every possible hindrance put in its path until it has been recognised and adopted abroad. The latest instance of this is of special interest at the present time. Now that our good friends the French have demonstrated the feasibility of travelling safely on the public roads in horseless carriages, there is some talk of permitting the pent-up engineering ability of our own land to exercise itself. And having progressed so far, it is to be hoped the infant industry will not be stifled beneath the heavy weight of unworkable Board of Trade or other departmental rules. A slack rein should be permitted, at any rate for a time, and until experience has supplied the powers that be with a little practical knowledge of the thing to be controlled.

The display at Tunbridge Wells on Tuesday, in which Sir DAVID SALOMONS figured so prominently, will, no doubt, give an impetus to the movement in favour of horseless carriages. The most encouraging sign was the crowd of eager and expectant spectators who manifested an intelligent interest

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in the object of the exhibition, and it is to be regretted that there was not more to be seen. Considering the large number of competitors who took part in the Paris-Bordeaux race, and the many manufacturers in France who are turning out successful "*voitures automobiles*" it is a pity that only those with the Daimler motors were forthcoming, with the exception of the one with the steam bogie in front, exhibited apparently as a sample of what should not be done. This latter device certainly worked well, beating the others as to speed, and had this very desirable quality, that it did not shake and tremble when standing, as did the others. But the smoke when firing up before starting, and the trail of steam behind when running, the undulations of the carriage when passing over the fairly level meadow, and the general appearance, make its chance of adoption in this country very remote.

A very interesting exhibit was a petroleum driven tricycle, ingenious in conception and with all the parts constructed and arranged with the neatness and finish characteristic of French work. The rider was at a disadvantage; running on a meadow is obviously harder work than on a good road, and the field was, moreover, on the slope, so that the pedals had to be used more than would probably be necessary in ordinary practice.

Where were the electric carriages? It cannot be said that there are none, because, as is well known, they have threaded their way through the streets of London years ago, and are presumably in working order to-day. Why, also, did not some of the English makers of petroleum carriages put in an appearance—Mr. J. H. Knight, for instance, who has been running about Farnham up hill and down dale for months in his little carriage? Why, again, the exhibition being for horseless carriages, was the Daimler motor fire pump introduced? It certainly did good service in clearing the arena of the too eager promiscuous public, who, contrary to police protest, crowded in and blocked the view. Perhaps it was a precautionary measure, because, as is too well known, the light oil used is risky, and if it took to firing in the wrong place would make short work of the carriages.

The most interesting episode occurred after the exhibition was over. As the large concourse of people were wending their way back to Tunbridge Wells, some on foot and some in carriages, the "*voitures automobiles*" came careering along, overtaking the other vehicles and threading in and out amongst them with apparent ease. To the credit of the Tunbridge Wells horses, be it said, they shied neither at the Daimler cars nor even at the steam bogie. If the horseless carriage movement is to be anything of a success the Tunbridge Wells exhibition will have to be followed by many another, and a greater variety of exhibits must be aimed at.

REVIEWS.

Electrical Laboratory Notes and Forms (Elementary and Advanced). Arranged by Dr. J. A. Fleming, M.A., F.R.S. (London: "The Electrician" Printing and Publishing Company, Limited. 1895.)

In a system of laboratory instruction, which aims at training a large number of students to make exact quantitative measurements, the demonstrator is required to give close attention to every student. Now, in order to save the teacher's time and energy in repeating practically the same directions to different students, and in insisting on careful and systematic records being made of the observations taken, some of the instructions for each experiment are usually given in printed Papers. The teacher may add verbal explanations as far as necessary. Such printed Papers have been in common use in our technical colleges during at least the last 13 or 14 years. In some cases the notes of physical laboratory work have been arranged in book form, each book being suitable for a year's course of instruction.

The volume before us contains a collection or selection of Electrical Laboratory Notes and Forms intended for the use of students and the assistance of demonstrators who are engaged in the work of systematic laboratory teaching. Twenty elementary and twenty advanced experiments, all of important bearing in practical work, are taken up, and some of them are dealt with in a complete and thorough manner. At the outset the reader is reminded that one object of laboratory teaching is not merely to carry out a particular set of experiments, but to train the student in habits of accuracy of observation, and in proper methods of recording results. Instructions are given for the use of these Notes and Forms. The student is rightly recommended to make a careful diagrammatic sketch of the arrangement of the apparatus and circuits for each experiment, although it is not clear on which part of the sheet the sketch is to be made, if there at all. The first two or three pages of each Paper are occupied with an account of the experiment and measurements, and with Notes on the precautions necessary to be observed in carrying it out properly. The student may obey orders as here given; he may make careful observations and record the results neatly in the Forms, and yet fail to realise a very important part of laboratory instruction. It may hardly ever occur to him to think of the degree of accuracy to which a measurement is made, or of the limits of possible errors in his work. If unable to do this exactly, the student should, at any rate, be trained to think for himself, to criticise the experiments, measurements and results, paying special attention to any source of error which may not be allowed for or corrected, and to show clearly how each error referred to would affect the final result. In this way the student would be led to make *deductions* that strike him as being borne out by the experiment in hand. In the Notes Dr. Fleming does not direct the student to discuss his results and draw conclusions.

A great deal must depend upon the demonstrator as well as on the apparatus available, and all students cannot be taken as of exactly the same mental calibre and proficiency according to rigid cast-iron forms. There should be room left for variation, and slight difficulties will only tend to stimulate thought, and raise the student above the automatic machine, by making him self-reliant, and calling forth some originality in carrying out experimental investigations.

A special feature of the volume is that for every experiment two or three blank pages or Forms are appended, ruled into columns with headings setting forth the quantities to be recorded. These are supposed to take the place of the time-honoured note-book, which is thus dispensed with altogether! The practical value of these blank tabular sheets, for educational purposes, may be questioned. If the headings only were given, the student would be more likely to profit by the exercise of copying them into his note-book, and ruling columns for himself. Practical experience as a demonstrator in an electrical laboratory soon leads one to recommend the average student, at any rate the beginner, to use a rough note-book in which to take down the results of the experiments, with sketches or diagrams made in the laboratory, and to enter these neatly in another book at home. The ruled pages might be used for the latter purpose, instead of for the rough notes, as indicated. Again, we find no directions given as to how the record is to be kept on those sheets which have not columns for all the quantities observed. To be reliable and useful the table must include not only the results of calculations made from observations, but also the *actual* figures observed. Attention to this point frequently enables the student to detect errors and check his calculations afterwards.

Dr. Fleming recommends the student, where possible, to calculate the results and plot out curves *at the time* of making the observations, during the progress of the experiment. The expediency of this plan is questionable for the ordinary student in the laboratory, although often useful for the trained experimenter. Errors may be noticed at the time, it is true, but some

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students may be tempted to make the readings fit the result aimed at; and besides, the observations are not likely to be so reliable, because the attention is diverted.

In experiment No. 20, a student has to work out at once during the run the indicated horse-power of a gas engine from the cards he takes at regular intervals of ten minutes. This is rather much to expect from an average beginner, especially when the explosions in the engine cylinder are irregular in number and power, and the diagrams vary accordingly. Moreover, no record of the card is given in the table, except the indicated horse-power so found! In this test of a gas engine and dynamo plant the so-called "*combined efficiency*" ignores the quality of the gas used and consequently the amount of heat supplied to the gas engine, so that, as far as the gas engine is concerned, only the *mechanical efficiency* is dealt with; and the volume of gas obtained is of very little value without its composition and heating power, together with the temperature and pressure of supply, yet these are not even mentioned. The measurement of the heat carried off by the cooling water in the cylinder jacket is also inexact. A water meter is supposed to give the *volume* of water passing, and although the inlet and outlet temperatures are to be observed, there are no columns left for them in the table. The *weight* of water is really the quantity required, and it is usually obtained by allowing the water to flow from a calibrated tank or into a vessel placed on a platform weighing machine. The exhaust gases from the cylinder escape without any notice whatever. The instructions for this "complete" test of a gas engine and dynamo plant are clearly incomplete.

Several of the Notes need careful correction and revision, and it is surprising this has not been done before publication. Two or three examples will suffice to show the sort of thing one finds at a glance. In (No. 18) the brake method of testing "large single motors, which cannot easily be moved from their positions," and of "1 H.P. or more," the student is seriously directed to use a "flywheel" only "10in. or 12in. in diameter, and 1in. or 2in." broad on the rim, with "two ropes ½in. diameter, laid parallel to each other along the edge of the flywheel and kept from slipping off by three little cleats"! We are then told that the weight attached to the rope stretches it. The explanation is confusing. Columns are wanting for the electric power put into the motor, and for the power given out on the flywheel—their ratio only is noted. In No. 29, the term "mean-square value" is misleading, and should be "square root of mean square," which is written in symbols $\sqrt{\text{mean}^2}$.

No. 30 (page 2): the expression "one of Lord Kelvin's multicellular electrostatic voltmeters has its terminals *short-circuited* by a *well-insulated* condenser" is hardly permissible. (Italics are ours.) The long explanation, at the foot of page 2 and top of page 3, regarding the capacity current of a voltmeter, is not to the point. The voltmeter is connected to the terminals of a condenser, which is kept charged by a succession of contacts; after the first few rushes of current, when the condenser has become fully charged, the subsequent passage of current into the condenser will merely be that required to make up for leakage; and this will be negligibly small compared with the "capacity current" when the condenser is kept constantly connected to two points, between which there is an *alternating* potential difference. The explanation given would thus appear to be entirely beside the mark. Probably the author had in his mind the determination of the ratio of the two resistances by the ratio of the readings of an electrostatic voltmeter when connected across a fraction of the resistance, and the whole of it respectively.

No. 35. In dealing with the efficiency test of a secondary battery, the author fails to impress upon the unwary student the important fact that the single set of readings which he is directed to take is utterly useless so far as a determination of battery efficiency is concerned. The importance of repeatedly charging and discharging the battery until the process becomes strictly cyclical is not even alluded to.

Still, many of the advanced Notes are very elaborate and complete, and will be found useful in well-appointed electrical laboratories, when not followed too closely, and supplemented by the instruction of a demonstrator. WILLIAM ROBINSON.

THE BRISTOL-KINGSWOOD LINE.

It is not as frequently as we would wish, that we have the opportunity of inspecting, in this country, such solid and thorough electrical engineering as that which we had the pleasure of visiting last Monday, when we joined a party formed by the British Thomson-Houston Company, and travelled down to Bristol to see the new electrical system of the Bristol tramways. Constructed as it has been on the Bristol-Kingswood line, the trolley system of electric traction, now first making its appearance under the new Board of Trade regulations, has evidently come to stay; and we may therefore reasonably look forward to a recrudescence of electrical manufacturing activity. Things have settled down into a steady state, in electric lighting matters; and though contractors may still expect many an electric lighting job, it is to the extension of electric traction and motive power that they must turn for their principal sources of revenue in the near future. We shall be late in the field, without doubt, when we compare our progress with that in America and on the Continent. But better late than never; and we gain by our tardiness, in being able to reap the benefit of foreign improvements, and to profit by the warnings which their earlier mistakes afford. Speaking of tardiness, it is not a little surprising that, of all the cities of the realm, Bristol, which for decades has enjoyed the well-earned epithet of "slow coach," has at last awoke and scored first in the introduction of tramway traction under the new and we hope relatively permanent *régime* of the Board of Trade. It is true that there already exist two other English tramways—that at Leeds and that in South Staffordshire—where the overhead trolley system has for some time been in vogue. But, apart from the tentative and experimental nature of these lines, they belong to the age which preceded the laws upon which all such lines will in future have to be built.

The section of the Bristol tramways system which has been selected as the first portion to be converted from horse traction to electric traction is about four miles in length. It extends from Old Market-street, the Mile End-road of Bristol, eastward through a densely populated district to the suburb of Kingswood. The route is very varied in its features; sometimes passing through broad thoroughfares which allow of a double track, and double-bracketed trolley poles between the tracks; sometimes extending through narrow streets, where single track or interlaced tracks are rendered necessary, and where the poles must be placed on the kerb, and must have very long single brackets to support the two trolley wires. Nowhere, however, is there any very sharp curve; but the gradients are particularly trying on the forward and the return journeys, though more particularly on the former, a succession of stiff grades having to be surmounted. The steepest incline is about 1 in 15, and extends along some 220 yards of track. We happened to be on a car that, in the course of its inaugural progress, had to re-start on this particular gradient; and it may be worth mentioning that the motors took the severe load very well, and rapidly gained speed up the hill.

Each of the motor cars is equipped with two Thomson-Houston motors, geared to the car axles by single reduction spur gear. The enclosure of this gear in an oil box will tend to minimise friction and wear. The motors are started on the series-parallel system; and the regulating resistance is not required to be kept permanently in the circuit unless the speed is to be very low. The electrical equipment of the motor cars also includes a number of glow lamps, for head lights and inside lighting. Some of these lamps are connected in series directly to the trolley; but the remainder derive power from a small storage battery carried on each car, and are thus alight when the trolley has to be detached from the overhead conductor. Some of the trailers are also fitted with both oil and electric lamps, the latter for use when they are trailing, and the former when they are drawn by horses.

There are at present 12 motor cars. The whole of the electric power for these is supplied from a power house erected on the site of the old tram-horse stables, about midway between the two termini of the electric line. The

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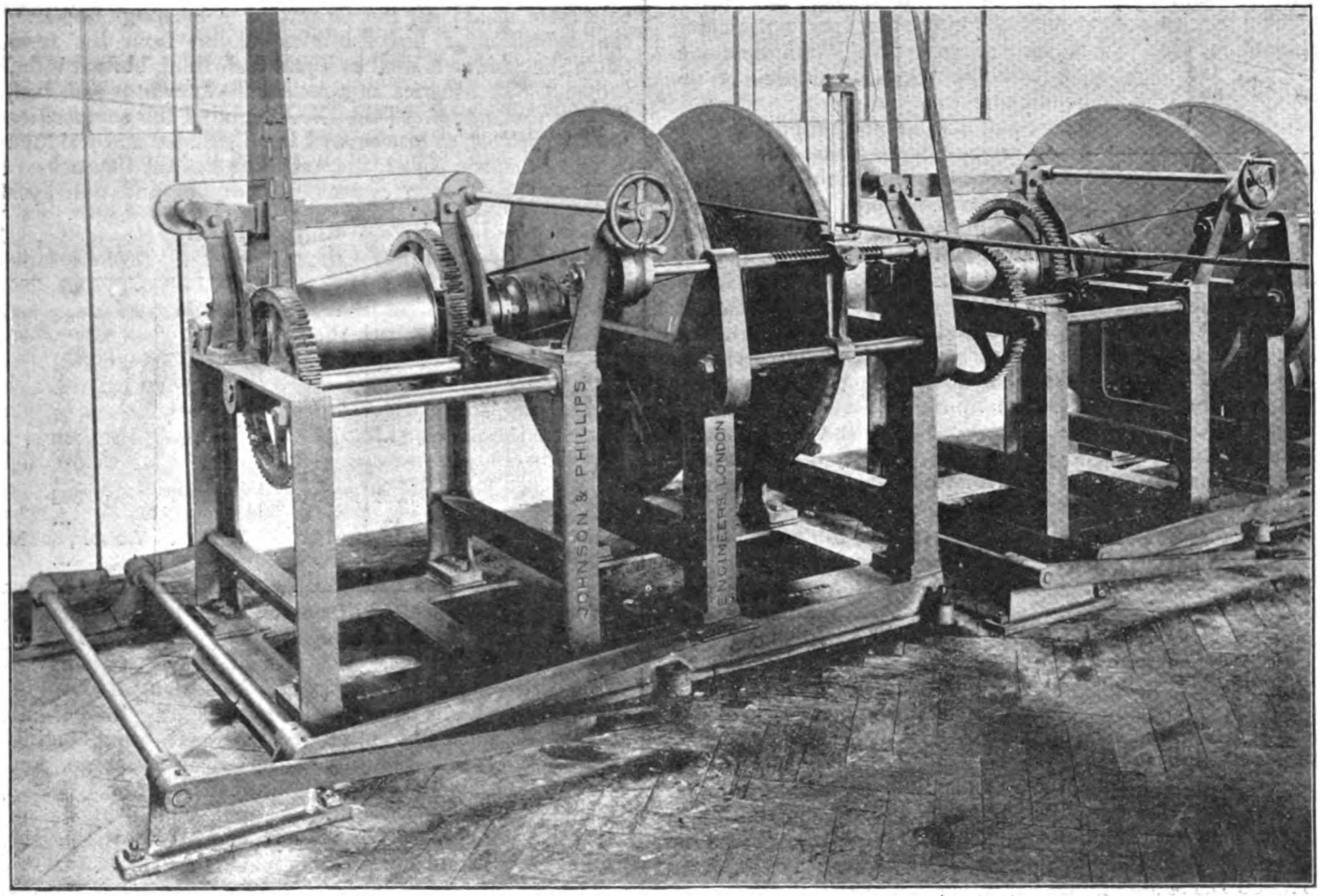
boiler and engine rooms are annexed to the commodious and well-arranged car sheds; the batch of substantial buildings also including repairing shops and other useful accessories. Within the boiler house there are, at present, two Lancashire boilers, fitted with mechanical stokers and other economising appliances. Steam at about 140lb. pressure is supplied from these to three sets of generating plant. Each of these sets comprises a 135 H.P. compound, two-crank Willans engine, running at 380 revolutions per minute, *rope-geared* to a Thomson-Houston four-pole continuous-current generator, capable of developing 200 amperes at 550 volts, at a speed of 650 revolutions per minute. The rope coupling of a Willans engine for electric power generation was in itself a novel, if not an unique, sight. It has been aptly said that in England we make our engines to suit the dynamo; in Germany they reverse the process, and make huge dynamos to suit their huge slow-speed marine-type engines; whilst in America they make a fit as best they can. It is evidently a piece of American practice that we have here, for we cannot imagine that anyone concerned thought high-speed engines coupled to their dynamos by cotton ropes were in themselves a desirable or up-to-date arrangement.

An interesting matter connected with the construction of this line leaked out during the characteristically brilliant speech with which Prof. Silvanus Thompson delighted us at the luncheon. We mention the incident because it furnishes an illustration of the care and technical skill with which the gas and water companies intend to watch the progress of electric traction in the vicinity of their works. It appears that the Bristol gas and water companies have long engaged Prof. Thompson's professional eye to scrutinise the construction of the line. No doubt the confession of this *incognito* shadowing came somewhat as a surprise for the contractors; but, doubtless, too, they breathed more freely when the learned professor declared that he would be very astonished indeed if, for many years to come, any electrolytic troubles should arise on the Bristol-Kingswood electric tramway.

The successful opening of this line of electric tramways is now an established fact. We hope that its successful continuous running will prove equally a fact, whether as an engineering work or as a commercial undertaking. Everything about the opening ceremony went off with great *éclat*, thanks to the combined generosity of the tramway company and the contractors, the British Thomson-Houston Company. Indeed, the only possible occasion for criticism is the magnitude of the ratio, when we put "the ceremony" in a numerator and "four miles of tramway" in the denominator. We have, of course, no wish to curtail our own enjoyments; but, for the sake of the industry, we shall be better pleased when the inauguration of a mere four miles of electric tramway in this country will be such a common and everyday occurrence that the event will call for little or no flourishing of trumpets, nor require that any portion of the electrical Press should indulge in the chanting of laudatory Latin songs.

AUTOMATIC COILING APPARATUS.

Our illustration shows some winding machines, of which three sets have recently been supplied by Messrs. Johnson and Phillips to the Postal Telegraph factory. The machines are designed for winding the cables on to collapsing drums for the purpose of making the cables into coils. They are fitted with automatic traversing gear for flaking the cable accurately on the drum, the speed and length of traverse of this gear being capable of variation to suit different diameter of cables. As the cable is being wound on to the drums an attendant stands by and examines it, to see that the outer covering is perfect, and it is therefore necessary that the speed of the cable shall be fairly constant. With a constant speed of the drum the speed of the cable would, of course, increase as the drum fills; this is compensated by means of the cone driving pulleys along



General View of Wire Coiling Machine.

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which the belt can be shifted by means of a small hand wheel. The machines are driven from a similar cone on an overhead countershaft, through a friction clutch, which is actuated by means of the foot levers and connecting rods shown.

MOTIVE POWER AND GEARING.*

(*Continued from page 516.*)

BY E. TREMLETT CARTER.

Gas and Oil Engines.

Gaseous and Liquid Fuel.

Classification.—The general properties of fuel and the principles of its combustion have already been stated. Gaseous and liquid fuels possess the same general properties and liberate heat, by combustion, in the same way as solid fuels. There is, however, this difference between the two cases, that solid fuels are invariably burned outside the engine, while gaseous and liquid fuels are capable of both internal and external combustion. The sources of gaseous and liquid fuels are very varied; they may be divided into (1) natural and (2) artificial sources.

The following Table includes the principal fuels in each class:—

Table XXVII.—*Gaseous and Liquid Fuels.*

	Natural.	Artificial.
Gaseous.	Natural gas.	Coal gas.
	Marsh gas.	Acetylene.
	...	Water gas.
	...	Producer water gas.
	...	Producer oil gas.
Liquid.	Petroleums.	Alcohols.
	...	Ethers.
	...	Creosote.
	...	Tar.
	...	Paraffin or shale oil.

Coal Gas.—The two most important fuels in the above Table are coal gas and petroleum, so far as this country is concerned; but in those countries where light hydrocarbon gases are freely emitted from fissures of borings in the ground, as in the oil districts of America and Southern Russia, natural gas is of considerable importance as a fuel. Coal gas is a manufactured article of varying composition and quality. It is a mixture of certain hydrocarbons with carbon monoxide and certain useless gases. Into its mode of making we need not here enter; the electrical engineer is chiefly concerned with it as a fuel supplied through pipes. Its average composition may be taken as that of the gas used in the Society of Arts trials of gas engines, an analysis of which is shown in the following Table:—

Table XXVIII.—*Average Composition of Coal Gas.*

Constituents.	Percentage volume.
Heavy hydrocarbons	3·77
Marsh gas (CH_4)	37·34
Hydrogen (H)	50·44
Carbon monoxide (CO)	3·96
Carbon dioxide (CO_2)	0·51
Oxygen (O)	0·00
Nitrogen (N)	3·98

From the large percentages of free hydrogen and lighter hydrocarbons, coal gas becomes an exceedingly rich fuel. The average thermal value per pound weight may be taken at 22,000 B.T.U.—a figure which is often exceeded, though also sometimes far from being reached. This datum is equivalent to a thermal value of 740 B.T.U. per cubic foot of gas; the specific volume being about 30 cubic ft. per pound. The evaporative power of average coal gas is, therefore, about 19·5lb. of water from and at 212°F. per pound of gas. Using bituminous gas coal, about 4·5 cubic ft. of commercial gas can be produced from one pound of coal, apart from any water gas which may be made with the coke residue. Gas works are now extensively fitted with coke-consuming gas plant, the products of which are added to the actual volatilised coal gas.

Petroleum.—Crude petroleum is a mixture of several liquid hydrocarbons of the paraffin (C_nH_{2n+2}) series, traces of the olefines also being present in the petroleum of certain districts. Its principal occurrences are in Southern Russia, on the shores of the Caspian Sea, and in North America, but considerable quantities of crude petroleum have been obtained in many other parts of the world. The natural oil has, unfortunately, never been obtained in commercial quantities in the United Kingdom. The occurrence of the oil in the vicinity of salt deposits has given rise to the hypothesis of their similar origin, yet the origin of petroleum is still enshrouded in mystery. In America the oil is pumped from great depths after boring operations have been undertaken, but in the Caucasus it often spouts copiously through the bore-holes. For example, when the Droojba well was uncapped a column of oil, some 18in. in diameter, rose to a height of 300ft., throwing up and wasting nearly 500,000 tons of oil before it could be checked.* In the Caucasus not more than 10 sq. miles of oil district have been exploited, while some 1,800 sq. miles have been proved to be rich in oil. In America the prospects of continuous supply are nearly, if not quite, as hopeful.

Crude petroleum is unsuited for commercial use, partly because of the presence of explosive hydrocarbons and partly on account of earthy impurities. It is subjected to processes of settling and distillation before being exported for use. The distillation is fractional—*i.e.*, it is carried on at successively higher temperatures, and is in several stages; but there are three principal stages: (1) The separation of low-flashing petroleum spirit; (2) the separation of burning oils; and (3) the separation of heavy lubricating oils from the residue. Often the residue is used as liquid fuel, being burned in boiler furnaces. In America this residue is known as *residuum*, in Caucasus as *astatki*. Table XXIX. shows the composition of Russian petroleum in terms of the distillates and residues, as given by Ludwig Nobel, the "oil king" of the Caucasus. The Table is based upon commercial outputs, and not upon a laboratory analysis:—

Table XXIX.—*Yield of Oils from Russian Crude Petroleum.*

Commercial oils.	Percentage volume.	Specific gravity.	Flashing point in degrees Fahr.
Benzine (light oil)	1·0	0·725	14
Gasoline	3·0	0·775	32
Kerosene (burning oil)	27·0	0·882	77
Soliarovi (lubricating oil)	12·0	0·970	212
Veregenni	10·0	0·890	302
Ordinary lubricating oil	17·0	0·905	347
Cylinder lubricating oil	5·0	0·915	392
Vaseline	1·0	0·725	...
Liquid fuel	14·0	Variable.	Variable, but high.
Lost in refining	10·0	...	...

Very frequently all the residue after kerosene has been distilled is used as liquid fuel, representing about 65 to 70 per cent. of the crude oil. The specific gravity of this refuse varies between 0·889 and 0·911. The yield of burning oil from American oils is, on the average, greater than from the Russian, as much as from 50 to 60 per cent. being obtainable. There are several qualities of American kerosene, known commercially as "Tea Rose," "Royal Daylight," &c. The specific gravity of these varies from 0·802—in the more expensive quality—to 0·820, in the cheaper kind; and the flashing point similarly varies between 100°F. and 122°F.

The heat of combustion of 1lb. of refined petroleum (burning oil) is on the average about 27,000 B.T.U. As high as 28,100 B.T.U. may be obtained from the lighter and more expensive oils; but, on account of their low flashing point, these are not always safe. Much lower value will be obtained from the cheaper and very crude oils; but these may leave a

* From a forthcoming work to be published by *The Electrician* Printing and Publishing Company. All rights are reserved.

* "The Region of the Eternal Fire."—Marvin.

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thick residue after combustion, which renders them unsuited to most oil engines, and unsatisfactory in any case. Russolene, or Russian kerosene, "Tea Rose" and "Royal Daylight" are the brands most commonly used in oil engines.

Natural Gas.—The outflow of oil from a newly-drilled well is generally preceded by the discharge, under enormous pressures, of gaseous hydrocarbons. In many places the gas soon subsides, and oil follows; but in other places a steady flow of gas is maintained, and the discharge may be drawn off through pipe lines, for lighting purposes or for combustion under a boiler. In America natural gas is largely used for steam raising; and the practical thermal value of the fuel is estimated as being equal to about 30,000 cubic ft. of the gas per ton of coal. According to this estimate, the thermal value is about 28,000 B.T.U. per pound of the gas. Richer yields of the gas often exceed a thermal value of 30,000 B.T.U.

Water Gas.—Pure water gas is obtained by the action of steam on incandescent carbon. It is rarely if ever used commercially; but the action is the basis of several commercial fuel gases, notably of Dowson gas. The action which takes place is endothermic, and it is represented by the following chemical equation—

$$H_2O + C = CO + H_2 . . . . . (97)$$

A mixture of hydrogen and carbon monoxide gases results. According to the equation, the mixed gas contains 93·33 per cent., by weight, of carbon monoxide and 6·66 per cent., by weight, of hydrogen. One pound of carbon will develop 2·5lb. of the gas. The calculated thermal value of the gas is 6,100 B.T.U. *per pound of the gas*, or 15,250 B.T.U. *per pound of solid carbon* contained in it. Now, the total heat of complete combustion of one pound of solid carbon is 14,500 B.T.U. Hence, the process is partially one of storage of energy; for the total heat of the gas is greater than that of the solid carbon, the surplus heat being supplied by the furnace which keeps the carbon incandescent and raises the steam.

Gas Producers and Storage Plant.

The Dowson Gas Plant.—Although the practical introduction of generator gas-fuel is to be attributed to Sir William Siemens, it will probably be acknowledged by all that the chief impetus which has been given to the use of gaseous fuel generated from fixed solid fuels came from Mr. J. Emerson Dowson, whose literature on the subject has widely extended the knowledge of this form of heat source, and whose admirable generating plant has rendered its use a commercial possibility.

Dowson gas is a form of diluted water gas, made by the action of a steam-and-air blast upon incandescent carbon, usually anthracite, but occasionally coke. The endothermic action indicated by equation (97) takes place; but in addition a portion of the carbon is completely consumed by the air, this latter action serving to maintain the high temperature of the generator. An illustrated description of the Dowson gas generating plant recently appeared in conjunction with an account of the Morecambe gas-engine electric supply station, in *The Electrician*, October 4, 1895, p. 753. On this account we shall here pass the detailed description of this form of gas generator.

Composition of Dowson Gas.—It has already been stated that Dowson gas is not a chemical compound, but a mixture of many gases. In actual practice the proportion of its constituent gases is variable within considerable limits, and the thermal value of the gas suffers corresponding changes. Firstly, the composition of the gas, in practice, seems to depend on the solid fuel used, anthracite giving, in general, a richer gas than coke. It appears that with coke too much air streams through the porous fuel and out at the top of the generator, without generating combustible fuel. Thus the percentages of nitrogen and of free oxygen are apt to be higher than where anthracite is used. Again, the composition of the gas depends upon the pressure of the steam blast, and upon the proportion of air which that blast can inject with itself. When the generator is called upon to develop gas very fast a high pressure of blast will be required, while when the demand for gas is low the pressure will have to be throttled down. Consequently the composition of the gas—and its dynamical power in the engines—will vary with the load put upon the gas generators. A test flame is usually kept burning near the generators, and the height and colour of this flame serve as some guide to the quality of the gas being produced. Table XXX. gives the average of several analyses made by Dr. Monaco on the gas given off directly from the generators, in a station at Canale, Piedmont. According to this average result the heat of combustion of one pound weight of Dowson gas is about 2,600 B.T.U., and the heat of combustion of 1,000 cubic ft. is 177,500 B.T.U. The theoretical volume of air required for this combustion is equal to the volume of the gas burned.

Table XXX.—*Average Composition of Samples of Dowson Gas taken from a Gas Generator at Canale, Piedmont. Temp. 32°Fah. Pressure 14·22lb. per sq. in. (abs.).*

——	Percentage volume.	Percentage weight.	Weight in pounds per 1,000 cubic ft. of Dowson gas.
Carbon dioxide (CO_2)...	8·40	14·73	10·057
Oxygen (O)	0·90	1·15	0·784
Hydrogen (H)	16·47	1·32	0·897
Carbon monoxide (CO).	27·50	30·67	20·946
Nitrogen (N)	46·73	52·13	35·595
Total..................	100·00	100·00	68·281

Thwaite's System.—For the production of Dowson gas, fuel composed entirely of *fixed* carbon (neglecting mineral matter) is requisite, and practically anthracite is the only fuel that answers the purpose. In many parts of this country the relative costs of anthracite and small bituminous coals are such that it is cheaper to use the latter in steam plant than the former in gas plant. Yet these parts are the most populous and industrial in the country. The need, therefore, has arisen for a gas generator which will generate fixed gaseous fuel from bituminous coal, using both the volatile and the fixed constituents of the coal. Such a gas plant has been devised by Mr. B. H. Thwaite. The principle of its action consists in the turning of the volatile portions of the fuel into products of complete combustion, and then reconverting them into combustible gas—this time *fixed*, not volatile—by passing them through a furnace of incandescent fixed carbon obtained from the coked fuel. The result is that all the hydrocarbons are turned into free hydrogen and carbon monoxide, while the fixed carbon produces only the latter of these gases. The only objection that can be raised against the theory of this most ingenious process is that it requires the available energy of the hydrocarbons to be considerably let down or reduced by the combination of their carbon with one equivalent of oxygen.

Gas Holders.—Hitherto gas holders have been used, in electric supply stations using generator gas, only as equalisers of the pressure of gas. There has been little or no attempt to store the gas for any great length of time, so as to equalise the load on the generators. At Morecambe, where there are two 75 H.P. Dowson generators and one of 150 H.P., and where gas engines amounting to more than 175 H.P. are daily at work, the gas holder has a capacity of only 1,500 cubic feet. So small is this in comparison to the draught of gas, that with full load on the station and no gas being freshly made the holder will be emptied in ten minutes. At other places the capacity is proportionately low. It is scarcely possible that under these conditions the gas plant can be working at its highest efficiency; and it would be well, in designing such plant, to provide so large a holder as that the fluctuations of load on the gas generators should be reasonably small.

Cost of Generator Gas.—Some facts may now be stated that will assist in making any definite estimate of the cost of working by generator gas. At the Morecambe station the coal is purchased for 18s. per ton, and the cost of fuel per B.T.U. metered out of the station varies from 0·3d. to 0·5d. In addition, the sawdust scrubber is recharged once every three weeks; the coke scrubber once every six months; the boiler consumes about 120lb. of coke per hour; and the

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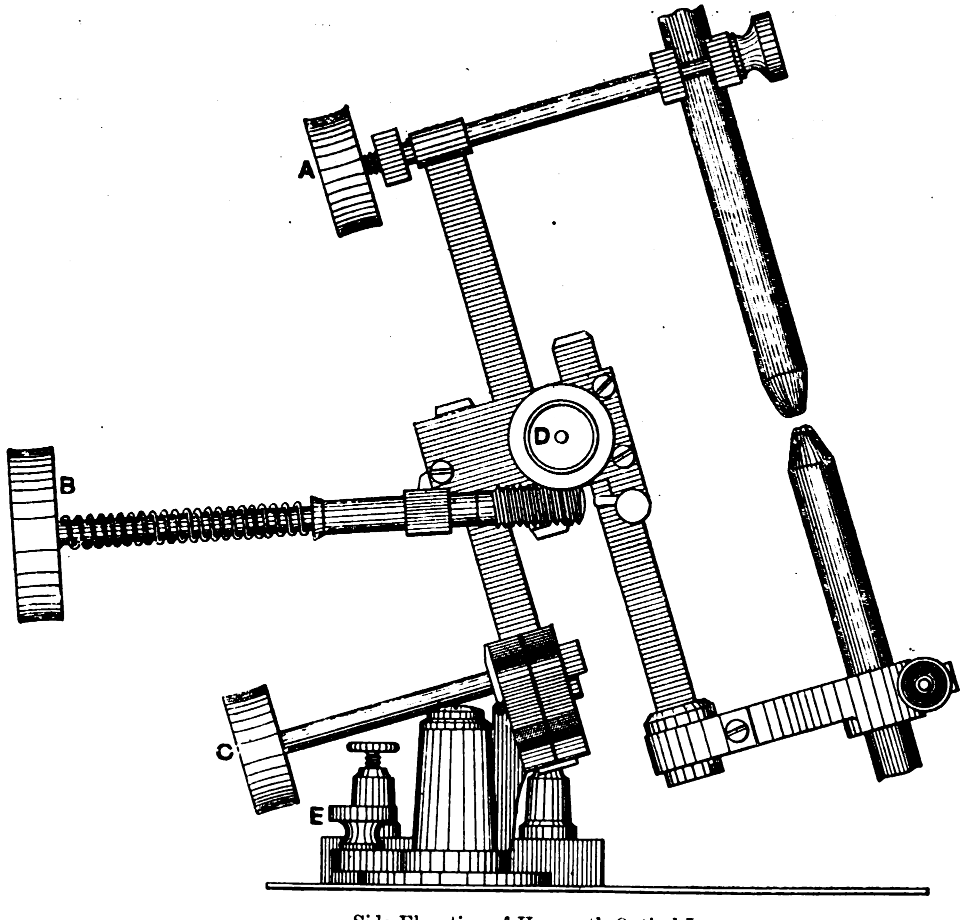
attendance required for the whole of the gas generator plant is one man. At the Coatbridge station, where there is a total gas generating capacity of 240 H.P., and where anthracite costs 12s. 6d. per ton, the coal consumed is at the rate of 0·6d. to 0·7d. per Board of Trade unit; the boilers consume 2·5 tons of coke per week; and sawdust for the scrubbers cost 2s. 6d. per week. The output of this station is about 11,600 B.T.U. per quarter in the winter quarter. At a large gas-engine station known to the author, but one not used for public electric supply, two generators each of 100 H.P., one of which is always used as a stand-by only, consume 22cwt. of anthracite per diem, on a 17 hours run, with banking up and stand-by losses included. The electrical output is about 640 units per run. On an average for half a year the coal consumption was 5lb per unit; but in the depth of winter the consumption fell to 4·25lb. per unit.

(To be continued.)

THE ROSS-HEPWORTH PROJECTION LANTERN ARC LAMP.

There has of late been a very noticeable activity among makers of projection lanterns in the direction of introducing the arc light, the general tendency being towards a gear which shall be at least as easy of manipulation as that of the old type of lantern, and resembling it externally as closely as may be. A very complete arc-light apparatus for projection lantern purposes has recently been devised by Mr. Cecil M. Hepworth, and is now being made by Messrs. Ross and Co., of New Bond-street; it was shown in the rough at the *conversazione* at University College this last summer, and attracted deserved attention.



Side Elevation of Hepworth Optical Lamp.

In the accompanying sketch is shown a side elevation of Mr. Hepworth's lamp. The carbon holders are supported by two massive toothed guide-rods, gearing into a pinion between them, which causes them to move in opposite directions. This pinion is connected to the tangent wheel D, which engages with a worm-wheel, and a slow feeding motion is given to the carbons by turning the milled vulcanite head B. Should it be required to bring the carbons momentarily together, the head B may be pushed forwards, causing the worm-wheel for the moment to act as a rack, and imparting a very rapid rotary motion to the tangent-wheel and pinion. A strong spiral spring on the feeding handle causes it to fly back the instant it is released, separating the carbons, and bringing them to the exact relative position they occupied before. Rotation of the top milled head A enables the lanternist to displace the positive cratered carbon relatively to the lower one. Rotation of the bottom milled head C raises or lowers both carbons bodily, so that the crater can be brought into the optical axis. If the milled head B is given a cant upwards, the worm-wheel is disengaged from the tangent-wheel D, and the carbons can be rapidly separated or brought together by turning D. One more movement has to be referred to, and that is a slot and screw E on the base plate, by means of which the entire gear may be swung round as required. The lamp is made to take 13mm. and 10mm. carbons, but, of course, can be arranged to take carbons of other diameters.

Mr. Hepworth's lamp is well made, and seems in every way likely to serve its purpose in a thoroughly satisfactory manner.

The Japan-Formosa Cable.—The manufacture of this cable is now in full swing at the Telegraph Construction and Maintenance Company's Works. Amongst the firms which tendered for this contract must be numbered the two French cable manufacturing companies.

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DR. FLEMING'S REPORT TO THE PLYMOUTH ELECTRIC LIGHTING COMMITTEE.

[ABSTRACT.]

After a short glossary of terms, Dr. Fleming states that he was requested to advise: (1) On the electric lighting generally of Plymouth by the Corporation; (2) on the utilisation of town refuse as fuel; (3) on the employment of electric traction in connection with tramcars in Plymouth; and proceeds to preface his remarks by a short statement of the present state of electric lighting in the United Kingdom. These preliminary remarks conclude as follows:—

"The above list of municipal electric light undertakings shows, however, that the public supply of electric current is no longer a matter on which the slightest room for doubt as to its practical success can exist. The results of the last five years' experience have also been to show that the advantage to the local authority in retaining the public supply of electricity in its own hands are very great. In many cases in which supply companies have built up a solid business, such as in the towns of Liverpool, Bath, Southampton and other places, the corporation or local authority are now feeling the necessity for acquiring it, and will generally have to pay more for it than it cost in the first instance to establish it. It may therefore be remarked that it is advantageous that in Plymouth there is no electric lighting company in present possession, and requiring to be bought out, but a clear field exists for establishing a Corporation Electric Station on the best lines. The experience gained in the last five years or more of the financial results of working shows that the business of public electric supply can be carried on with a profit, which is not only sufficient to repay the loan and meet current interest, but which affords a prospect of making a further margin of profit to the advantage of the town. The experience generally has been that the first year of working is sufficient to place the undertaking in a position to pay its outgoing expenses, and that from and after that time increasing contributions are made to the loan repayment and interest fund."

System Suggested for Adoption at Plymouth.

The adoption of an alternating-current supply system, with transformer sub-centres, is recommended, the Cattewater site, a property owned by the Corporation, being considered well adapted for the establishment of a supply station. The station building is recommended to be designed for an ultimate output equal to 30,000 8 c.p. lamps; only about one-third of the station to be erected at first, and provision made in the initial building in generating plant at first only for 7,500 8 c.p. lamps operated at one time, or for about 10,000 lamps connected to the mains. As regards the size of a unit, Dr. Fleming advises the adoption, at first, of one not larger than 75 or 100 kilowatts; the alternators to be direct driven, as at Portsmouth or Leicester, and to generate current at 2,000 or 2,400 volts; the current to be transmitted by armoured concentric cables laid direct in the ground to the transformer sub-stations. Dr. Fleming suggests the adoption of the plan he has carried out successfully at Taunton, where no junction boxes are used at all, and hence no receptacles for the collection of gas, and, therefore, no risk of street-box explosions. This plan consists in making at once, when the distributing cables are laid down, a connection or service to every house. For the distributing mains he recommends concentric lead-covered and steel-armoured cable laid under the pavements, as these are quickly laid and give no trouble.

The Report then proceeds as follows:—"I have considered very carefully the question of supply of electric current for power to private houses, shops, and places of business. As gas in Plymouth has a low price, the supply of electric power will have to compete against gas engines served with cheap gas. I think that this may act to retard the growth of a demand for current for power in the daytime, and it has not been found that the sale of power in small units has progressed very fast in any of the provincial towns. If, however, further inquiry shows the necessity of meeting any demand for power in small units which cannot be met more cheaply by gas motors, then I should suggest for adoption in this case a two-phase alternating-current system, by which current, not only for light, but for power, can be distributed, if required. As regards the frequency of alternations, my own strong preferences are for a moderate frequency, such as 50 periods per second, which has been adopted with success at Portsmouth, Ealing and Derby."

The Report then proceeds to strongly recommend that a day supply be not given at first, and that on the subject of charge the full price, viz., 8d. per unit, should be charged for the units supplied to all lamps which burn one hour or less per day; but that a reduction to 4d. per unit be made for all units supplied over and above the one hour per day for such lamps.

Dr. Fleming states that he holds the view very strongly that whenever a corporation undertakes the electric supply, good street lighting should form part of the scheme. Every ratepayer has an equal interest in good and well-arranged public lighting in the streets, and the adoption of a system of arc and incandescent lighting for the streets is, he considers, an essential matter. Ordinary continuous or "rectified" alternating currents are suggested.

Capital Outlay.

After discussing the matter at some length, Dr. Fleming concludes as follows: "Hence it may be considered that for a well-designed alternating-curent supply station, having a total capacity, say, of 400 kilowatts, and a lamp connection of 10,000 8-c.p. lamps, and spare plant and effective working capacity of 300 kilowatts, the probable revenue would be about £5,000 a year, and the capital outlay about £35,000. On an annual output of 200,000 units it can be shown that the whole operating cost can be brought within £3,500, and thus leave £1,500 to pay the share of sinking fund and interest. . . . The above estimate does not include the arc-lighting plant. The general recommendation I make for this portion of the work is that arc-lighting plant should be established at first for about 90 arc lamps with proper reserve plant. This will require four direct-driven arc-lighting machines, three for use and one spare plant, these being either dynamos or equivalent plant in rectifiers. Separate engines will have to be provided for these arc-light dynamos if adopted, but the steam can be taken from the same boilers which supply the steam for the incandescent lighting dynamos. If the rectifiers are employed no separate engines are required, and, subject to the consideration of tenders, the experience at Portsmouth and other places warrants me in believing that there are strong reasons in favour of employing the rectifiers for the arc-lighting plant."

On the Employment of Refuse Destructors for Power Purposes.

"One question on which I was requested to advise in connection with any proposed scheme for electric lighting at Plymouth is the employment of a refuse destructor for generating steam. In the last eight or nine years widespread interest has been aroused on the subject of refuse destruction in towns, and in connection with the subject attention has been given to the possible utilisation of the power represented by the heat given out by the combustion of this refuse. Very different opinions have been expressed by various authorities on this subject, and I may say at the outset that the greatest caution is necessary in accepting many of the statements which have been made on this subject, and also in applying the experience which has been gained in one place to another.

"As your borough surveyor is, I understand, engaged in collecting information for a report to you on the whole subject of refuse destruction, I have handed over to him a quantity of information which I had collected together, on the subject of refuse destruction and the utilisation of the heat for steam generating purposes. I may say, however, that the broad general result I have derived from the consideration given to this subject is that it would be unwise for the Corporation to embark hastily on any scheme which has for its basis a proposal to establish a refuse destructor solely with the view of generating power for electric lighting. The waste heat from a destructor already existing, or which has to be erected purely on sanitary grounds, may be usefully utilised as an adjunct in generating steam for electric lighting purposes; but the statement which has been made that the ash-bin refuse of towns is capable of being made available and sufficient for the whole electric lighting likely to be required is one which has not at present received sufficient confirmation in fact or experience. The general result derived from the actual experience of refuse destructors is that each cell of a destructor is capable of yielding directly by its waste heat on an average 5 H.P., and that such a cell may consume from 5 to 6 tons of ash-bin refuse per day without the use of forced draught.

"Opinions differ very widely as to the economy and utility of using the forced draught; but if we set on one side exceptional cases, and take the above as an average figure, then it is perfectly certain that an amount of refuse destruction equal to about 30,000 tons per annum cannot possibly yield directly the amount of horse-power required in the electric lighting station at the hour of maximum full load. In order to maintain the 10,000 8-c.p. lamps above suggested something like 500 or 600 H.P. must be available at the time of maximum load, but the direct heat from the refuse destructor of the capacity required for the consumption of the above amount of refuse would not probably amount to more than 50 or 60 H.P. The matter would have an altogether different aspect if the power generated by the boilers of the refuse destructor could be stored. A scheme has been put before the Shoreditch Vestry, in London, for utilising the waste heat of dust destructors in combination with a system of steam storage invented by Mr. Druitt Halpin. This system practically consists of large tanks or boilers, into which the steam from the destructor boilers is passed, and in which water and steam are accumulated under considerable pressure for utilisation at a subsequent time. The experiment of thermal storage and destruction will be watched with great interest by engineers, but it would, I think, be wise to hold back from following on the same lines until some experience has been gained

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of the safety and economy of such a system of thermal storage in practice.

"The one fact that stands out prominently is that the waste heat of the refuse destructor, furnishing at the rate of 1 H.P. per ton of refuse burnt, if utilised directly, is not sufficient to supply the power required for the suggested electric lighting in Plymouth during the hours of maximum demand. It might, however, be utilised during the daytime or hours of night if the destructor station were placed in contiguity with the electric lighting station.

"I therefore suggest in this connection that the plans of your borough engineer with regard to refuse destruction in Plymouth should hold in view the possible utilisation of the waste heat for part of the power required in the electric lighting station, and that the destructor station and electric lighting station may therefore very conveniently be placed in contiguity on the Cattewater site, but at the same time I hold the opinion that the electric lighting station should be made at first entirely independent, and that the question in the forefront as regards a destructor station should be the sanitary one. There will be no difficulty in making the necessary arrangements to utilise the waste heat from the destructor for steam generating, and using it as far as possible in the electric lighting station, if the two are placed side by side. If subsequently a system of thermal storage enables us to do more than we can at present do by the combustion of the ash-bin refuse, that also can be added, but at the present moment I advise strongly that the electric lighting station be made independent of the other.

"At the present time we are able to refer to a number of schemes which have been proposed for the utilisation of the waste heat of destructor cells, but an examination of what has actually as yet been achieved does not warrant me in advising the adoption of any of the proposals which have been put forward for depending entirely on refuse combustion for the generation of current for electric lighting. As your borough engineer is dealing with the subject there is no need to enter into further details as to the manner in which such waste heat as is available can be employed in raising steam."

On the Employment of Electric Traction in connection with Tramcars at Plymouth.

After discussing the *pros* and *cons* of the conduit system, the overhead trolley system, and accumulator cars, Dr. Fleming sums up as follows: "There is, therefore, little room for doubt that the only practical system of electric tramcar traction at the present moment is the overhead system. If this is carried out with all the precautions and knowledge now available, I do not consider that an overhead system is at all objectionable. The light iron posts which carry the trolley wires can be made available as supports for arc or incandescent lamps in the streets in which they exist, and with proper regard to the construction of this overhead work there is no reason to believe that it would in any way interfere with other traffic or be a cause of complaint by its appearance. As regards the cost of working, a careful analysis of a large number of electric railway accounts shows that the average working cost per car mile, exclusive only of interest on capital, is approximately 6½d. in America and 5½d. in Europe, and that the ratio of working expenses to receipts in both countries is approximately 60 per cent., in contrast to which the working cost per car mile on horse tramways appears to be on an average 10d. per car mile, and the ratio of expenses to receipts over 80 per cent."

Dr. Fleming concludes by stating that his general suggestion as to electric traction in Plymouth is that a careful consideration should be given to the question of operating one line at first electrically in the eastern part of the town by a well-devised overhead system, and that the system of power transmission should be such as to be capable of being extended to lines running out in other directions if the results warrant further extension, the Cattewater site being used. His opinion is, however, that the generating machines necessary for supplying the currents for the electric traction should not be the same as those employed for the electric lighting, though steam for both plants might be supplied in one common battery of boilers.

ELECTRIC TRACTION FOR LEEDS.

A special meeting of the Leeds City Council was held on Tuesday afternoon for the purpose of considering the question of tramway traction.

Alderman FIRTH, as Chairman of the Highways Committee, moved that the report presented by the Highways Committee on the subject be adopted. In doing so he briefly reviewed the action of the Committee that was appointed to consider the matter. It would, no doubt, be understood by the Council that they were not there that afternoon to discuss the question as to whether the tramways should be worked by the Corporation or be let to a company, but they were assembled merely to discuss what kind of haulage should be adopted. The Tramways Committee had neither spared time nor trouble in their investigations. There were no two opinions, so far as Leeds was concerned, that a more humane system of haulage than that by means of horses ought to be adopted for the permanent working of the tramways. As to steam haulage, which obtained in parts of the city, many of the members of the Council came to the conclusion years ago that steam engines in the streets ought not to be tolerated as soon as a better system of haulage could be found. Then the Committee's attention was drawn to a system of haulage with motors worked by oil. After carefully examining they came to the unanimous conclusion not to adopt that. Another kind of traction suggested was by motors worked by gas, and in regard to this also the Committee were unanimously of opinion that it would not do for Leeds. Two kinds of traction then only remained for the Committee to consider—the cable system and electricity. It had been suggested by certain members of the Council, and by other people outside, that the two systems might be adopted in the city—that the cars should be drawn by cable in one part of the city and propelled by electricity in another. In the centre of the city it was thought they might have the cable system and in the outskirts the electric system. It was patent, however, that the two systems could not be worked together. The Committee had to look at this question first of all from the standpoint of initial capital cost and secondly the working expenses. The initial cost of the necessary equipment to work the cable system in Leeds would, it was estimated, be £428,922, and the annual working cost £111,819. These figures were worked out on the basis of giving a 7½ minutes' service to all the outskirts of the town, a 3¾ minutes' service for another part, and for the immediate centre of the city a 1⅞ minute's service. The Committee felt it was only fair that both the advantages and disadvantages of the two systems should be set out in the report presented to the Council. The advantage of cable over electric traction was, in the first place, the fact that for the former no unsightly poles were required in the streets, and no overhead wires. There was, too, less wear and tear by the cable system, and the cars moved with less noise than when propelled from overhead wires. The initial cost for the adoption of the electric system in the city would be £378,499, and the working cost £90,072 a year. These figures, he knew, had been questioned. The city engineer was, in the first case, responsible for the figures. Could the city engineer possibly have any interest in trying to put one scheme before the public in preference to another? An element quite as essential in any system they might adopt as its cheapness was its efficiency. There was no question in the minds of the majority of the Committee that the electric system of haulage was far superior to the cable system. One of the advantages of electricity over the cable was that no central slot was required in the street, upon which horses' feet could skid or bicycle wheels could enter. In the cable system three-fourths of the power generated was used to work the cable itself, if there was not a single car put upon it. Now, as far as electricity was concerned, the power generated could practically all be utilised. Electrical cars, too, could vary their speed, and this was a very important factor. The cable car could not vary its speed, but must travel according to the speed of the cable. Therefore, if a car got behind its time it could not make it up afterwards. The speed of the cable, too, would have to be fixed in accordance with the speed at which the cars in the centre of the city were required to travel. In addition, there was less interference with the streets with electricity than with cable in case of repairs. Again, if anything happened to the cable, the whole system was out of gear, and no car could run until the damage had been repaired. No such thing obtained with the overhead electrical system. If a wire broke in a place, the breakage could be located. Another important feature was that they could not reverse the motion of a cable car, which must proceed to its destination. As to the objections raised to the poles and wires required for the overhead electric system, they could judge by their own experience in Leeds. The Roundhay people complained bitterly when the posts and wires were put up in their neighbourhood; but now, he ventured to say, there was scarcely an inhabitant in that district who would consent to have those posts and wires removed, and the system of haulage changed. It had been stated that cars on the Roundhay Park line weighed no less than 9½ tons. The Committee had had one of them weighed, and found that its weight was only 6¼ tons. But electric cars were now being produced which did not weigh more than 5 tons, and that was not excessive. The large steam-drawn cars in the city were 4½ tons. The Tramways Sub-committee had carefully and deliberately considered this question, and their report had been confirmed by the Highways Committee. The Tramways Sub-committee were all but unanimous in favour of the report, and the Highways Committee were also very nearly unanimous on the question.

Alderman SCURHAM seconded the resolution.

Alderman NORTH supported, having confidence in the Tramways Committee, and believing that the overhead electric system was the

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best available. He added that he had been in favour of the cable system, but had seen reason to change his view. He hoped that the resolution would be carried, and that they would proceed at once to carry it into effect.

Mr. HANNAM moved an amendment to the effect that the report be referred back to the Highways Committee for further consideration. He was a progressive man and desired to see the best possible system adopted, but he did not think the question had been sufficiently considered in detail. There were systems which had not received attention. He was disposed to regard Wilson's cable, in use in South Staffordshire, superior to anything else. He admitted that in the event of a change of system at some future time it would be easier effected and at less expense if the electric system were adopted, but while recognising the merits of that system, he felt that the erection of overhead wires would be a disfigurement of the thoroughfares. There was no need for hurry in the matter, and he asked that the claims of the cable system he had mentioned should be considered.

Mr. BEAUMONT, who seconded the amendment, contended that the members of the Highways Committee had simply given formal approval of the report of the Tramways Sub-committee in order that the question might come before the Council, and had not thereby pledged themselves to vote for the electric overhead system recommended by the report.

Alderman SCARR urged that they should lose no time in laying down the electric system.

Mr. DENISON pleaded for further delay, and then argued in favour of the adoption of the cable, which he said had always been admitted to be a profit-making system. He suggested that they should provide a cable for the Headingley route, and apply the electric overhead system to the Kirkstall route, and see which was the more satisfactory.

Mr. GRAHAM also supported the amendment, and spoke in favour of the cable system.

Mr. J. F. CARTER opposed the resolution, submitting that the erection of wires would be the ruin of the city.

Mr. TWEEDALE said he was not content to vote for the electric overhead system. He was told by electricians that there was one serious objection to it on the ground that, with a quick service of cars, the metals became charged with electricity to such an extent that the fluid escaped through the street pipes, and found an entrance into the houses along the route. In America, he was informed, thousands of pounds had been expended in efforts to get rid of this defect, but so far without success. It seemed to him that more definite information was required.

Mr. MART said the cable, in his judgment, was out of the question, being far too costly. As a member of the Tramways Committee, he had calmly and without prejudice considered the matter, and was of opinion that if the Council would boldly declare itself in favour of the overhead electric system and carry it out, there would be no cause to regret the step. That would be much cheaper than either the cable or the conduit electric system, and when a self-contained electric car was available there would be comparatively little loss in making the change. Objection was taken to the overhead wires, and those on Roundhay-road were pointed to; but, as had been shown, it was possible to have an overhead installation which was ornamental, and which would facilitate the lighting of the streets by electric lamps. He had heard not a single valid argument which would warrant them in sending the matter back to the Committee.

Mr. BATTLE could not agree that the report of the city engineer was in any way of a biassed character. Mr. Hewson had honestly given to the Committee in the report the result of his investigations. The electric system appeared to be the cheapest, and it was certainly, in his opinion, the most comfortable. No one could desire greater ease than riding in the Roundhay-road cars. The resolution, however, he was afraid, was of too sweeping a nature, and thought they had better wait a little, and consider whether the present receipts from the tramways justified the enormous expenditure suggested in the report.

Mr. SCOTT also supported the amendment, maintaining that the question was too important to be hurried.

Mr. GORDON spoke in favour of the amendment. Although in favour of an electric system, he did not consider himself competent to judge of the merits of the different electrical systems—overhead, conduit, and self-contained cars. They wanted some reliable expert evidence before they proceeded to spend the money suggested.

Mr. LEUTY, M.P., was opposed to going in for samples three miles long.

Alderman WARD said they had had an opportunity of examining the books of the Roundhay Park concern, and of ascertaining the exact cost of its working, and it was upon this information that Mr. Hewson had computed the cost of working the overhead electric system. With respect to the overhead wires, it was not proposed to repeat the arrangement on the Roundhay line. The poles, where necessary, would be put against the buildings, and where the road was wide enough it was intended to have ornamental standards, which would also permit of lighting the thoroughfares by electricity. Here choice must be between cable and electricity, and if cost were considered he could not understand how any member could hesitate in preferring electricity. Those who counselled delay had complained of the delay in bringing forward the report and in proceeding to improve the tramways. In voting for the resolution, members would not be pledged to the spending of the whole of the estimate; it was the intention of the Committee to carry out one section at a time, and if that were done they would have an opportunity of seeing how far the system was successful. At present it was apparent that the overhead system was the greatest commercial success. Mr. Gordon proposed to bring in experts. So many experts had been offering their services that the Committee had found them a nuisance. In the hands of experts they would not know what course to adopt, and he hoped the Council would not accept Mr. Gordon's advice. He should certainly vote for the resolution.

Mr. HENRY, who supported the resolution, asked, if decision in the matter was to be delayed, what was to be done with the worn-out tramway tracks? At present, thousands a year were being spent on these, and if there was to be further delay, that waste must go on. He could not see that anything would be gained by waiting until after the forthcoming municipal elections had taken place, for the new members would require some time to become informed in the matter, and when they had obtained their knowledge it might be said that November was again drawing near. It was clear that the Council might for ever delay settlement if that were to be a reason for doing so.

Alderman FIRTH, in his reply, pointed out that harm might arise from delay, because several miles of the existing lines were exhausted. It was scarcely safe to travel on the Chapeltown route. They were now spending at the rate of betwixt £4,000 and £5,000 a year in simply patching those old lines, and if those were relaid they would be relieved of such expenditure. As to calling in experts, he said every expert had his own fad. A committee of experts would not present a report in 20 years. So far as the Committee were concerned, not a single man of them had entered upon his investigations with a bias on his mind. They had come, he believed, to a wise conclusion, and he asked, in the interests of the city, to let there be no further delay on this question. Whether they preferred cable or electricity, do not let them delay the matter any longer.

The amendment was then put, and was lost by 24 votes to 29 votes.

Mr. WILSON then moved a further amendment that the report be adopted, and that it be an instruction to that Committee to forthwith extend the Roundhay electric tramways to the park and centre of the city on the conduit system, with a view to testing its value.

This was seconded by Mr. MOSES GAUNT, but Alderman Firth assuring Mr. Wilson that it was the intention of the Committee to proceed in the first place with one short length of conduit as an experiment, Mr. Wilson withdrew his amendment.

The report was then adopted by 40 votes to 11 votes.

The Leeds Corporation Highways Committee have lost no time, after the adoption of their report by the Council, in advancing the question of the future tramway haulage one step further. On Wednesday afternoon a meeting of this Committee was held in the Council Chamber, and instructions were given to the Tramways Sub-committee to make arrangements for carrying the resolution into effect. It was suggested that the overhead wires from Sheepscar should be extended to the Dispensary, in North-street, and that an electrical conduit be laid from there to Boar-lane. A thorough test, it was argued, could thus be made of the practicability of the overhead and conduit systems being worked in conjunction with each other. However, the matter rests with the Sub-committee to make recommendations. Before the meeting concluded a hearty vote of thanks was accorded to Alderman Firth, the chairman. The resolution was moved by Alderman Ward, seconded by Hannam, and supported by every member of the Committee.

BOOKS RECEIVED.

"Alternating Electric Currents." By Edwin J. Houston and A. E. Kennelly. (New York: The W. J. Johnston Company.) Price $1.

"Mesures Electriques." By Eric Gerard. (Paris: Gauthier-Villars et Fils.)

"Cavi Telegrafici Sottomarini." By Emanuele Jona. (Milano: Ulrico Hoepli. 1896.)

"Elements of the Mathematical Theory of Electricity and Magnetism." By J. J. Thomson, F.R.S. (London: C. J. Clay and Sons.) Price 10s.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *October 5, 1895.*

Parsons' Turbine in America.—The Westinghouse Electric and Manufacturing Company has announced that it has purchased exclusive rights for the use and manufacture of the Parsons steam turbine in the United States.

The Buffalo-Niagara Franchise.—The matter of the franchise granting the Niagara Company the privilege of selling electric current within the city of Buffalo is not yet definitely settled. Several weeks ago the committee of the City Council in charge amended the franchise originally offered so as to meet, it was thought, all the objections of the Niagara Company, extremely great concessions being made for this purpose. This week, however, the franchise was again rejected, and the demand made that the compensation to the city should be reduced from 5 per cent. to $2\frac{1}{2}$ per cent. of the gross receipts. When the framing of the franchise was first undertaken by the Buffalo authorities it was apparently thought that the Niagara Company was in a defenceless position, and very onerous conditions were incorporated in the first draft of the measure. Somewhat to the astonishment of the Buffalo people, it was then found that the Niagara Company appeared to be quite indifferent about transmitting power to Buffalo, and after a time the efforts made in building up a manufacturing city in the neighbourhood of the Falls brought the Buffalo people to realise that perhaps they were the ones to act the part of suppliant. This seems to be the position they have now assumed, and the attitude of the Niagara Company is considered by many people to confirm their belief that the talk of transmitting the power of Niagara to a distance was a mere blind—the Niagara enterprise being primarily a land-jobbing scheme, which expects to derive profit, not from the electrical plant in itself, but in leases and rentals from the vast landed property which it possesses in the immediate vicinity of the power house, and now being developed as a manufacturing centre.

Prof. Forbes and the American Press.—The article by Prof. Forbes in *Blackwood's* has been receiving surprisingly wide attention from the newspaper Press of this country, and the comments printed are not, to say the least, favourable toward the Professor of the claims made as to his share in the success of the Niagara scheme; it should be added, however, that the matter of the article is scarcely considered by the newspaper writers from a technical standpoint, notwithstanding the conclusions arrived at. The many unfortunate remarks made about America and Americans in the article have been resented in an old-time "spread eagle" style, and it is not too much to say that Prof. Forbes at the present time is perhaps more unpopular in America than any Englishman has been for a generation.

CORRESPONDENCE.

MAGNETIC UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It seems to me that the success of the volt, ampere and ohm as practical units of E.M.F., resistance and current respectively is due not more to their being of convenient values for everyday requirements than for the fact of their simple relationship. For one person who requires to know the relationship of these units to the C.G.S. system there are ten who use them without thought or knowledge of their derivation.

If names must be given to units, I heartily agree with Prof. Thompson that the C.G.S. unit should be the ones named, using prefixes "kilo," "mega," &c., for if one must hark back or forward through 10^x intervals when making a calculation, it is convenient to have x indicated beyond doubt in the prefix, instead of having to recall it with an effort of memory, or even perhaps to look up some reference.

Reverting for a moment to Prof. Lodge's letter in your issue of September 6th, I was somewhat amused, when—thinking I would knock the bottom out of his argument for simple multiples by suggesting that he should take one or two seconds less instead of exactly three weeks—I found that his 15,834,000 seconds equals not three weeks, but exactly 26 weeks 1 day 6 hours 2min.! Did the Professor then write a random number of seconds, or has he unwittingly taken one of the precious simple multiples with which our practical system of weights and measures abounds which properly belonged to some other system? (Those of your readers who have time to spare might try whether 15,834,000 is divisible by 4π or any function thereof!) Seriously, 15,834 *mega* seconds would not be an inconvenient expression, were it not that in this special case it would be convenient to know how many weeks and days (the relation between which has been unalterably fixed for us) were represented in the time.

Referring again to Prof. Thompson's speech at the B. A. meeting, is there any reason why we should not compound the prefixes thus: de-mega, cent-mega, mil-mega?

Stress has been laid upon the necessity for distinguishing between **H** and **B**, and I fully recognise the convenience of doing so; but are not such distinctions in reality relics of the "action at a distance" idea? If we suppose a coil of wire in vacuo and an alternate-current sent through it, what generates the E.M.F. of self-induction? The answer is, I suppose, the magnetic lines generated in the ether. Does it not seem, then, that the force and the compression, or whirl, or whatever it may be, are one and the same? Does not the very idea of force distinct and separate from motion, compression, or tension, seem to savour of action at a distance? Still, I admit that the idea of force seems necessary to our present mode of thought.

Returning for a moment to our coil of wire in vacuo. If **B** is defined as that which will generate E.M.F., then we must have a value of μ for ether; and if this remains unchanged when air is admitted, should we not regard air as being magnetically inert or having μ = zero? If **B** is regarded as existing only in what we know as material, then we must regard the ether as material, or else concede that **H** can generate E.M.F.!
—Yours, &c., W. B. SAYERS.

Glenwood, Bearsden.

"INERT" IRON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to your Editorial Note at the end of my letter published in your journal, I think that you have misunderstood the meaning I attributed to the word "inert."

The machine was run on open circuit, and no E.M.F. could be obtained. The iron showed no trace whatever of magnetism, and consequently no current was produced.

I believe it is exceedingly rare to find a large mass of iron so completely devoid of magnetism that delicate tests give no indications.—Yours, &c., DAVID SALOMONS.

October 12, 1895.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The experience described by Sir David Salomons in your last issue is interesting in that it affords an example of what may occur to any shunt-wound machine under similar circumstances. The explanations offered of the cause of demagnetisation do not, however, appear to be very conclusive.

The more probable cause would appear to be due to the dynamo being switched on to the cells at a time when its E.M.F. was less than the difference of potential at the terminals of the battery. Under these circumstances current from the cells would pass through the armature in the opposite direction to that due to the rotation of the armature, and since the resistance of the shunt winding is great compared with that of the armature, a comparatively small current would pass through the former, but its direction would, of course, still be such as to maintain the original polarity of the field magnets.

When the automatic cut-out acted the E.M.F.'s of self-induction of the *two* machine circuits (armature and shunt) would act in opposition to each other in the armature and

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shunt winding as one closed circuit. If the E.M.F. of self-induction of the armature is greater than that of the shunt winding, the resultant current would be such as to demagnetise, or even reverse, the polarity of the field magnets.

The same effect would, obviously, be obtained when switching shunt machines in or out of parallel, if the E.M.F. falls below the difference of potential of the 'bus bars.—Yours, &c.,

York, October 15, 1895. J. PIGG.

EXPERIMENTS ON TRANSFER OF HEAT THROUGH PLATES WITH VARIOUSLY-ARRANGED SURFACES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to your remarks and useful suggestions in last week's issue on my Paper on the "Transfer of Heat through Plates with Variously-arranged Surfaces," it seems clear that the condensed layer of water deposited on the surface of the plates retarded to some extent the transfer of heat. In the case when copper wire was wound round the cylinder and exposed to steam, it was noticed that the spaces between the coils were full of condensed water which could not easily drain away, and the results showed that the wired cylinder absorbed heat from steam less rapidly than the plain one.

The variation in the effect of the ribs may have been influenced by the difference between the specific heat or capacity for heat of water, air and steam. It may have been possible that when the plain surface was in contact with water that heat was flowing through the plate to nearly its full extent, and any addition of ribs or "feeders" could not materially affect the flow. When, however, the cylinder was surrounded by a medium of considerably less capacity for heat, like air or steam, it might be expected that the projecting ribs or "feeders" would then be able to have effect.

I intend, as you suggest, to try the effect of ribs in liquids of different specific heats, such as oil and melted paraffin wax.—Yours, &c., WILLIAM G. WALKER.

47, Victoria street, Westminster, October 16, 1895.

ALTERNATE-CURRENT WAVE-FORM DELINEATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Allow me to point out to you that the method of photographically and automatically delineating periodic curves, described by Messrs. Barr, Burnie and Rodgers in your issue of September 27th, is not new, as the authors seem to think. I described some time ago (see *La Lumière Electrique*, September 12, 1891, and *La Lumière Electrique*, September 16, 1893) a similar arrangement. The only new element is the employment of a mirror actuated by a cam; but I think the rotating drum device preferable for the purpose of photographic recording.—Yours, &c., A. BLONDEL.

[Not only did a detailed illustrated description of M. Blondel's device appears in *La Lumière Electrique* of September 12, 1891, as he points out, but we ourselves published in our issue of October 2, 1891, p. 603, Vol. XXVII., a brief abstract of this article. We must fain plead guilty to an undoubted and inexcusable editorial nod.—ED. *E.*]

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We regret very much to learn, for the first time, from the advance proof of M. Blondel's letter, that our curve tracer has been anticipated.

The devices as described in *La Lumière Electrique* have been unknown to the Central Technical College, and of those who spoke of our apparatus and method at the British Association; all have shared our ignorance of the previous similar work of M. Blondel.

With regard to M. Blondel's criticism of the cam: we would point out that the advantage claimed is chiefly for its use in the instrument which *visually* traces a wave. For photographic records a plane screen or a cylinder may be used, as we stated in our Paper.—Yours, &c.,

BARR, BURNIE and RODGERS.

THE MAGNETIC FORCE DUE TO ANY PLANE CIRCUIT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On examining M. Colard's formula for the magnetic force due to unit current in any plane curve, at any point in its plane (*The Electrician*, September 20th, p. 694), I find that it is not correct, at least as it stands.

The formula given is

$$F = \int \frac{ds}{r \rho \cos \phi}, \quad \ldots \ldots \quad (1)$$

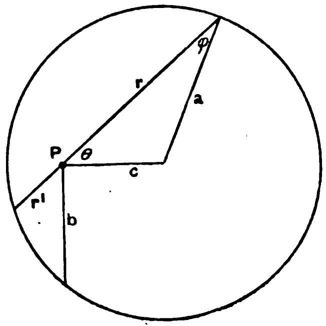
where ϕ is the angle between r and ρ. As mentioned in *The Electrician* of October 4th, I have elsewhere proved that

$$F = \int \frac{d\theta}{r}, \quad \ldots \ldots \ldots \quad (2)$$

and this is not difficult to verify. The formula (1), since $ds = r \sec \phi \, d\theta$, can be put in the form

$$F = \int \frac{d\theta}{\rho \cos^2 \phi}.$$

Comparing this with (2), it obviously does not hold good for a short length of a curve. But possibly (1) was intended only to apply to a closed curve. Its fallacy in this case might be proved generally, but I shall content myself with applying the formula to the case of a circle.



Let a be the radius, c the distance from P, the point where the force is required, to the centre of the circle, θ the angle between c and r, and b half the minimum chord through P, so that $b^2 = a^2 - c^2$.

Then we have $a \cos \phi = \frac{1}{2}$ (chord through P)

$$= \sqrt{a^2 - c^2 \sin^2 \theta}.$$

Hence the integral to be found—namely,

$$\frac{1}{a} \int \frac{d\theta}{\cos^2 \phi} = a \int \frac{d\theta}{a^2 - c^2 \sin^2 \theta}.$$

This can be solved by putting $z = \cot \theta$; the result is

$$-\frac{1}{b} \tan^{-1} \left(\frac{a \cot \theta}{b} \right).$$

This has to be taken for the complete circle; or it may be taken between the limits 0 and $\frac{\pi}{2}$, and the result multiplied by four. We then get, for the force at P,

$$F = \frac{2\pi}{b}.$$

Now I have proved elsewhere that

$$F = \kappa \frac{a}{b^2},$$

where κ is a coefficient having a value varying from 4 to 6·3 (for which I have given a geometrical construction). And it is obvious that the two formulæ are not equivalent.

However, probably M. Colard has merely made some slight slip in his work, as everyone does now and then; and I only point out the discrepancy in order to prevent any misunderstanding on the subject.—Yours, &c., W. H. EVERETT.

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THE FILING OF CATALOGUES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We have received a letter from the United States Patent Office, asking us for copies of our illustrated catalogues, price lists, circulars, &c., for filing in the library of the Patent Office.

From this letter (of which we send you a copy enclosed) you will see that they have the very laudable object in view of filing these catalogues for reference and "for other purposes," and it has occurred to us whether such a record might not with advantage be procured by our own Patent Office, and so place us on a level with our cousins across the water in having a Government Department for the preservation of this otherwise unrecorded literature.—Yours, &c.,

JOHNSON AND PHILLIPS.

[COPY.]

United States Patent Office.

It is desirable, for purposes of reference, to obtain for the library of the Patent Office copies of illustrated catalogues, price lists, circulars and other publications. In many cases, where no illustrations are given, such lists and catalogues are of great service in determining the meaning of words used in the arts, and for other purposes. It would seem particularly appropriate that the library of the Patent Office should be made a place of deposit for this unrecorded literature of the arts, which would otherwise in a few years be lost. Some of the most valuable books in the library are such lists, some of them more than 70 years old. That such a means of preserving for all time pamphlets of this sort is offered should alone be an inducement to all interested to aid in making this collection as complete as possible. Three copies in general should be sent, one for permanent deposit in the library, and two or more for the use of examiners, but all of them to belong to the library, and to be in charge of the librarian. When successive editions are published, each new one should be sent direct to the Library, U.S. Patent Office, Washington, D.C.

Washington, D.C., October 4, 1895.

SIR: Your attention to this circular is asked, and your contribution, so far as lies in your power, solicited.—Very respectfully,

(Signed) JOHN S. SEYMOUR, Commissioner.

To Messrs. Johnson and Phillips,
14, Union-court, Old Broad-street, E.C., and
Charlton, Kent, England.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

SPECIAL NOTICE.—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s. The Edition for 1896 is in active preparation, and orders for Advertisements and Subscriptions can now be sent in.

NEW BOOKS AND EDITIONS.

The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices:—*

LABORATORY NOTES AND FORMS.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett *(now ready)*. Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with many origina illustrations, price 2s. 6d. nett, is now ready.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s. —each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

A SHEET TABLE showing Total Capital Outlay and Receipts and Expenditure for the year 1894 of the Statutory Electric Supply Undertakings of the Metropolis is now ready, printed on thick paper, price 6d.

A SHEET TABLE giving similar particulars in relation to Provincial Statutory Electric Supply Undertakings is now ready, printed on thick aper, price 6d.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d. post free (abroad 11s.).

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

'DRUM ARMATURES AND COMMUTATORS."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d (abroad 8s.). Prospectus on application.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E Kennelly and H. D. Wilkinson, price 6s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

TENDERS INVITED.—Tenders are being invited by the Postmaster-General (*a*) for the supply of red fir telegraph poles, and (*b*) for creosoting the poles with 10lb. or 12lb. of creosote to the cubic foot. Forms of tenders may be obtained on application to Charles E. Stuart, Controller of Stores, General Post Office, E.C., and tenders must be in by noon on Monday, the 28th inst.

——— The Director of Public Works, Madrid, invites tenders for the concession for the construction and working of a tramway from Madrid to Colmevar Viejo, Chamartin and Rosa. Tenders by the 15th prox. to the Direccion General de Obras Publicas, Madrid.

——— The Saltash Town Council invite tenders for lighting the district by electricity, gas, or otherwise, from the 4th January next. Particulars of the Chairman of the Works Committee, Mr. W. Alford, 3, Springfield-terrace, Saltash, to whom tenders should be sent not later than Saturday, the 25th inst.

——— The Glasgow City Improvement Trustees invite tenders for wiring the New Family Home, in St. Andrew-street, for the electric light. Tenders to the Town Clerk (Sir J. D. Marwick), City Chambers, Glasgow, by the 21st inst.

——— *Extension of Time.*—The Municipal Authorities of Tongres have extended the time for sending in tenders for the electric lighting of the town until November 8th. Tenders to the Conseil Municipale, Hotel de Ville, Tongres, Belgium.

——— The Glasgow Corporation require tenders for the construction of a new line of tramways, commencing at the termination of the existing tramways at Rockvilla and terminating at Saracen Cross, Possilpark; and also for electrically bonding the rail-joints of the above-named tramways. Tenders, not later than 10 a.m. on the 22nd inst., to Sir J. D. Marwick, Town Clerk, City Chambers, Glasgow.

——— Tenders are required for the lighting of Miners' Hall, Ashington, Northumberland. Particulars of Messrs. Boolds and Hardy, Morpeth.

——— Tenders are invited for the lighting and ventilation of the Lowestoft Town Hall. Tenders to the Town Clerk.

——— The Guernsey Railway Company invite tenders for two electric motor bogie cars to seat 80 persons and suitable for the overhead wire system. Particulars from the Secretary.

——— The London County Council require tenders for a lift and two hoists at their Belvedere-road Works. Tenders to the Engineer's Department, County Hall, Spring-gardens, S.W., by the 28th inst.

ELECTRIC LIGHTING SCHEMES INVITED.—The Battersea Vestry offer premiums of £50, £30 and £15 for the best three schemes, reports, designs and estimates for a system of electric lighting for the parish of Battersea. Schemes must be delivered to Mr. W. Marcus Wilkins, the Vestry Clerk, before 12 o'clock (noon) on Thursday, December 12th next.

TENDERS ACCEPTED.—In our last issue we gave the name of the successful tenderers for supplying the South Molton Shirt and Collar Manufacturing Company with generating machinery, wiring the Company's premises for the electric light, &c., as Messrs Newton and Hawkins, Taunton. The accepted tender was that of Mr. F. M. Newton, Taunton.

——— The Shoreditch Vestry have accepted the tender of the British Insulated Wire Company for the supply of high-pressure and low-pressure electric light mains and conduits, and that of Messrs. W. T. Glover and Co. for the supply of additional high-pressure mains. These contracts have been let at schedule price. Messrs. Siemens Bros. and Co., Reid Bros., the Callender Company, W. T.

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Henley's Company, the Fowler-Waring Company, and the India-Rubber Company also tendered.

TENDERS ACCEPTED.—The Committee of the Staffordshire County Infirmary received 21 tenders for wiring and fitting the Infirmary for the electric light. We give below a list of these tenders, from which it will be seen that the Committee have decided to accept the tender of Messrs. Drake and Gorham, and that a tender was also received from the Stafford Corporation Electricity Works :—

Drake and Gorham (London) (*accepted*)	£397	0	0
Benham and Sons (London)	836	0	0
Hewes, Geary and Co. (Church Gresley)	796	10	9
Spagnoletti and Crookes (London)	677	0	0
Rooper, W. O. (Stafford)	663	15	1
Laing, Wharton and Down (London)	618	0	0
Corlett Electrical Engineering Company (Wigan)	615	0	0
Northern Counties Electrical Construction Company	586	10	0
Fletcher, Hirst and Co. (Burnley)	566	0	0
Anderson, T. S. (Sheffield)	550	0	0
Walsall Electrical Company (Walsall)	523	15	0
Strode and Co. (London)	500	0	0
Stafford Corporation Electricity Works	491	15	3
Fowler, Lancaster and Co. (Birmingham)	475	0	0
Ball (F. W.) and Co. (Bristol)	468	6	0
Waring (S. J.) and Sons (Liverpool)	455	0	0
Lea, Son and Co. (Shrewsbury)	442	0	0
Liverpool Gas Fittings Company (Liverpool)	434	0	0
Paterson and Cooper (London)	381	10	0
Kendal (J. Lomax) and Co. (Liverpool)	380	0	0
Bennett and Druce (Preston)	319	0	0

——— The Harrogate Town Council received 57 tenders for the supply of machinery and apparatus for their electric light scheme, and the following have been accepted :—Messrs. Houldsworth and Sons, Bradford, for boiler-house plant (without brickwork), at £1,516 ; Messrs. S. Z. de Ferranti (Limited), London, for steam alternator plant, and for switchboard and instruments, at £7,428 and £671. 3s. respectively ; British Insulated Wire Company, Prescot, for mains (exclusive of accessories), at £2,931 ; Brush Company, London, for transformers (exclusive of small sizes), at £403. 7s. ; and Southgate Engineering Company, London, for an overhead crane at £190. The tender for meters has not yet been let. The Town Council received some 30 tenders for wiring the Montpelier Baths, and that of Messrs. Paterson and Cooper being the lowest, has been accepted.

TENDERS RECEIVED.—At the meeting of the Electric Light Committee of the Wakefield Corporation on Tuesday last Mr. Robert Hammond's report on the electric lighting tenders was considered. A noticeable feature in connection with these tenders was that the figures of Messrs. S. Z. de Ferranti (Limited) and John Fowler and Co. for supplying the engine-house plant were almost the same, the amounts being £9,102 and £9,091 respectively. Mr. Hammond's report stated that either firm could be relied upon to do the work to the satisfaction of the Corporation, but he left the selection of the type of engine in the hands of the Committee. After considerable discussion the Committee decided to give out the whole of the contract for supplying the works plant to Messrs. John Fowler and Co., Leeds, at the sum of £10,900. The following additional tenders were also recommended for acceptance :—British Insulated Wire Company, cables, culverts and trenching, at £3,192. 3s. 4d.; Messrs. John Fowler and Co., transformers and distributing switchboard, at £448 ; Brush Electrical Engineering Company, arc lamps and posts, at £252. 10s.; Westinghouse Electric Company, meters, at £233. 18s. 3d. ; and Mr. Thomas Smith, of Rodley, Leeds, for an overhead crane, at £253. The whole of these contracts amount to £15,279. 11s. 7d., as against Mr. Hammond's estimate of £15,893, submitted to the Local Government Board.

SALE BY AUCTION.—From our advertisement columns this week it will be seen that Messrs. Wheatley Kirk, Price and Goulty, in compliance with instructions from Mr. D. Ellis, the receiver and manager in the liquidation of Poole and White (Limited), will sell by public auction at an early date that Company's electrical engineering works, together with the valuable and modern fixed and loose plant, &c. Plans and particulars can shortly be obtained gratis from Messrs. Steavenson and Couldwell, 93, Gracechurch-street, or from the auctioneers, 49, Queen Victoria-street, and Albert-chambers, Albert-square, Manchester.

——— Messrs. Percy Huddleston and Co. will sell by public auction on Tuesday, the 29th inst., at the Newton Heath Cable Works, Newton Heath, Manchester, some important plant and machinery, loose tools and utensils of an electric cable and wire works. The sale is announced to commence at 11 for 12 o'clock prompt, and catalogues may be had on application to the auctioneers, 72, Finsbury-pavement, London, E.C., or 20, Chapel-walks, Liverpool. Further particulars appears in our advertisement columns.

REMOVAL.—The Westralian Electric Lighting and Supply Company have removed to 54, Old Broad-street, E.C., where all communications should in future be addressed.

PARTNERSHIPS DISSOLVED.—The partnership business of electrical engineers and boat builders hitherto carried on by Messrs. Martin and Johnson at Strand-on-the Green, Chiswick, has been dissolved.

——— Messrs. T., W. A. and S. R. Malson, who have hitherto carried on business as electric fuse makers under the style of the Patent Electric Shot Firing Company at Chesterfield and Newbold, have dissolved partnership.

BANKRUPTCY DIVIDEND.—All claims against the estate of Walter Andreae, recently trading as an electrical engineer at 47A, Lower Belgrave-street, S.W., must be sent in to the Official Receiver (Mr. G. Wreford), Bankruptcy Court, Carey-street, W.C., by the 23rd instant.

LIQUIDATIONS.—A summary of the statement of affairs and observations in the winding-up of the Proprietary Gold Recovery Company (Limited) has just been issued by the Official Receiver. The order for the winding-up was made on the 17th July last, and the Company was incorporated in July, 1894, with a nominal capital of £150,000, for the purpose of purchasing and developing Mr. J. B. Hannay's patents for extracting the precious metals from their ores, and by an agreement dated July 18, 1894, the Company agreed to purchase these patents for certain considerations, including a cash payment of £5,000. Mr. E. J. Pape, the original promoter of the Company, who was interested in the patent rights to the extent of one-half, made in 1891 an unsuccessful attempt (in conjunction with Mr. Hannay) to form a company for demonstrating the process. In March, 1894, an agreement was entered into between Mr. Pape and Mr. Hannay, under which Mr. Pape had the option of forming a company for the acquisition of the patents. After some time differences of opinion arose between Mr. Hannay and Mr. Pape in regard to certain machinery which was acquired by the Company. The failure of the Company is attributed by Mr. W. Crooks and Mr. W. C. Johnson to Mr. Hannay's refusal to practically demonstrate the method of recovering the gold from the cyanide solution by means of the electric current, while Mr. Hannay states that he was always ready to demonstrate the process if suitable plant had been provided, and he attributes the failure to the depletion of the Company's funds by the Directors in the purchase of plant which was useless for carrying out his process.

——— At the extraordinary general meeting of the Hope-Jones Electric Organ Company (Limited) on September 10th it was decided to wind up the Company voluntarily, and Mr. R. S. Blease, C.A., Fenwick-street, Liverpool, was appointed liquidator.

THE "I.E.C." DRY CELL.—It is now some three years since the first dry cells were put on the market, and nearly every month brought a new type of these batteries into existence. Amongst the new-comers is a dry battery put on the market by the International Electric Company, which they have named the "I.E.C." dry cell. We are told that some of these cells have run as long as 768 hours uninterruptedly, short-circuited on a 5-ohm bell. The same cells having had a rest of a fortnight, were then again run for 343 hours consecutively, and allowing a further interval for recuperation, the cells yielded another output of 104 hours, giving a grand total of 1,215 hours before exhaustion. The International Electric Company are willing to give cells free of charge to any public institution interested in the comparative tests of dry cells.

ELECTRIC CRANES.—Messrs. Glover and Co., of Hatcham Saw Mills, London, S.E., being dissatisfied with manual labour for working the crane by which they stacked their timber, recently adopted electricity as a substitute. The firm found that if they worked the crane by steam power they would have to pay a very much heavier premium for fire insurance. The dynamo which is used for generating the current is also employed in the evening for the lighting of the works and offices.

THE MANUFACTURE OF THE ELECTRIC INCANDESCENT LAMP IN ENGLAND.—Considerable concern was expressed some time ago that foreign competition would soon drive the English-made incandescent lamp entirely out of the market. A visit to the works of the Sunbeam Lamp Company at Gateshead-on-Tyne at once disabuses the mind of anyone harbouring such fears, for to meet the demand this Company have been compelled to make large extensions to their plant. It is well known—to the electrical trade at least—that some few years ago this Company was stopped in their manufacture of high candle-power lamps by an injunction brought against them for supposed infringement of the "master" lamp patents ; but as only about a year had to run before the expiration of these, the Company, rather than enter into a costly litigation, wisely ceased operations. During the interim considerable money was expended in perfecting the factory for the output of smaller lamps, as well as the high candle-power lamps for which they had already gained a name. The composition of the filament used in the "Sunbeam" lamp is a speciality of the Managing Director, Mr. Edmundson, whose con-

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nection with manufacture of glow lamps since their first introduction gives him an unequalled experience in all the details in the manufacture of incandescent lamps. The spacious building occupied by the Company is, by the way, the scene of Charlotte Brontë's book "Jane Eyre," and was originally the Gateshead Hall, a building of much interest. It is perhaps unnecessary to say that great care is exercised in manufacture, no lamp being passed unless satisfactory in every point as regards candle-power, voltage and efficiency, each individual lamp before finally packing for storage being tested three times. The demand for "Sunbeam" lamps has exceeded the most sanguine hopes of the Company.

ELECTRICAL POWER STORAGE COMPANY (LIMITED).—This Company forward us a circular giving prices and particulars of their new cell inspection lamp, which will prove useful in examining the condition of the larger type of "E.P.S." cells. A 4-volt lamp, supplied with sufficient flexible conductor and spring clips to hang on the lugs of two adjacent cells, is employed. The connections are enclosed in an acid-proof tube, and are so arranged that a new lamp can be easily inserted when required.

CATALOGUES.—We have received from Mr. John Spencer, of the Globe Tube Works, Wednesbury, Staffs., a pamphlet containing prices and particulars of his electric wire and cable tubes, wrought-iron tubular telegraph poles, steam and vacuum gauges, pipe joints, &c. Tables of dimensions are also given.——From the Britannia Company, of Colchester, we receive a circular descriptive of their new "Facile" carriage motor, for which they claim many advantages.

ELECTRO-HARMONIC SOCIETY.—A smoking concert will take place on Monday next, the 21st inst., at the St. James's Hall Restaurant (Banquet Room), Regent-street, London, W., at eight o'clock.

ABERDEEN.—At a recent meeting of the Buildings Committee of the Public Library an estimate of the cost of wiring the building for the electric light was submitted, and at the last meeting of the Town Council the Committee were authorised to proceed with the work.

ALDERLEY EDGE (MANCHESTER).—The District Council at their last sitting decided to sell their Provisional Electric Lighting Order to Mr. S. V. Clirehugh, of Manchester, who is acting on behalf of a company about to be formed for the purpose of lighting the district electrically.

ASHTON-ON-MERSEY.—The Parish Council are making inquiries into the cost of lighting the district by electricity with a view to applying for a Provisional Order.

BATH.—A proposal has been made for lighting the markets by electricity, and a report thereon is being prepared by Mr. A. McTavish.

BOOTLE.—The Town Council have engaged Mr. T. L. Miller, of Liverpool, to report upon the lighting of the town by electricity.

BRADFORD.—The *Bradford Observer* of the 12th inst. contains the following letter anent the change recently made by the Corporation in their method of supplying electric current :—

SIR: I should like to ask, through your valuable paper, if our Borough Electrical Engineer or any of the Gas and Electricity Committee can give a satisfactory reason for altering the town supply from 115 volts to 220. There has already been spent about £50,000, if not more, on this luxury, and, now they have got a good supply, they must start spending more money, and also cause their consumers to do likewise. There were in the town, up to December last, about 37,000 incandescent lamps running at 115 volts. At whose expense are all these lamps going to be changed to 220 volts? I think it will be a great injustice if the ratepayer should have it to do just to suit a lot of men who love spending other people's money. The elections are getting very near now, and I think ratepayers ought to send men who will stop all this tomfoolery in spending money on such things as electricity and oil gas, and utilise it in providing other things that will benefit the town more.—Yours, &c., G. F. K.

Bradford, October 11, 1895.

BUSINESS LECTURES.—The Cowper-street School Old Boys' Club has inaugurated a series of practical trade lectures on mechanical, industrial and commercial subjects. These lectures are calculated to be of service to young men engaged in trade or general business, and visits to the works of some leading firm in each department have been arranged. Further particulars from the Secretary at the Schools, Cowper-street, E.C.

CARDIFF.—The Town Council have now obtained the formal sanction of the Local Government Board to their borrowing £16,385 for electric lighting extensions.

CHELSEA (LONDON, S.W.).—The Chelsea Electricity Supply Company recently wrote to the Board of Guardians, suggesting that the new workhouse buildings should be wired for the electric light, and the communication has been referred to the Finance Committee for consideration and report.

CHELTENHAM.—The Cheltenham Conservative Club was lighted electrically for the first time on Saturday last. The work of wiring and fitting has been carried out by Messrs. R. E. and C. Marshall.

CHICHESTER.—At the last meeting of the Town Council a member took exception to an item in the accounts of £31. 10s. for a report on the electric lighting question, and Mr. Councillor Prior, in explanation, said that when the report was obtained they were considering the subject of the lighting of the district newly-added to the borough area, and it was thought desirable to obtain information as to the cost of electric lighting before they finally decided to adopt gas. He added that the money was well spent, as the gas company reduced their prices to a considerable extent on the receipt of the electrical engineer's report.

COLWYN BAY.—The Urban District Council have decided to apply for a Provisional Order.

CORK.—The Electric Lighting Committee of the City Council have engaged Mr. T. W. Smith, of Messrs. Calvert and Co., Manchester, to advise them on the electric lighting question.

DENBIGH.—At their last meeting the Town Council referred the question of lighting the town by electricity to the Lighting Committee.

DERBY.—Meetings in connection with the scheme for promoting the construction of an electric railway between Derby and Ashbourne, will be held at Mickleover on the 18th inst., and at Ashbourne on the following day. It is reported that there is a very strong feeling in favour of the scheme in Derby and the neighbourhood.

DEWSBURY.—Recently some very successful experiments in cooking by electricity were carried out in the presence of several gentlemen at the Railway Hotel. The Corporation are endeavouring to create a demand for current for cooking and heating purposes in the district, and with this object in view Mr. J. B. Mitchell (the borough electrical engineer) has decided to keep some cooking and heating utensils at the Corporation Electricity Works in Bradford-road for the inspection of the public.

DOUGLAS (ISLE OF MAN).—The Town Commissioners on Tuesday confirmed the draft agreement for leasing the Douglas Bay Tramways for 21 years to the Isle of Man Tramways Company. Under the agreement the Company are authorised to construct and work a cable tramway to Upper Douglas.

EALING (LONDON, W.).—The estimates of the Electricity Department of the District Council for the coming half-year were recently published. The maintenance charges are put at £1,800, while the revenue, based on the number of lamps actually connected to the mains, is put at £1,400. As, it is stated, there is a continual increase in the number of customers, it is anticipated that the revenue will greatly exceed the estimated sum.

ELECTRIC TRACTION.—Mr. W. J. Carruthers Wain (president of the Tramways Institute of Great Britain and Ireland) has again set out on a visit to the United States and Canada for the purpose of making further inquiries into the question of electric traction. Mr. Wain intends to inspect all the newest and most improved methods of traction in these countries.

EXETER.—At the meeting of the City Council on Wednesday last it was decided to appoint a Special Electric Light Committee to take charge of the Electric Light Company's undertaking recently purchased by the Council, and to confer with the Exeter Electric Light Company as to repairs to and renewal of the plant.

FLEETWOOD.—The Board of Trade have extended the time for complying with the terms of the Fleetwood Provisional Order (1890) to March 30th next.

GOVAN.—At Tuesday's meeting of the Govan District Lunacy Board a long discussion took place on the question of the lighting of the new Hawkhead Asylum Hospital. Several members favoured the adoption of the electric light, but on a division a motion for the appointment of a committee to make inquiries into the cost of electric light was lost.

HACKNEY.—At the last meeting of the Vestry the Sanitary Committee's report, which recommended the adoption of a combined electric lighting and refuse-destructor scheme for the parish, was, after a short discussion, adopted.

HAMPTON WICK.—The Lighting Committee are to consider the subject of lighting the district electrically.

HARROGATE.—In another column we give particulars of the tenders which the Town Council have accepted for supplying electrical plant and machinery. At the last meeting of the Council it was stated that £27,000 would be required to complete the electric lighting scheme, instead of £25,000 as originally estimated. The contracts already let amount to £13,202, and the Town Clerk was authorised to borrow £2,000 in addition to the £25,000 authorised at the last meeting.

HUDDERSFIELD.—The Electric Lighting Committee have decided to reduce the charge for electric current for cooking purposes to 2½d. per unit, and at the last meeting of the Committee the borough electrical engineer (Mr. A. B. Mountain) was instructed to prepare and issue a pamphlet showing the advantages of electricity for motive power, cooking and heating purposes. Instructions were

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also given to the Town Clerk to obtain the necessary powers to enable them to extend the electric light mains to Longwood.

ILFRACOMBE.—At a special meeting of the District Council last week the question of the purchase of the gas works was under consideration, and, after some discussion, it was decided not to take any further steps in the matter until they had obtained information as to the cost of lighting the town by electricity.

INVERNESS.—Some time ago notices were received by the Town Council from the Caledonian Electric Supply Company and the Municipal Electric Light and Power Company of their intention to apply for Provisional Orders. On receipt of these notices the Council evinced a desire to obtain further particulars of the schemes of these Companies, and the Town Clerk was accordingly instructed to write for particulars. At the meeting of the Town Council last week it was stated that no reply had been received from either Company, and the Council therefore decided to oppose both applications.

KINGSWOOD (BRISTOL).—At the meeting of the Urban District Council on Wednesday it was decided to approve the plans recently submitted by the Tramways Company for the extension of their line to Warmley Hill. Work on this extension was commenced yesterday (Thursday).

LANCASTER.—Mr. A. S. Barnard, who was recently appointed electrical engineer at the Hull Corporation Electricity Works, has now formally resigned his position of borough electrician at Lancaster. The Hull appointment is worth £250 per annum, while the Lancaster Corporation only gave a salary of £120 !

LLANELLY.—At the last meeting of the District Council it was decided that a committee of the whole Council should wait upon Mr. J. C. Howell for the purpose of arranging the terms as to the purchase by him of the Llanelly Provisional Order.

MANCHESTER.—At the meeting of the Town Council on Wednesday a long discussion took place on the motion to receive the report of the Special Tramways Committee. The report recommended the Corporation to apply for powers to work the tramways after the leases expired in 1898 and 1901 respectively. Mr. Vaudrey moved that the matter be referred back for further consideration, as he contended that the question had not been sufficiently discussed in committee, and he thought that before applying for Parliamentary powers they should endeavour to obtain the cooperation of the Salford Corporation, through whose district some of the tramways ran. This course was favoured by several other members, and a long debate ensued. Mr. Southern, who supported the motion, suggested that the Corporation should take care to obtain powers for working the tramways by electricity, steam, or by horses. The proposal of the Committee was ultimately adopted.

MILE END.—The Board of Guardians recently discussed the plans and estimates prepared by their works superintendent (Mr. Burden) for the lighting of the workhouse premises by electricity. The cost of the installation was roughly estimated at £5,000. It was decided to apply to the Local Government Board for their sanction to the scheme, and in the meantime the Clerk was instructed to write to other boards of guardians who had already adopted electric lighting, for information as to cost of installation, &c

MONMOUTH.—Some time ago Col. Ducat held an inquiry on behalf of the Local Government Board into the application of the Town Council for sanction to borrow £20,000 for a joint electric lighting and refuse-destructor scheme, and the Board have now written to the Council, stating that, having regard to local objections to the electric lighting portion of their scheme, they wish to be supplied with additional figures as to the estimated initial outlay on and probable income from the scheme. The Board also ask for more definite information as to the probable income from the sale of electric current, &c., for private purposes. In reply, the Town Council state that the initial cost of an electric light installation, capable of supplying current to an equivalent of 2,500 8 c.p. is £5,600, while the total estimated revenue would probably amount to £1,018. 6s. 8d. In this estimate of income, the Council have altogether omitted the revenue which would be earned by the electric light works if the joint scheme were adopted. This source of revenue is estimated to bring in a further sum of £225 per annum. The principal reason for establishing electric lighting works in conjunction with the sewage scheme was to lower the cost of the latter scheme, and the Council further point out that the electrical machinery could be employed in the daytime to pump the sewage.

MORLEY.—The new Town Hall, which was formally opened by the Right Hon. H. H. Asquith, M.P., on Wednesday, is lighted throughout by electricity. The installation was carried out by a local firm, Messrs. Graham and Chapman.

NEW CABLE STEAMER.—It is stated that the New Zealand Government have placed an order with Messrs. Dunlop and Co., Port Glasgow, for the building of a new steamer, which is to be employed for cable and lighthouse work. The vessel is to be completed within six months, and will cost about £30,000.

NEWPORT.—The Town Council have decided to wire the Free Library buildings for the electric light.

REIGATE.—A special meeting of the Town Council was held on Monday for the purpose of considering the subject of lighting the town by electricity. Notices had been given by Messrs. C. J. Grist and Co., the Guildford Electricity Supply Company and the Town and Village Electric Light and Power Company, of their intention to apply for Provisional Orders. Councillor Powell moved the appointment of a sub committee to make inquiries into the matter and report to the Council, the committee to have authority to employ an electrical expert to advise them as to the cost, &c. A long discussion ensued, and the resolution was eventually carried.

ROMFORD (ESSEX).—A motion by Mr. Westgate that the Council take the necessary steps for obtaining a Provisional Order was, after some discussion, defeated at the last sitting of the District Council.

SOUTHEND.—At the last meeting of the Town Council it was decided to engage Prof. A. B. W. Kennedy to report upon and prepare a scheme for lighting the town by electricity at a cost of 100 guineas.

SWANSEA.—It was anticipated that a long discussion would arise on the electric lighting question at Wednesday's meeting of the Town Council. Mr. Viner Leeder had given notice of his intention to move that the recent resolution of the Council adopting the minutes of the Electric Light Committee be rescinded, but the Mayor ruled this notice out of order. It was, however, stated that some alterations had been made in the original plans of the Committee, and it is expected that this concession will have the effect of greatly minimising the present opposition to the electric lighting scheme.

TELEGRAPH WIRE EXPORTS.—Notwithstanding a slight increase in the activity in the export of telegraph wire and apparatus during the past month, the value of the exports only amounted to £45,268, as compared with £49,820 in September, 1894. The returns for the first nine months of the year show a total of £383,437, as compared with £1,304,594 in the corresponding period of 1894.

THE ELECTRIC LIGHT IN BRAZIL.—It is reported that Cataguazes and the Quarantine Station at Ilha Grande are to be lighted electrically, while work in connection with the electric lighting of the cities of Maceio and Para is making rapid progress; 86 arcs of 2,000 c.p. each, and 1,800 incandescents varying from 16 to 25 c.p. will be employed in the lighting of the latter city, and the generating plant will be capable of supplying current to an equivalent of 10,000 16 c.p. lamps. The whole of the machinery has been supplied by Messrs. Siemens and Halske, Berlin.

WALSALL.—The Town Council have decided to borrow additional money for electric lighting extensions.

WILMSLOW (NEAR MANCHESTER).—At the last meeting of the District Council the electric lighting question was discussed at great length. Mr. Ross moved that the Council take the necessary steps to obtain a Provisional Order, but the gas interest, which happens to be very strongly represented in the Council, succeeded in getting the matter postponed for 12 months.

WOKING.—At a recent meeting of ratepayers in the St. John's and Goldsworth Ward it was decided to adopt the electric light for the lighting of the district, and at the last meeting of the District Council the Surveyor reported that he had obtained a tender from Messrs. New and Mayne, who estimated the cost of erecting lamp pillars at £260, while electric current would cost £4. 4s. per lamp for 2,200 hours, or a total of £168 for 40 lamps. The capital expenditure would be repaid by half-yearly instalments of £44. 18s. 8d. in seven years.

WORKS LIGHTING.—Messrs. Ambrose, Foster and Co., of Leicester, propose to make extensive alterations in their premises, including the introduction of the electric light.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

September 19, 1895.

17,479. C. P. J. FITZSIMON. Dublin. An improvement in connection with electric pushes for hall or other doors, which may be used in connection with or replace existing door knobs, handles, or pushes.

17,481. R. H. BEST. London. Improvements in electroliers.

17,495. V. I. FEENY. London. Electrical heating apparatus. (H. W. Johns Manufacturing Company, United States.)*

17,505. C. HOEPFNER. London. Improvements in electrodes.

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17,507. J. Graizier. London. Improvements in and relating to electric cables.

17,510. R. Hacking and G. Brand. London. Improvements in electric current meters.

17,525. C. Kellner. London. Improvements in the electrolytical manufacture of bleaching liquid.

17,526. A. F. Berry. London. Improvements in electrical transformers.

17,528. A. F. B. Gomez. London. A new and improved electro-deposition, more especially applicable to electro-plating.

17,529. B. J. B. Mills. London. Improvements in arc lamps and in stands therefor. (E. P. Hopkins, United States.)

September 20, 1895.

17,573. G. Poore. London. Improvements in electrolysis.

17,603. M. M. Bair. London. Improvements in electric batteries.

September 21, 1895.

17,631. L. M. Guyomard. Manchester. Improvements in microphones.

17,634. W. H. Soulby. Rochdale. Improvements in and relating to incandescent electric lamps.

17,655. B. M. Drake and J. M. Gorham. London. Improvements in secondary batteries.

17,656. B. M. Drake and J. M. Gorham. London. Improvements in spring contact switches.

September 23, 1895.

17,734. H. Landergan and G. C. Grahame. London. A new or improved electrical alarm and connections therefor.

17,745. H. H. Lake. London. Improvements in or relating to electrolytic cells. (C. Hoepfner, Germany.)

September 24, 1895.

17,758. M. E. Crowne and H. C. Fowler. London. An improved automatic electrical cut-out.

17,773. E. M. Edelsten. Liverpool. An improvement in telephone fittings.

17,782. G. Wall. London. The adjustable electric-dial contact.

17,788. D. Clerk. London. Improvements in electromotors. (H. Lacy, L. F. Johnson, and W. J. Slacke, United States.)*

17,790. D. Clerk. London. Improvements in electromagnets and method of winding the same. (H. Lacy, L. F. Johnson, and W. J. Slacke, United States.)*

17,791. D. Clerk. London. Improvements in dynamos. (H. Lacy, L. F. Johnson, and W. J. Slacke, United States.)*

17,811. F. King. London. Improvements in or connected with secondary batteries.

17,825. W. H. Beck. London. A new or improved porous plate, body, or electrode. (J. Johnson, J. H. Robertson, J. H. Crosman and W. H. Jewell, United States.)*

17,830. H. H. Lake. London. Improvements in and relating to mechanism for electrically indicating the extinction of lamps, and for analogous purposes. (H. See, United States.)*

17,864. J. W. Hall. London. Improvements in or relating to electric indicators or annunciators.

17,871. W. L. Gunn. Bristol. Improvements in compositions for protecting ships' bottoms against fouling, preserving wood and shielding submarine electric cables from penetration by torpedo worms.

September 25, 1895.

17,878. F. Lister. Keighley. Improvements appertaining to road or other vehicles propelled by gas, steam, electric, or like motor mechanism.

17,918. P. H. Baily. London. Improvements in the manufacture of incandescent electric or glow lamp.

17,919. F. E. Garner and C. R. Bliss. London. Improvements relating to telegraph and like poles.

17,921. J. W. Swan. London. Improvements in the manufacture and production of filaments for incandescent electric lamps.

17,924. R. W. Hill. London. Electric smoke annihilator.

17,925. R. W. Hill. London. Production of carbonate of soda and chlorine gas by electricity.

17,949. E. Krönke. London. An improved process for electro-copper-coating ships' hulls in a dock.*

September 26, 1895.

18,018. V. Croizat. London. Improvements in incandescence electric and gas lamps and lanterns.

18,034. H. Leitner. London. Improvements in oxidising lead and lead compounds for the construction of electrical accumulators.*

18,036. H. Leitner and E. Reicher. London. An improved process for the preparation of electrodes for primary, secondary, and dry batteries.*

18,038. H. Leitner and E. Reicher. London. Improvements in and appertaining to electrodes.*

September 27, 1895.

18,065. J. Haynes and H. Hampton. Manchester. Improvements in the method of and means for electrically illuminating block dials and signs.

September 28, 1895.

18,152. R. Goldlust. London. Improvements in telephones.

September 30, 1895.

18,200. F. M. Lewis. Leeds. Improvements in connection with arc lamps, more particularly adapted for electric search lights.

18,226. C. Fisker and L. Bertram. London. Improvements in secondary batteries.

18,236. T. A. Clarke. Liverpool. Improvements in or connected with electric burglar and other alarms.

October 1, 1895.

18,305. R. E. B. Crompton. London. Improvements in means of supporting and insulating electric conductors within culverts or like conduits.

18,318. T. E. Adams. London. Improvements in hanger boards for electric arc lamps.*

18,369. J. E. Amen. London. Improvements in electric locomotives.

October 2, 1895.

18,376. W. M. Hart and W. H. Whiteside. Bradford. Improvements in holders for incandescent electric lamps.

18,385. A. M. Rosebrugh. Toronto. Duplex telephony.

18,406. G. B. Baldo. Trieste. Mode of producing contemporary hypochlorites, chlorates, hydrochloric acid, caustic soda, and hydrogen from the sea water by means of the electricity.

18,420. A. H. S. Daniell. London. Improvements in electrical apparatus for railway signalling.

October 3, 1895.

18,440. G. Hill. Manchester. Improvements in arc lamps.

18,453. G. H. Nisbett. London. Electric cable casings.

18,483. G. Davis. London. Improvements in electric glow lamps.

18,484. A. M. Billington. London. Improvements in safety devices or fuses for electric circuits.

18,505. H. O. F. Bindemann. London. A new or improved method of and apparatus for electrically transmitting indications or changes of position of a body.*

October 4, 1895.

18,531. W. Thomson (Baron Kelvin). Glasgow. Improvements in recording instruments for telegraphic and other purposes.

18,557. J. B. Torres. London. Improvements in galvanic and storage batteries.

18,583. H. Edmunds. London. Improvements in means for making electric connection between lengths of rail and the like.

18,584. H. Edmunds. London. Improvements in or connected with electrical conductors.

18,586. R. Pearson. London. An improvement in secondary batteries or accumulators.

18,588. G. W. Partridge and A. F. Berry. London. Improvements in fusible cut-out or safety devices for electric conductors.

October 5, 1895.

18,602. H. W. Headland. London. Improvements in electric light and tail lamps for omnibuses, tramcars, and other road vehicles.

18,622. N. Greening and N. Greening and Sons (Limited). Manchester. Improvements in commutator brushes.

18,632. C. M. Dorman and R. A. Smith. Manchester. Improvements in holders for incandescent electric lamps.*

18,673. L. Denayrouze. London. An automatic speed regulator for electromotors.

18,681. G. Ferraris and R. Arno. London. Improvements in alternate-current distribution.

18,692. F. E. Everard. London. Improvements in the construction of electrodes or plates for secondary batteries.

18,696. J. G. Lorrain. London. Improvements in or connected with electric railways or electric transport. (F. C. Esmond. United States.)

18,697. J. G. Lorrain. London. Improvements in or connected with electric railways or electric transport. (F. C. Esmond, United States.)

18,698. J. G. Lorrain. London. Improvements in or connected with electric railways or electric transport. (F. C. Esmond, United States.)

18,699. J. G. Lorrain. London. Improvements in or connected with electric railways or electric transport. (F. C. Esmond, United States.)

18,700. J. G. Lorrain. London. Improvements in or connected with electric railways or electric transport. (F. C. Esmond, United States.)

18,701. J. G. Lorrain. London. Improvements in or connected with electric railways or electric transport. (F. C. Esmond, United States.)

October 7, 1895.

18,725. G. H. Nisbett. London. Improvements in electric cables.

18,726. A. L. Dearlove and G. H. Nisbett. London. Improvements in electric cables.

18,769. R. J. Crowley. London. Improvements in or relating to the transmission of electricity and sound, and a means of reducing electrical resistance in the air, earth, or sea.

October 8, 1895.

18,822. W. Crawshaw and H. Bevis. London. Improvements in mounting electric incandescent lamps for orchestral reading and like purposes.

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18,868. H. W. LIBBEY. London. Improvements in electric velocipedes.

18,870. W. LANGDON-DAVIES and THE ALTERNATE-CURRENT ELECTRO-MOTOR SYNDICATE (LIMITED). London. Improvements relating to electromotors and transformers.

18,875. H. EDMUNDS. London. Improvements in concentric electric cables.

October 9, 1895.

18,911. H. BENEST. London. Improvement in electrical hanging bell push.

18,912. C. GILLARD. Chard. Illuminated decoration by electric light in plaster ornaments.

18,931. W. WEBBER. London. Improvements in prepayment apparatus for attachment to gas, electricity, or other fluid meters. (Date applied for under Patents, &c., Act, 1883, Sec. 103, April 16, 1895, being date of application in United States.)

18,935. J. PROBERT and E. F. MOY. London. Improvements in apparatus employed in regulating electromotive force in alternating-current circuits for theatre lighting or other useful purposes.

18,944. G. SUTTON and R. J. HATTON. London. An improved method of insulating electric conductors.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

13,422. THOMPSON (Maréchal and others). Electric relays.

14,850. LANGHANS. Electric lamps.

16.687. VOGT. Electric bells.

18,172. MACLEAN and BALL. Extracting gold by electrolysis.

18,427. HUTIN and LEBLANC. Electrical traction.

19,668. GOMEZ. Arc lamps.

20,432. ALLSOP. Electric bell for mines, &c.

20,442. GWYNNE and KENNEDY. Arc lamps.

20,595. GRIMES. Railway electrical signalling devices.

21,043. CLARK and WEATHERALL. Galvanometers.

21,140. SIEMENS BROS. AND CO. (LIMITED) (Siemens and Halske). Controlling electrical illumination.

21,141. SIEMENS BROS. AND CO. (LIMITED) (Siemens and Halske). Electromotors.

21,366. KING. Electrically-propelled vehicles.

21,439. LACEY. Electrical sewer ventilator.

21,446. BARLEY. Electric meters.

21,555. TIMMIS. Secondary batteries.

21,613. PARKER. Telephones.

21,821. THOMAS PARKER (LIMITED) and T. PARKER. Dynamo-electric machines.

21,822. MEWBURN (Hornig and another). Electrolytic separation and alloying of metals.

22,340. ADDENBROOKE. Multipolar dynamo machines.

1895.

3,679. FOSTER. Arc lamps.

3,903. FITZPATRICK (Electric Bell and Resistance Company). Electrical conductors.

9,937. HAMMACHER. Secondary batteries.

11,864. RIBBE. Plate for electric accumulators, &c.

12,622. MÜLLER. Secondary or accumulator cells.

13,205. PUPIN. Telegraphic signalling.

13,573. STOCK. Telephone switches.

14,023. NEWTON (Ewing). Writing telegraphs.

14,337. BAKKER. Electric fire alarms.

14,792. ROGERS ARC LAMP COMPANY (LIMITED) and ROGERS. Arc lamps.

14,801. LUCKOW. Electrolytic production of oxides and salts.

14,842. THOMPSON (Bradley). Electric condensers.

14,937. GORDON. Electric block signals for railroads.

NEW COMPANIES, STATUTORY RETURNS, &c.

ROBERT DAWSON AND COMPANY (LIMITED).—This Company was registered on October 8th with a capital of £20,000, in £5 shares, to acquire the business of engineers, iron, steel and brass founders, boiler makers, lighting, heating and ventilating engineers, &c., carried on by Robert Dawson and Company (Limited), at Stalybridge.

ELECTRIC SIGN AND GENERAL ADVERTISING COMPANY (LIMITED).—This Company was registered on October 12th, with a capital of £5,000, in shares of £1 each, to acquire and take over as a going concern the business carried on by Guy C. Fricker, electrical engineer, and Alfred W. Poulton, at 46, Queen Victoria-street, London, E.C., to enter into an agreement with the said Guy C. Fricker and Alfred W. Poulton, and to carry on the business of manufacturers of and dealers in electrical and other advertising apparatus and appliances. The first subscribers, with one share each, are: Alfred W. Poulton, Guy C. Fricker (electrical engineer), F. Miller, G. S. Warmington, D. J. E. Edmonds, W. H. E. Godolphin and F. Huntley. The first Directors are: Alfred W. Poulton (Chairman and Managing Director), and Guy C. Fricker.

WEST AUSTRALIAN ELECTRICAL TRUNK POWER AND LIGHTING COMPANY (LIMITED).—This Company was registered on October 8th, with a capital of £510,000, in 500,000 Ordinary and 10,000 Deferred shares of £1 each, to carry on in West Australia and elsewhere the business of an electric lighting company in all or any of its branches, electricians, electrical engineers, mechanical and general engineers, and electrical apparatus manufacturers; to construct, lay down and establish all necessary cables, wires, lines, batteries, accumulators, lamps, apparatus and works; to generate, accumulate, distribute and supply electricity, &c. The subscribers, with one share each, are: C. G. Kistner, H. J. Kidd, L. Brown, A. E. Dayes, A. W. Boon, B. H. Bourne, and A. H. Skan.

HALIFAX AND BERMUDAS CABLE COMPANY (LIMITED).—The annual return to October 9th has been filed. The whole capital of £50,000, in £5 shares, has been taken up, and has all been issued as fully paid.

HARRINGTON ELECTRIC LIGHT COMPANY (LIMITED).—The statutory return to October 1st has been filed. The whole capital of £2,000, in £1 shares, has been taken up, and a call of 5s. per share has been made.

I. R. S. ACCUMULATOR COMPANY (LIMITED).—By a recent agreement 50,000 fully-paid shares in this Company have been allotted to Mr. A. W. Stormont, of Old Broad-street, London, E.C., in discharge of a debt of £50,000.

KEIGHLEY ELECTRICAL ENGINEERING COMPANY (LIMITED).—An agreement has been entered into by this Company with Edward Clough, of Keighley, Yorkshire (liquidator of the Keighley Electrical Engineering Company, Limited (in liquidation), which provides for the allotment of 1,000 shares (1 to 1,000), each with 10s. considered as paid, in full satisfaction of a debt of £500 owing to the said Edward Clough.

PHŒBUS ELECTRIC BATTERY SYNDICATE (LIMITED).—This Company has entered into an agreement with C. N. Ganzentes, electro-chemist, for the acquisition of his invention and secret process relating to a new compound fluid or charge for portable primary batteries. The consideration is the allotment of 1,500 fully-paid £1 shares in the Company.

CITY NOTES.

MEMORANDA.—Bank rate, 2 per cent. (Feb. 22, 1894). Price of silver, $30\frac{9}{16}$d. per oz. (Oct. 17th). Consols ($2\frac{3}{4}$ per cent.) $107\frac{3}{8}$—$107\frac{1}{2}$ for money, $107\frac{3}{8}$—$107\frac{1}{2}$ for account; $2\frac{1}{2}$ per cent. $105\frac{1}{2}$—$106\frac{3}{4}$ (Oct. 17th). Stock Exchange Settling Days: Consols, Nov. 6th; Stocks and Shares Continuation Day, Oct. 28th; Ticket Day, Oct. 29th; Pay Day, Oct. 30th.

BIRMINGHAM ELECTRIC SUPPLY COMPANY (LIMITED).—Letters of allotment for the recent issue of shares in this Company have been posted. It is stated that the new issue was entirely taken up by the present shareholders, more than twice the required amount being applied for.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED). — The accounts of this Company show a profit sufficient to enable the Directors to recommend a final dividend of 3s. per share, making, with previous distributions, a total dividend of 6 per cent. for the year ended June 30, 1895, and also the payment of a bonus of 2s. per share, both free of income tax, which together will amount to £32,500, leaving a balance of £34,410, of which amount £30,000 has been placed to the reserve fund and £4,410 carried forward. The register of transfers will be closed from the 22nd to the 30th instant inclusive.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended October 13th were £916, against £920 in the corresponding week of 1894, a decrease of £4. The total receipts for the half-year amount to £12,774, against £12,931 for the corresponding period of 1894, a decrease of £157.

HYDERABAD (DECCAN) COMPANY (LIMITED).—At an extraordinary general meeting of this Company on Tuesday last the chairman (Mr. G. H. M. Batten) said that the Directors were considering a project for utilising the flow of the Kistna River, about 12 miles distant from the Company's mines, as a means of providing cheap motive power for mining and milling purposes. The power could be easily transmitted electrically, and would be much cheaper than steam power.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 13th inst. amounted to £1,118. The amount for the corresponding week last year was £906; increase, £212.

SALT LAKE AND OGDEN GAS AND ELECTRIC LIGHT COMPANY (LTD.).—It is stated that letters of allotment for the recent issue of Preference shares of this Company have been issued.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY (LIMITED). The sale of electricity by this Company for the quarter ended September 29th, at 6d. per unit, amounted to £7,402, as against £6,935 at the same rate for the corresponding period of 1894.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended October 11th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,248.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have decided to recommend for the six months ended June 30th last, the payment of a dividend at the rate of 6s. per share on the First and Second Preference, and of 1s. 3d. per share on the Ordinary shares. By an error we stated in our last issue that the traffic receipts of this Company for the half-month ended September 30th were £1,703, as compared with £2,679 in the corresponding period of 1894. The figures for 1894 should be £1,679.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, Oct. 9.		Price Wednesday. Oct 16.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 12.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,012,880	Stock	10/0	Anglo-American ... xd	47	49	45	47	4 15 9	Jan., Apr., July, Oct.	..	..
£2,993,560	Stock	20/0	Do. Preferred ... xd	87½	88½	86	87	5 3 6	" "	89⅝	87
£2,993,550	Stock	5/0	Do. Deferred	7¾	8¼	7½	7¾	..	" .. "	7⅝	7⅝
£173,400	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)	102	105	102	105	3 16 11	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	14	14½	14	14½	4 9 8	Mar., June, Oct., Dec.	14⅜	14
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906)	111	115	111	115	4 7 11	June and December	..	..
10,000,000	$100	$1¾	Commercial Cable Capital Stock	164	168	164	168	4 3 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	13	14	13	14	5 14 4	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	20½	21½	20½	21½	4 13 0	" "	20¾	—
12,931	5	2/0	Direct Spanish (fully paid)	4	5	4	5	4 0 0	April and October ..	..	—
6,000	5	10%	Do. Preference 10 per Cent.	9¾	10¼	9¾	10¼	4 7 7	" "	..	—
£80,000	Stock	4½%	Do. 4½% Debentures of £50 each	104%	107%	104%	107%	4 5 1	" "	..	—
60,710	20	2/0	Direct United States Cable, 1877 ... xd	8¾	9½	8¾	9½	4 6 6	Jan., Apr., July, Oct.	..	..
400,000	10	2/6	Eastern ... xd	17¼	17¾	17¼	17¾	3 14 4	" "	17¼	17
70,000	10	6%	Do. 6 per Cent. Preference ... xd	18	18½	18	18½	3 4 10	" "	..	..
£1,297,837	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	129	132	129	132	3 1 5	May and November	131¾	131½
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899	107	110	107	110	4 11 9	February & August	..	..
250,000	10	2/6	Eastern Extension ... xd	18	18½	18	18½	4 1 1	Jan., Apr., July, Oct.	18½	18½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	128	131	128	131	3 1 4	February & August	130½	129½
£54,100	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103	107	103	107	4 14 7	January and July	[illegible]	..
£80,600	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900	103	107	103	107	4 14 7	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	108	111	108	111	3 12 5	February & August	..	..
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.)	114%	117%	114%	117%	3 9 5	May and November	—	..
180,227	10	1/3	Globe Telegraph and Trust ... xd	10⅛	10⅜	10⅛	10⅜	3 19 6	Jan., Apr., July, Oct.	10⅜	10⅛
180,042	10	6%	Do. 6 per Cent. Preference ... xd	17	17½	17	17½	3 9 7	" "	17¼	17
150,000	10	5/0	Great Northern	21¾	22¼	21¾	22¼	3 16 3	Jan., April, and July	22⅛	21⅞
£180,000	100	5%	* Do. 5 per Cent. Debentures, 1883 issue	103	106	103	106	4 14 9	March & September	105½	..
17,000	25	37/6	Indo-European	50	53	50	53	4 14 4	May and November	51½	..
37,548	10	..	London Platino-Brazilian	..		..		..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures	106	110	106	110	5 9 7	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942 xd	109	112	109	112	3 11 5	..	..	..
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	5¾	..
8,381	£100 Cert.	35/0	*Submarine Cables Trust 6 per Cent.	128	133	127	132	4 10 11	" "	130	..
15,609	10	2/0	West African Telegraph	5½	6½	5½	6½	..	January and July	..	—
£233,300	100	5%	* Do. 5 per Cent. Debentures (red.)	104	107	104	107	4 13 11	March & September	..	—
30,000	10	2/0	West Coast of America	1½	2	1½	2	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	100	105	100	105	7 15 4	June and December	..	..
88,321	10	6d.	West India and Panama	¾	1	¾	1	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10½	10¾	10½	10¾	5 14 8	May and November	..	..
4,669	10	6%	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	5 13 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.)	111	114	111	114	4 8 6	June and December	..	..
64,242	15	6/0	Western and Brazilian	10	10½	10½	10¾	4 8 11	May and November	10½	10
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	6½	7	6½	7	..	—	6¾	6½
33,129	7½	1/6	Do. 5 per Cent. Deferred	3¾	4¼	3¾	4¼	..	—	..	..
£165,200	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910	104	108	103	107	5 12 2	February & August	105½	..
£206,400	100	6%	* Do. 6% Mort. Debs., Series "B" 1910	104	108	103	107	5 12 2	" "	..	—
$1,177,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds	113	118	113	118	6 1 9	May and November	..	—
£164,300	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	100	103	100	103	5 17 1	March & September	..	—
			TELEPHONES.								
44,000	5	2/6	Chili Telephone (fully paid)	3½	4	3½	4	..	..	3¾	..
224,850	10/0	1½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	—
171,504	£1	8·215d.	Oriental Telephone and Electric (fully paid)	9/16	11/16	9/16	11/16	..	Yearly	—	—
484,597	5	2/6	National	6⅛	6⅜	6⅛	6⅜	3 18 5	June and December	6 5/16	6⅛
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	16	18	16	18	3 6 8	" "	17⅛	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	15	16	15	16	3 15 0	" "	..	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	6¼	6½	6¼	6½	3 16 11	—	6⅜	6 5/16
1,100,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.)	106	108	106	108	3 5 5	January and July	107¼	107
58,000	5	3/0	United River Plate	2¾	3¼	2¾	3¼	..	" "	..	..
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	93	98	92	97	5 4 5	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid)	13½	14½	13	14	1 14 6	—	14½	13½
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid)	14½	15½	15	16	3 15 0	—	15⅛	15⅜
£100,000	Stock	5%	* Do. 5% Debenture Stock (red.)	133	137	133	137	3 13 8	June and December	133¾	135
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	5½	5¾	5½	5¾	..	—	..	..
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900	—		—		..	—	..	—
8,322	£5	..	House-to-House Electric	—		—		..	—	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	—		—		..	—	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	..	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid)	7¾	8¼	7¾	8¼	..	—	..	..
111,000	5	..	London Electric Supply	..		..		..	—	..	..
49,900	£10	6/0	Metropolitan Electric Supply (fully paid)	11½	12	11½	12	2 10 0	..	11 15/16	11⅝
150,000	Stock	4½%	* Do. 4½% Debs.	117	119	117	119	3 16 5	June and December	119	117
6,452	£10	2/0	Notting Hill Electric	8½	9½	8½	9½	..	—	9½	9½
..	..	..	Rand Electric	⅜	½ prem	7/16	½ prem	..	—	..	—
19,980	£5	2/0	St. James and Pall Mall	8¼	8¾	8¼	8¾	..	—	..	..
20,000	£5	7%	Do. 7 per Cent. Preference	9	9½	9	10	3 10 0	—	..	—
59,900	5	2/6	Westminster Electric Supply (fully paid)	8½	9	8½	9	3 1 1	..	8¾	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	1½	1¾	1½	1¾	3 11 8	—	1 11/16	1½
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2	2½	2	2¼	5 6 8	—	2 3/16	2
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	112	115	111	114	3 19 6	March & September	114	112½
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref.	1½	2	1½	2	..	January and July	..	—
89,261	5	1/6	Edison and Swan United	1¾	2¼	1¾	2¼	..	..	..	—
£100,000	Stock	4½%	Do. 4% Mortgage Debenture Stock	104	107	104	107	4 5 1	..	106½	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		..		..	..	..	—
110,000	2	..	Electric Construction	⅝	⅞	⅝	⅞	..	..	⅝	..
12,845	2	2/9¾	Do. 7 per Cent. Cumulative Pref.	2	2½	2	2½	5 12 0	..	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	¾	1	¾	1	..	..	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	¼	¾	¼	¾	..	..	..	—
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	19	21	19	20	3 15 0	February & August	20	19¾
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896	100	102	100	102	4 8 3	March & September	..	—
15,995	£10	..	International Okonite Ordinary	..		..		..	—	—	—
16,000	£10	..	Do. 8 per Cent. Preference	—		..		..	December and June	..	—
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid)	⅛	⅜	⅛	⅜	..	..	..	..
87,350	12	12/0	Telegraph Construction and Maintenance	43	45	43	45	4 0 0	March and July	44½	43½
£150,000	100	5%	* Do. 5 per Cent. Bonds	104	107	104	107	4 14 7	January and July	..	—
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)	..		..		..	..	..	—
41,098	£5	..	Do. Preference (fully paid)	..		..		..	..	—	—
£100,000	10	6/0	W. T. Henley's Telegraph Works Ordinary	13½	14	14	14½	4 2 9	..	13¾	13½
£30,000	10	7/0	Do. 7 per Cent. Preference ... xd	15½	16½	15½	16½	4 4 0	..	16⅛	15 11/16
£[illegible]0,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock	105	108	106	109	4 2 11	..	106½	..
			RAILWAYS AND TRAMWAYS.								
£680,000	Stock	1⅛%	City and South London Railway	38	40	38	40	3 2 6	May and November	38	..
7,650	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 4 9	..	..	..
£10,171	Stock	4%	Do. 4% Perpetual Debenture	134	136	134	136	2 19 9	May and November	..	..
37,500	£10	2½%	Liverpool Overhead Railway	11⅞	12⅛	11⅞	11⅞	1 17 11	—	—	—
10,000	10	5%	Do. 5% Preference	15	15½	15	15½	3 4 9	..	..	—
1[illegible]5,000	Stock	4%	Do. 4% Debenture	112	114	112	114	3 10 2	January and July	—	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

ESTABLISHED 1861–1878.

No. 910. [No. 26. Vol. XXXV.] FRIDAY, OCTOBER 25, 1895. PRICE SIXPENCE.

NOTES.

WE have always held the opinion that, although certain things may be "managed better in France," we could at least claim to be ahead of any other country in the manufacture and laying of submarine cables. If, however, the French Government realise within two years the expectations foreshadowed in the conditions of the contract set forth in another column for a "direct cable of great speed and high transmitting power" between Brest and New York, we shall have to make rapid strides in cable enterprise in order to maintain the position which we have undoubtedly held since the early days of submarine cables.

IT would have been more satisfactory had the actual speed of this projected cable been given. Cables nowadays cannot be considered of high speed with a capacity of anything under 30 theoretical words per minute. Before a cable can be so described it should have the capacity of at least 40 theoretical words per minute; but if the French Company can successfully lay and maintain a cable of 3,400 nautical miles, and get a speed of over 30 theoretical words, they will have accomplished something in cable enterprise beyond anything which has ever been done by any other company. To give these results we estimate that it would be necessary to have a core of about 1,200lb. copper and 1,000lb. gutta-percha per nautical mile, and leaving out of the question the great cost of such a cable, the mechanical difficulties alone would be enough to condemn the scheme. A core of this size would require a much greater number of wires than usual for the outer sheathing, and the difficulties which have already been experienced in laying cables of less than half the size of core would make it an "impossible cable." The great additional weight of such a cable would render it very difficult—if not impossible—to repair in such great depths of water as that in which the projected cable would necessarily be laid. We do not think the French Company can have sufficiently realised the enormous weight of a cable of this capacity and the serious difficulties of transport. Even supposing a cable of this capacity were successfully manufactured and laid, it must be remembered that the speed of thirty words per minute is the theoretical speed. This would not be more than equal to about fifteen code words, and after deducting for preambles, repetitions, &c., the actual number of paying words could not, taking the most favourable view, be more than 10 paying words per minute. A cable of this capacity could not be considered, even viewed from the most patriotic standpoint, "a cable of great speed."

SHOULD the steam from central station boilers be superheated? And, if so, where should the superheater be placed? These questions occupied the greater part of the attention of the speakers who took part in the discussion on Mr. BURSTALL's admirable Paper on "The Electric Lighting of Edinburgh," which was read before the Institution of Mechanical Engineers last Wednesday. With characteristic up-to-dateness, and no doubt profiting by his experience at Glasgow, Prof. A. B. W. KENNEDY has placed steam superheaters in the flues, to reduce the liquefaction of the steam in the pipes. Up to the present, as the Professor confessed, these superheaters appear to have done little else than superheat the unfortunate people over the boilers whose duty it has been to look after the thermometers. But this will soon be changed as much as good non-conducting lagging can change it. Most of the speakers were in favour of superheating of some sort; but opinions were divided as to whether the superheat should be derived from the boiler furnace gases or from a separate furnace. The advantage of a separate furnace is that the steam can be superheated independently of the condition of the boiler fires; for it is usually the case that most superheating is wanted when the boilers are making, and the engines are taking, very little steam. The Edinburgh superheaters are placed in a very late part of the boiler flues, where the furnace gases cannot ordinarily be above 800°F. One speaker thought such a "superheater" might only be "a disguised water trap," and doubted if the steam derived any heat therein. Without doubt, the best place to superheat the steam is in a forward part of the flues, where it can get heat first-hand; but there is considerable risk in placing a superheating apparatus in such a place, owing to the difficulty in getting at it, and the impossibility of cutting it out if anything goes wrong.

ANOTHER question which came up for a goodly share of discussion was the relative merits of steam and electrically-driven feed pumps. The latter are used at Edinburgh, but no tests of their efficiency in regular work have yet been made. The steam pump came in for the usual amount of execration, and was dubbed a perfect "steam-eater." Why "eater"? One non-electrical man made a faint defence of it, by saying

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that if the exhaust steam from the donkey engines is sent into the feed heater there is not a great loss of heat. On the other hand, an experienced chief engineer at one of the oldest electric supply stations in London solemnly declared, that if we work out the economy from the electrical or the steam side we can make the electrical or the steam pump appear the more economical, as we may desire! Cooking of this sort makes one disposed to think that that engineer has been reading the Edinburgh superheater thermometers! Seriously though, there is no doubt that, as he meant to convey, *a priori* calculations and estimates are practically worthless; and the question will only be settled when we can compare the figures representing some months of running of each kind of feed pump under conditions sufficiently alike.

In the course of his remarks Mr. Geipel gave an interesting datum for the loss of heat from exposed steam pipes and flanges, which, as Prof. Kennedy said, "we should all lay to heart." It appears that from each square foot of bare metal surface of pipe or flange, under steam, there is dissipated heat at a rate equivalent to the consumption of half a ton of coal per annum. The need for careful and efficient lagging could scarcely be emphasised in a better way; unless, indeed, the pictorial illustration described by Prof. Kennedy can surpass it. The professor stated that he had noticed that when the shadow of a long steam range was projected upon a white-washed wall by arc light, the lines of the lagged pipe were firm and steady, whereas the outline of each bare flange in the pipe was blurred by a violent commotion of uprising currents of heated air. This is a very tangible expression of the leakage of that half-ton of coal per annum of which Mr. Geipel gave warning.

To those who are still interested in the Magnetic Unit question, we commend for perusal the remarks made theron by our American contemporary the *Electrical World*. Whether or no these criticisms represent the deliberate opinion of scientific men and dynamo-designers across the ocean we cannot say; at any rate they strike us as exceedingly just, not to say exceedingly obvious. "Ill blows the wind that profits nobody," and amidst the confusion which seems likely to arise from the conflict between the English and American proposals, the peaceful Briton may console himself that at any rate a few more years will roll before he is called upon by the unanimous voice of the leaders of electrical science all over the world to adopt a system of units and names for which he has never expressed any decided desire.

The whole of this Magnetic Unit controversy is an amusing instance of the way in which mere vociferousness carries the day, even in the calm circles of science. The practical man, taking his cue, as he should do of course, from his scientific superiors, submissively and gratefully adopted the pure C.G.S. system of magnetic units for his designing work as soon as magnetism became an article of commerce; the only emendation made by him being the adoption of the "ampere-turn." Under the circumstances, therefore, one would have thought he might well have been let alone. There seems, however, every likelihood that he will be ultimately forced *nolens volens* to use names and units he has never clamoured for and would rather be without. Such is the irony of fate! Of course, had the practical system sanctioned by usage been a mere mass of irrationality, scientific men would have had the weight of argument to oppose to the dead-weight of custom. But in this case the system sought to be overthrown is one of science's own devising, and one which "practicians" have for once in a way found tolerably suitable for every-day use.

We are told by our New York contemporary that "*The Electrician*, which had always expressed itself in opposition to specific names for magnetic units, in summing up a recent and extensive correspondence on the subject in its columns, frankly admitted *a strong drift of opinion* favouring such names." The italics are ours. What we *did* say was as follows:—"The correspondence in our columns is a proof that, while there exists a strong feeling against tampering with old units or coining needless new ones, there apparently is some need for names to fit those actually in use. . . . While objecting to the wholesale creation of fantastic names, and units of more than doubtful utility, we are ready to admit that something like a case has been established for recognising by a definite name the unit of magnetic flux."

From the moment when liquid air proved such a valuable agent for producing extremely low temperature in scientific research, it has been evident that, if only certain great difficulties could be surmounted, it might find a large sphere of applicability in commerce. But these difficulties seemed insuperable, and not the least of them was the fact that it is impossible to keep liquid air at ordinary temperatures, because these are above the critical temperature of liquefaction. In all the experiments conducted by Prof. Dewar and others, the liquid air has been kept well exposed to the atmosphere, and has automatically maintained its liquid state and its extremely low temperature by virtue of its gradual evaporation. Were a quantity of the liquid to be sealed up in a vessel, it would rise to the temperature of the surrounding air, and would *de facto* cease to be liquid. It would pass through the critical state and become gaseous. We will not stay to contemplate the enormous strength and thickness of a cylinder capable of holding air in such a state of compression, nor the civil regulations which would have to be enforced if such a cylinder was not to become a more terrific danger than any infernal machine. But it is indisputable that, if it is to become an article of commerce, liquid air must have some better vehicle than such as would be afforded by open pint pots with vacuum jackets.

It was reported in *The Times* last Monday that Herr Linde had succeeded in making liquid air on a commercial basis, and by a novel process. By a succession of compressions, coolings and expansions, the coolings being effected by expanding a portion of the compressed gas in a jacket surrounding the other portion to be further cooled, a succession of decrements in temperature is produced; until, when the critical tempera-

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ture is reached, the air is liquefied by a final compression. It is claimed that in the process the air grows richer in oxygen, and at length contains some 70 per cent. of this constituent. What becomes of the nitrogen, and how it is got rid of, are not specified. We have little doubt that Herr LINDE can liquefy air in this way; we have greater doubt about the cost of the liquid so produced being reasonably low; but the chief question in our minds is: How will he keep it?

A PARAGRAPH which affords internal evidence of external inspiration has been lately perambulating. It concerns an electrolytic cell known as the Hargreaves-Bird, designed for the decomposition of common salt. Published accounts are somewhat involved, but as far as their import can be gathered they may be summarised thus: The cathode is quasi-amphibious, and its aerial fraction permits the employment of some gas, such as carbon dioxide, which by its combination with one of the essential products of electrolysis—caustic soda—lowers the critical voltage of the cell. It is true that the product at the cathode—viz., sodium carbonate—is relatively and absolutely less valuable than caustic soda, and thus the advantage of a lowered critical voltage is at least compensated. The figures quoted are of the usual misleading kind; an efficiency of "80 per cent." is claimed, by which the wise understand a reference solely to amperes; volts, we suppose, cost nothing. Taking the published estimate of voltage at 3·5, the true efficiency drops at once to 50 per cent. or under, which is precisely that generally found to obtain with most electrolytic processes. Of more importance than the claim to an exceptionally high efficiency is the statement that the exposed cathode allows the oxidation of the hydrogen which accompanies the caustic soda under normal conditions of working. But if this be true the critical voltage should drop correspondingly, and there is no evidence that this occurs. As a matter of fact, we should require unusually good experimental evidence to induce us to believe that any oxidation whatever takes place. On the whole, further information would not be supererogatory.

WE have been informed, in connection with the remarks made in our leading columns last week anent the recent exhibition of horseless carriages at Tunbridge Wells, that no effort was spared to make the show a thoroughly representative one; but either owing to lack of time, lack of faith in their own devices, or lack of patriotism, the inventors of carriage motors other than the Daimler failed to respond. With regard to the steam-horse, about whose exploits we made some comments, we learn that the one which was to have been exhibited could not be completed in time, and, in order not to disappoint, an old one, made many years ago, was sent. A new type, which is said to drop no cinders and emit no steam, will shortly be ready. As a first attempt, the exhibition certainly did credit to the energetic initiative of its promoter.

Electric Traction in Germany.—It has been decided to adopt electric traction on the tramway between Nuremburg and Furth.

A Large Gas Engine.—A large gas engine has, says the *Gas World*, been made in Rouen; 320 indicated horse-power with fuel gas, and 450 with coal gas.

James Forrest Lecture.—The next "James Forrest" lecture, at the Institution of Civil Engineers, will be delivered on Thursday, May 7th, by Prof. A. B. W. Kennedy. Its subject will be "The Applications of Science to Engineering."

Cable Interruptions and Repairs:—

	Date of Interruption.
Cadiz-Teneriffe	Sept. 25, 1895.
Maranbarn-Para	Oct. 10, 1895.

Electric Lighting Charges in Berlin.—On January 1, 1896, a new tariff of charges for current will come into force, by which the present system of charging will be greatly simplified, though only a slight reduction on the original figures will be made. For lighting the price per unit will be 7·2d., but for power the price remains at 2d.

A Correction.—In our issue of the 11th inst., in announcing the death of Herr Eugen Langen, we mentioned that the deceased was part proprietor of Felten and Guilleaume. This firm inform us, however, that Herr Langen was in no way connected with them. The sole proprietors of the firm are the sons of the late F. C. Guilleaume.

Isle of Man Tramways.—It has been ramoured that the Isle of Man Tramways Company intends to purchase the steam line between Douglas and Peel, and to convert it into an electric line; also that it contemplates the extension of the Douglas-Laxey line to Ramsey, thus making a through communication by electric railway between Ramsey and Peel.

Unprecedented Bell Telephone Output.—The record-breaking net increase in the Bell Telephone output, 12,659 instruments for the month ending September 20th, as compared with 2,568 for the corresponding period a year ago, furnishes, says the *Electrical Engineer* of New York, one of the best indications of general trade improvement. The total number of instruments outstanding is 649,219, as compared with 575,223 last year.

Electric Locomotives for Great Altitudes.—It is stated by the *Western Electrician* of Chicago that a representative from the Baldwin Locomotive Works, with an expert electrician from the Westinghouse Company, together with Sir Henry Tyler, ex-president of the Grand Trunk Railway, will shortly start for Peru, where, it is said a test of the feasibility of the electric locomotive is to be made upon a railroad 15,000ft. above the sea level.

Accumulator Cars in New York.—The storage battery cars which are to be tried on the Second and Fourth-avenue Railways in New York are to be equipped with chloride batteries, which will be put under the car, and so placed that the shifting of batteries can be done expeditiously. The work is being carried out by the Electric Storage Battery Company of Philadelphia, which now controls the important United States patents on storage batteries. It is hoped to reduce the cost of handling and maintaining the batteries in service to 1½d. per car mile.

South-West London Polytechnic Institute.—The organisation of this, the newest of London polytechnics, has been brought almost to completion under the direction of Mr. Herbert Tomlinson, F.R.S., the principal, and a programme of useful work in technical instruction has been arranged for the forthcoming winter session. The scientific, artistic and domestic sides of life are well provided for, the last chiefly for the girl students, who receive, among other things, instructions in "Housewifery," and doubtless are awarded valuable certificates in this eminently practical subject.

American Opinion of the Bristol Line.—The *Street Railway Review*, of Chicago, has brought out a "Montreal Convention" number, in which there is much local colour. Our contemporary confesses that "there are a number of interesting features" about the Bristol electric tramway, "and it can even give American roads some pointers in some respects." Our contemporary states that the Bristol line is "the first one built under the new ironclad regulations." We have heard of cast-iron regulations, but perhaps our contemporary thinks these too brittle. Surely, if regulations are ironclad, it must be because the core is soft and weak!

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Visible Radiation and Temperature.—A new determination of the lowest temperature at which a hot body becomes visible is published by Sgr. Pettinelli, in tho *Nuovo Cimento.* He heated a cast-iron cylinder, 30cm. long and 14cm. broad, in a wrought-iron jacket over a Bunsen burner to a temperature of 460°C., as indicated by an air thermometer, and then observed its flat end in a dark room from a point 60cm. above it. When it had cooled to about 415deg. the red heat vanished and gave way to an indefinite hazy glow. This glow completely disappeared at 404deg., and repeated observations gave an error of only 3deg. Highly emissive substances, such as the "mantles" made by Auer and others for incandescent gas lighting, became visible at the same temperature; but reflecting surfaces had to be heated 20deg. higher before they appeared to the eye, and glass still more. These low temperature rays were found to traverse glass and water like ordinary light rays, but they suffer a comparatively greater absorption. Different eyes differ slightly in their capacity of seeing them; the maximum divergence being about 6deg. But then the extent of surface must be the same. Sgr. Pettinelli found that if he screened off all but $\frac{1}{10}$th of the surface, the body had to be heated 6deg. higher than before to become visible. Hence he concludes that the contradictory results obtained by previous experimenters are due to differences in the areas of the hot bodies investigated.

Car Heating by Electricity.—In a Paper read before the Street Railway Association of New York, Mr. J. F. McElroy discusses the subject of car heating by electricity, and gives a number of useful data. He objects to embedded resistance wires, on the ground that the powdered fire-clay or other embedding material will necessitate a higher temperature in the wire and will thereby increase deterioration. Exposed iron wires are advocated, and if these are kept below about 400°F. no difficulty will be experienced from oxidation. Iron is recommended on account of its high temperature coefficient, whereby any excessive rise in temperature tends to check a further rise by considerably augmenting the resistance and diminishing the current. With German silver this automatic control is less marked. Inasmuch as a car passenger (a standard one, we presume) liberates 191 British units of heat per hour, it follows that the cost of an electric car heater will be less in a crowded than in a comparatively empty car. Moreover, an element of economy exists in the care which, on chilly days, a conductor may take to close the car door promptly after the passage of a passenger. The cost of heating a car in winter time averages 17·6 cents (about 9d.) per day of 15 hours for electrical energy alone. The aggregate cost of heating a car by coal stoves, including attendance, averages 19·25 (about 9½d.) per day of 15 hours.

A Plea for Electric Railways.—There is a remarkable article under this title in *Electrical Engineering*, of America. The author sets himself the task of proving the national necessity for electric railways. He finds a resting place for the vertex of his inverted pyramid in the opening assertion that "the desire for a home is implanted almost as strongly in the human breast as the instinct of self-preservation." Then follow two stanzas from "the Poet Laureate" to show that a man who has a home will have to work for it. Next comes the reflection that when a man has a home he will sometimes want to "go home," and "it is here that the street railway and particularly the electric road offers a solution." Country cousins who flock to the cities must not merely be housed, but "if America is to shun the examples of Greece and Rome, and escape their fates, they must be *homed.*" It was "a French discovery originating in the classic experiments of Marcel Duprez" (*sic*) which renders it possible to go home by electricity. Then follow a number of curves to show how many people go home, and how many miles they go, and what they pay. After all this comes another classic allusion, with the terrible reflection that in the present imperfect means of transit is "the handwriting on the wall, behind which, if unheeded, lurks as grim and inexorable a fate as that which stood in the Chaldean banquet hall; for the public, like the mills of the gods, grind fine though slowly." Surely no municipality can be found to resist such arguments as these.

A New French Transatlantic Cable.—As we have already announced in our issue of October 4th, M. André Lebon, Minister of Posts and Telegraphs, will immediately lay on the table of the Chambre des Députés a Bill concluding a contract with the Compagnie Française des Câbles Télégraphiques for the establishment, maintenance, and working of submarine telegraph cables between France, North America, and the Antilles. According to the terms of that contract, the French Company undertake—(1) To lay within a maximum period of two years, between Brest and New York, a new and quite direct cable of great speed and of great transmitting power; (2) to maintain in good working order, or, if wanted, to replace the present Brest-St. Pierre and New York cable, called the "P. Q." cable, thereby duplicating the line of communication. "This first considerable result," says *Le Temps*, "which gives every security to our relations with America, and will constitute an outlay estimated at £1,200,000, will be carried out in consideration of a yearly subsidy of 800,000fr. (£32,000), which may eventually be reduced when the traffic receipts reach 1,650,000fr. (£66,000) by the application of two-thirds of the receipts to the benefit of the Treasury, the subsidy to cease altogether when the traffic amounts to more than 2,850,000fr. Moreover, the Company will be bound, without any further Government subsidy, to extend the French transatlantic lines to the Antilles by a new cable from New York to Puerto-Plata, connecting at that point with the cable system already owned by the concessionary Company, which serves our colonies. The correspondence of the metropolis with our Antilles colonies may then be transmitted by cables exclusively national."

Buffalo and Niagara Falls Electric Railway.—The present Buffalo and Niagara Falls Electric Railway has just completed a double-track railway from the Buffalo City line to the City line of Niagara Falls, which was opened for business last month. Some interesting particulars of the line are given in a recent issue of the *Electrical Engineer* of New York, from which we quote the following:—"The line is 14½ miles long, and passes through the villages of Tonawanda, North Tonawanda, and Lazalle. The Company charges 50c. for a round trip from Buffalo to Niagara Falls, including transfer over the electric railways both in Buffalo and Niagara Falls. The track construction is of the most substantial kind, 73lb. girder rails being used. These rails have been laid in 60ft. lengths upon white oak ties 8ft. long, 6in. thick, and 9in. wide. These ties are placed 2ft. between centres, and the track for its entire length is ballasted under the ties, 2ft. outside and between the tracks with crushed stone. Stone ballast is 18in. deep over the entire line, extending from 5in. under the ties to the top of the rails, which are 7in. high. The rails are prevented from spreading by heavy brace tie plates, placed 6ft. apart, and the joints, of which there are only one-half the usual number, are held in place by very heavy angle bars, 36in. long, and secured by eight bolts of 1in. diameter. The bonding throughout has been done with Chicago bonds, besides which the four rails are cross-bonded at frequent intervals. The overhead construction is of the usual kind; wooden poles have been used throughout. The Company expects ultimately to take power from the Cataract Construction Company for the entire line. At present this Company furnishes power for the section nearest Niagara Falls only, which includes about five miles of double track. For supplying the rest of the line with power, a steam plant has been installed, comprising four 125 H.P. return tubular boilers, built for high pressure; two compound condensing Ball engines, and two 200 H.P. multipolar generators, furnished by the General Electric Company. The Company owns, and is now operating, 20 motor cars, each equipped with four "G.E." 800 motors. By special switch, these motors can be operated all in series, or in multiple series, or all in multiple, and these combinations, with varying amounts of resistance in the armature circuits or shunting fields, give a wide range of speed. With motors all in multiple, a speed of 40 miles per hour has frequently been reached, and the Company is now operating its cars daily over a practically straight and unobstructed portion of its road over three miles long at a speed exceeding 30 miles per hour. On Sunday, September 22nd, the road was opened for public travel. During this day, the cars were taxed to

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their utmost capacity, and many thousands of people along the line were unable to get transportation."

Electric Traction in Rome.—An Italian correspondent sends us the following :—A new electric line has recently come into operation. It belongs to the Tramways Company of Rome, and is of special interest on account of the power being derived from an alternating current supply. The line, which is nearly three kilometres long, double track, connects the main railway station of Rome with the centre of the town. The maximum gradient is about 7 per cent. for a length of 500 metres, the remainder of the line being practically level. The sharpest curves have 15 metres radius. A five-minutes service is carried out by seven cars, which take 12 minutes one way and 13 or 14 minutes on the reverse trip. The cars are of the closed type, with two internal and two external platforms, and weigh seven tons empty, the stated capacity being 16 passengers seated and 24 on the three platforms (the fourth being reserved for the driver); the total number of passengers carried is, however, sometimes as high as 50 or 55, bringing the total weight to 10 tons. The car body, which is elegantly finished and brilliantly lighted, is driven by two "G.E." 800 motors. A series-parallel controller, "G.E." type K, is employed for speed regulation, with an additional switch enabling the motors to be short-circuited, and so act as brakes. In addition two mechanical brakes are fitted, one acting on the wheels as usual, and the other on the rails directly. A system of electric bells is actuated by the lamp current, which enables every passenger from his own seat to easily communicate with the driver. The current is supplied at 300 volts by a single trolley, on the standard overhead system. The whole plant derives its power from the alternating Tivoli-Rome transmission. To obtain the necessary transformation a set of high-speed dynamo-motors, having multipolar field and a single armature connected with two collecting rings on one side, and a communicator on the other side, is installed at the end of the transmission line, and a battery of Tudor accumulators is thus charged. This battery, kept constantly charged, supplies the power to the electric tramway. The electric equipment of cars and overhead work was carried out by the General Electric Company of America; the cars are supplied by Messrs. Miani Silvestri and Co., of Milan, and the generating station was equipped by Messrs. Ganz and Co. The line had to be opened on September 1st. Owing, however, to some difficulty experienced with the working of the rotary converters, horse traction had to be resorted to for some weeks, and the inauguration of electric traction was delayed till September 19th. Everything is now working satisfactorily in this plant, and the receipts are exceptionally high, the cars nearly always travelling full.

Method of Automatic Control for Forced or Induced Draft.—In the September number of *Electric Power* of New York, Mr. Horatio A. Foster, writing on the above, says that for many years power-actuated blowers have been in use for forcing air under the grates of steam boilers, or for pulling the air through the fire and forcing it up chimney, but not until late years has the subject received anything like the attention it deserves. It is quite common to apply forced draft to boilers of insufficient capacity or lacking in chimney area both on land and water, and of late the system has been very largely applied in new plants for the use of cheaper grades of fuel and to avoid the erection of costly chimneys. Where blowers are used essentially for reducing the cost of fuel, it becomes necessary to provide some method of automatic control, for if left to the fireman it is capable of a most uneconomical misuse. When suitable apparatus is provided for automatic control of the supply of air under the grates, then forced draught becomes highly efficient, and such seems to have been provided in the apparatus as designed by John E. Beckman, in which also the blower engine is practically out of the control of the fireman. As the steam pressure rises above a predetermined point, the engine is slowed and less air is forced under the grates and the rise is checked. On the other hand, as the steam pressure gradually falls, the speed of the blower gradually increases, and the air supply is automatically increased according to the demand. This regulation is effected generally by a steam-reducing valve of customary type, so piped that it opens to increase the speed of the blower engine as the steam pressure falls and gradually closes to decrease such speed as the pressure rises. This operation can also be secured by connecting to a damper regulator an ordinary throttle valve in the steam pipes supplying the blower engine. Provision is also made to limit the speed of the blower engine in both directions; that is, the engine is never allowed to stop entirely, as it would if regulated by the device above described, but a by-pass, consisting of a small pipe, is carried around the main regulating valve, and steam is by a regulating valve therein admitted through this by-pass at such a pressure as to maintain the blower at a slow speed when the main valve is shut off. By this means a little air is forced through the grates at all times, keeping the fire ready for an important demand. It will be perceived that by this method the supply of air to the furnace of one or a number of steam boilers is at all times automatically regulated. The fireman has nothing more to do with the matter than to maintain the fires in good condition. So long as he puts on the coal and keeps his fires reasonably clean, the rate of combustion is entirely out of his control and is automatically determined by the demand. Moreover, the changes are made gradually, so that the furnace is not alternately heated hotter than necessary and then cooled lower than necessary. This apparatus has been in use in a number of steam plants in the city of Buffalo for some time with considerable success, so much so that it is now attracting a great deal of attention from steam users and engineers outside that city.

Current Electrical Science.—The last report of the *Séances de la Société Française de Physique* contains some interesting electrical items. At one meeting, M. de Kowalski made some experiments with various forms of vacuum tubes in order to discover the precise nature of the CATHODE RAYS. In an H-shaped tube, with electrodes, the rays passed in one direction only through the connecting tube—viz., from the cathode—and made a phosphorescent patch upon the next wall. An electrodeless tube, with a capillary portion in the middle, when excited by Tesla currents, gave patches at both ends. In both cases the rays were deflected by a magnet. In connection with these experiments, M. Curie described some crucial experiments upon the magnetic deviation of light waves. Light-rays were made to run the gauntlet of a magnetic field of 14,000 units for a length of 20cm., the field having a direction perpendicular to the light-rays. But although a hundredth of a millimetre of deviation could have been seen, no such thing was discovered. On the question of the EFFECT OF MAGNETISATION UPON THE ELECTRO-CHEMICAL PROPERTIES of certain bodies, M. Hurmuzescu has at last, with the aid of the capillary electrometer, obtained consistent results. He finds that iron is always made electro-positive by magnetisation. Nickel behaves in the same manner, but bismuth is made electro-negative. The *Physical Review* contains a Paper on alternate currents with ZIG-ZAG E.M.F. CURVES, by E. C. Rimington. Such E.M.F.'s are, to say the least, rare in actual practice, but Mr. Rimington pleads that some dynamos in the market give an approximation to such a curve, and as he also investigates curves of a square or block type, he may be said to touch the two extremes between which the practical and more or less sinusoidal curve finds its place. Although the E.M.F. goes up and down in straight lines, the current does not do so, except when there is no self-inductance. With ordinary values of self-inductance, say 0·01 henry, the current curve is nearly a sine curve, with its nodes opposite the maxima and minima of E.M.F. In the case of a block curve, representing a constant positive followed abruptly by a constant negative E.M.F, the current curve becomes zig-zag, reaching its maximum at the point of interruption. The same number contains a Paper, by Messrs. Guthe and Briggs, on the ELECTROLYTIC CONDUCTIVITY of the peculiar hydrate of sulphuric acid represented by $H_2SO_4 + H_2O$. It has long been supposed that this has the least conductivity of any of the hydrates of that acid. The authors show that whatever the temperature the minimum depends upon the molecular volume, and always occurs when that is 32·1. The dip in the curve of conductivity and concentration becomes less sharp at higher temperatures. The solid crystals of the substance have a very much lower conductivity, and the curve suddenly jumps up at the melting point, whereas if the liquid is undercooled the conductivity diminishes gradually and steadily.

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THE CHARGING OF A CONDENSER.

BY ALFRED HAY, B.SC. (EDIN.).

In his Paper on "Transient Electric Currents," published in the *Phil. Mag.* for June, 1853, William Thomson (Lord Kelvin) first gave the mathematical theory of the discharge of a condenser through an inductive resistance, and indicated the existence of electrical oscillations under certain conditions. Numerous experiments have been carried out in support of this theory, the earliest of which were due to Feddersen, who used the method of the rotating mirror. Since then a very large number of experiments, including the brilliant researches of Hertz, Lodge, and many others, have been adduced as proofs of the existence of oscillatory discharges.

The experiments about to be described are intended as a small contribution towards the already overwhelming mass of experimental evidence as to the existence of the oscillations which take place in the charge or discharge of a condenser when certain conditions as to capacity, resistance and inductance are fulfilled. In many experiments on condenser discharges very small capacities were used, rendering the period of oscillation very short, and hence accurate quantitative work difficult. By using a larger capacity we increase the period, and so facilitate the determination of the instantaneous values of the varying quantities.

In the *Phil. Mag.* for 1892, Vol. XXXIV., p. 389, an account is given by Dr. W. L. Robb of experiments "On Oscillations that occur in the Charging of a Condenser." In these experiments capacities of from 0·1 to 1 microfarad were used. Most of the experiments described are qualitative. The method of experimenting consisted in varying the time of charging by using contacts of very short duration. This was accomplished by the use of two steel spheres, one of which was fixed, while the other was suspended, so that when deflected and let go it impinged on the fixed sphere; the time of an impact was taken as the unit of time. The experiments showed that oscillations occurred in the charge. Towards the end of the Paper some quantitative results are given, obtained by using a Helmholtz pendulum for making and breaking the circuit. But the number of points on the curve is not sufficient to indicate its shape with any degree of accuracy.

If the relations of capacity, resistance and inductance are such that the condenser when allowed to *discharge* does so in a series of oscillations, then the *charging* current of the condenser, as well as the potential difference at its terminals, when a source of constant E.M.F. is applied to the circuit, will also undergo a series of oscillations. In this case the potential difference at the condenser terminals may rise to a value considerably in excess of the charging E.M.F. of the battery.

Let a condenser of capacity C be joined up in series with an inductive resistance r, of inductance L, and let a constant E.M.F. of E units be applied to the circuit. Then we have the equation

$$r\,i + \mathrm{L}\frac{d\,i}{d\,t} + v = \mathrm{E}, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where i stands for the instantaneous current, and v for the potential difference at the condenser terminals. Differentiating (1), we get

$$\mathrm{L}\frac{d^2 i}{d\,t^2} + r\frac{d\,i}{d\,t} + \frac{1}{\mathrm{C}}\,i = 0. \quad . \quad . \quad . \quad . \quad (2)$$

Solving (2), and taking account of the initial conditions that, when $t=0$, $i=0$ and $v=0$, we find

$$i = \frac{\mathrm{E}}{\sqrt{r^2 - \frac{4\,\mathrm{L}}{\mathrm{C}}}}\,\epsilon^{-\frac{r}{2\mathrm{L}}t}\left\{\epsilon^{t\sqrt{\left(\frac{r}{2\mathrm{L}}\right)^2 - \frac{1}{\mathrm{LC}}}} - \epsilon^{-t\sqrt{\left(\frac{r}{2\mathrm{L}}\right)^2 - \frac{1}{\mathrm{LC}}}}\right\} \quad (3)$$

This equation shows that oscillations will occur when $r^2 < 4\,\mathrm{L/C}$, the period being

$$\frac{2\pi}{\sqrt{\left(\frac{r}{2\,\mathrm{L}}\right)^2 - \frac{1}{\mathrm{L\,C}}}}.$$

In order to investigate the action experimentally, a method was adopted similar to that used in some experiments on "Current-Rushes," published in *The Electrician* * about a year ago. The method consists in reproducing an essentially non-periodic phenomenon, or the initial stages of it, in rapid succession, so as to render it periodic by artificial means, and investigating the variation of the quantities involved by means of a Joubert contact-maker.

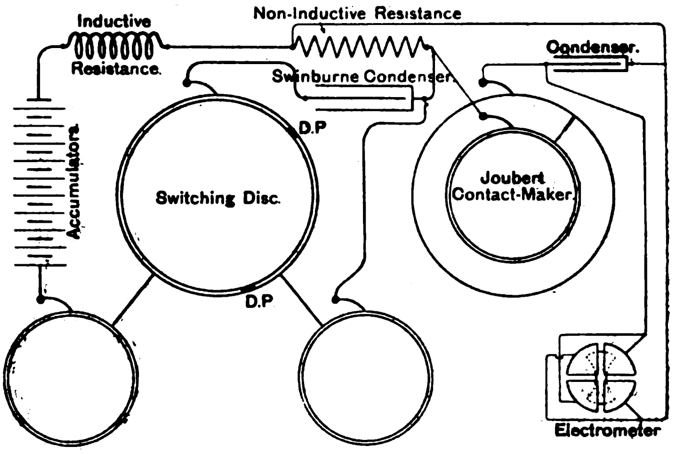

Fig. 1.—Diagram of Apparatus.

The arrangement of apparatus used is shown diagrammatically in Fig. 1. For the sake of clearly exhibiting the connections of the circuits, the various switching discs are shown separately, although as a matter of fact they are all mounted side by side on the same shaft. The discs are made of wood, and one of them, marked "switching disc" in the diagram, is provided with a brass rim divided into two portions by the vulcanite distance-pieces D.P. The smaller discs shown below the switching disc carry simple contact-rings. The discs were

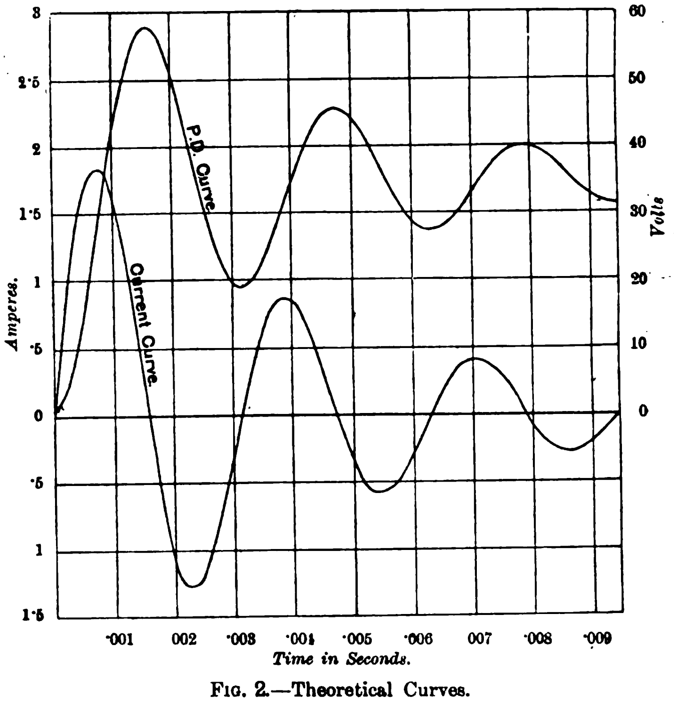

Fig. 2.—Theoretical Curves.

driven round by an electromotor running at a constant speed, and the number of revolutions per minute was determined, so that the time of one revolution, or any fraction of it, was known. Hence the time-value of one division of the scale attached to the Joubert contact-maker could be determined. It will be readily seen, by examining the connections of Fig. 1, that in one revolution of the shaft carrying the discs, the following operations are performed.

* *The Electrician*, Vol. XXXIII.

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The condenser, discharged to start with, is connected, through an inductive resistance, to the terminals of the charging battery. Contact is maintained for a certain interval of time, during which the condenser is being charged. The battery is next disconnected, and the condenser is short-circuited and discharged. The same cycle of operations is repeated in every revolution of the switching discs.

The instantaneous values of the current are ascertained by having a non-inductive resistance in the circuit, which at definite time-intervals is connected to the terminals of an electrometer shunted by a condenser. Similarly, by connecting the terminals of the condenser at known intervals of time to the electrometer, the instantaneous values of the potential difference are ascertained.

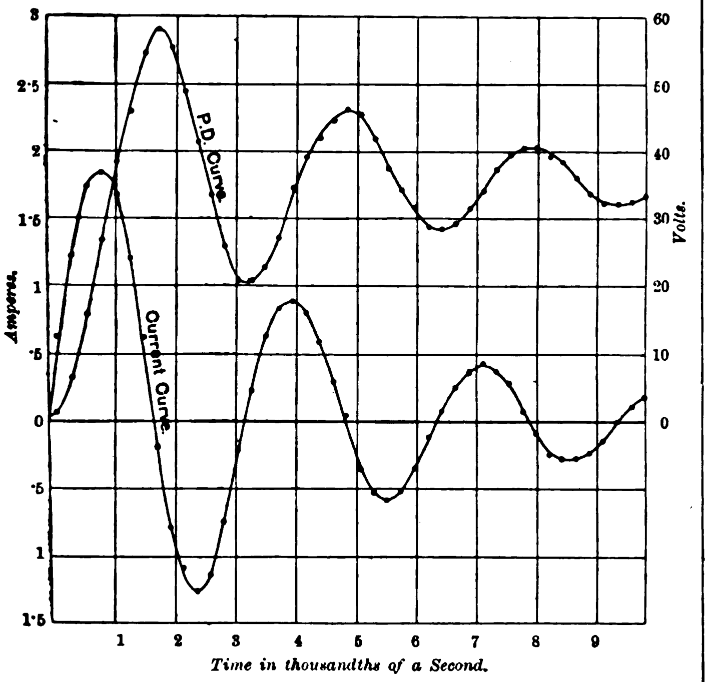

Fig. 3.—Experimental Curves.

In the first set of experiments, the capacity, resistance and inductance of the circuit were so related that the charge was oscillatory. The values of these quantities were:—

$$r=3{\cdot}6\,;\ L=0{\cdot}0076\,;\ C=32{\cdot}6\times10^{-6}.$$

Substituting these values in equation (3), we find for the current

$$i=2{\cdot}216\,\epsilon^{-237\,t}\sin 1{,}995\,t, \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

the charging E.M.F. being 33·6 volts.

By using equation (1) we find for the potential difference at the condenser terminals

$$v=33{\cdot}6-33{\cdot}83\,\epsilon^{-237\,t}\sin(1{,}995\,t+\alpha), \quad . \quad . \quad (5)$$

where $\alpha=83°\,12'$.

Experiment showed, however, that in spite of the condenser having been short-circuited for a considerable time, its coatings became charged to a potential difference of about 1 volt during the brief period between the instant of open-circuiting it and that of switching on the charging battery. The actual potential difference at the condenser terminals when fully charged was 34·6 volts. Hence the effective charging E.M.F. in the circuit at the commencement of the charge was 33·6 volts, the value used above in calculating the current. In order, therefore, to compare the calculated values of the potential difference with those obtained experimentally, we have to add 1 volt to each ordinate of the curve given by (5). The theoretical curves so obtained are shown in Fig. 2, and the corresponding experimental curves in Fig. 3. It will be seen that there is a very fair agreement between the two sets of curves, such discrepancies as are noticeable being probably due to inaccuracies in setting the Joubert contact (a small displacement of which produced a considerable change in the values of the quantities observed), to variations in the speed of the electromotor driving the switching discs, and to slight errors in taking the electrometer readings.

The curves show very clearly the nature of an oscillatory charge, the oscillations being due to the presence of inductance in the circuit. In another set of experiments, a non-inductive resistance was used. Instead of equation (1), we have in this case

$$r\,i+v=E, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

which by differentiation gives

$$r\frac{di}{dt}+\frac{1}{C}\,i=0. \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Solving this equation, and remembering that when $t=0$, $v=0$, we find

$$i=\frac{E}{r}\,\epsilon^{-\frac{t}{rC}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

The values of the various quantities were as follows:—

$$E=34{\cdot}6\,;\ r=921\,;\ C=32{\cdot}6\times10^{-6}.$$

Substituting in equation (8) we get

$$i=0{\cdot}0376\,\epsilon^{-33{\cdot}3\,t}. \quad . \quad . \quad . \quad . \quad . \quad (9)$$

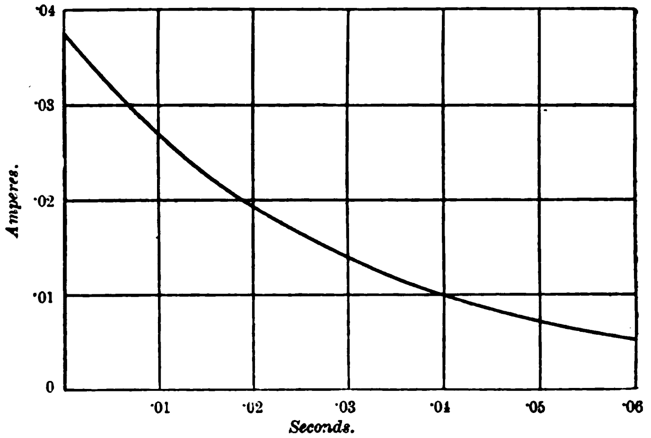

Fig. 4.—Theoretical Curve, Condenser Charged through Non-Inductive Resistance.

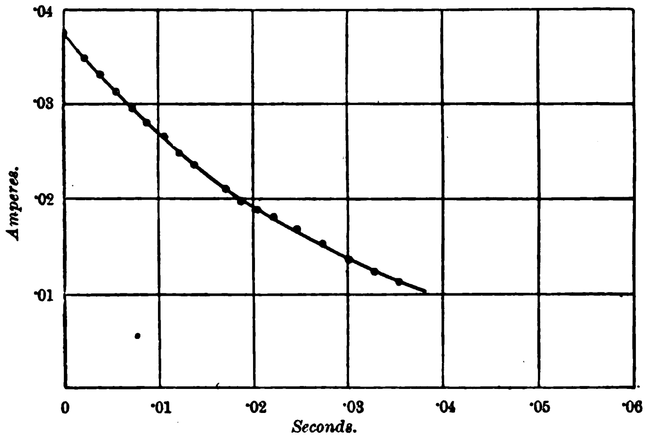

Fig. 5.—Experimental Curve, corresponding to Fig. 4.

The theoretical and experimental curves corresponding to this case are shown in Figs. 4 and 5 respectively. A comparison of the two curves shows that they are in substantial agreement.

The main interest of the above experiments lies not so much in the fact of their showing, qualitatively, the existence of oscillations in the charge, as that they enable us to make a fairly accurate *quantitative* comparison between the actual curves of current and potential difference, and those deduced theoretically.

In conclusion, I wish to thank Mr. G. B. Bryan, a senior student of University College, Nottingham, for assistance in carrying out the experiments.

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ALTERNATE-CURRENT ELECTROLYSIS.

BY W. R. COOPER, M.A.

In *The Electrician* for August 23, 1895, some notes were given upon the production of phase-difference by alternate-current electrolysis. My attention has since then been called to a joint Paper by Dr. J. Hopkinson, E. Wilson and F. Lydall, entitled "Alternate-Current Electrolysis," which was read before the Royal Society in 1893. As nothing beyond a note of the work appeared in *The Electrician*, an abstract of the Paper will be of interest, as showing how readily a phase-difference can be obtained when the conditions are suitable—*i.e.*, when the electrodes are close together, and the impressed E.M.F. is not large. This was not, however, the main object of the investigation. The authors desired to determine the efficiency of an electrolytic cell when used as a condenser, and also to gain some idea as to how thick a coating of the ions suffice to give complete polarisation.

In the experiments described, current from a Siemens alternator was passed through two cells in series, having platinum electrodes (exposed on one side only) 23¼ sq. in. (150 sq. cm.) in area placed ⅛in. apart. The current and potential difference at any time were measured by a Kelvin quadrant electrometer,

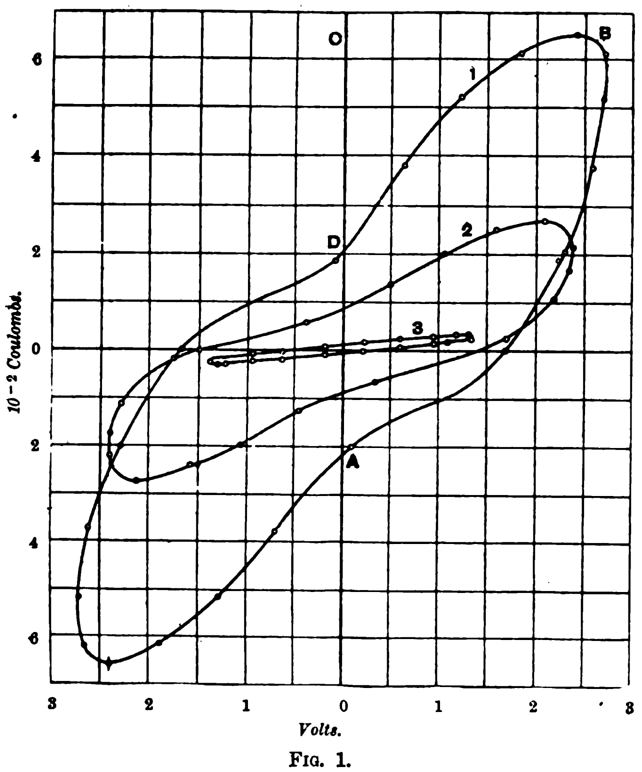

Fig. 1.

in circuit with a revolving contact-maker. The electrolyte used throughout was of water 100 parts by volume and sulphuric acid five parts.

The first part of the Paper deals with the question of efficiency. Curves are given in which amperes and volts are plotted in terms of time. By integrating the current curve, the number of coulombs passing during any desired interval is known; and thence curves are plotted between the potential difference across the cells and the quantity of electricity at corresponding times. These are closed curves after the manner of those due to hysteresis as shown in Fig. 1, and the area of any one of them is a measure of the total energy dissipated per cycle. The efficiency is readily determined. For example, in curve 1 the total energy expended on the cell is proportional to the area A B C, whilst the energy recovered is proportional to D B C. Thus the efficiency of the cell as a condenser is given by the ratio of these areas. Results are given of six experiments in which the efficiency varied from 23 to 43 per cent with the plates ⅛in. apart. In the first case the maximum pressure amounted to 2·7 volts, and the maximum current was 43·3 amperes (curve 1); in the second case the corresponding figures were 1·3 and 2·06 (curve 3).

Experiments are then described in which the frequency was varied as well as the current. The platinum plates were placed ¼in. apart, so that a movable electrode might be intro-

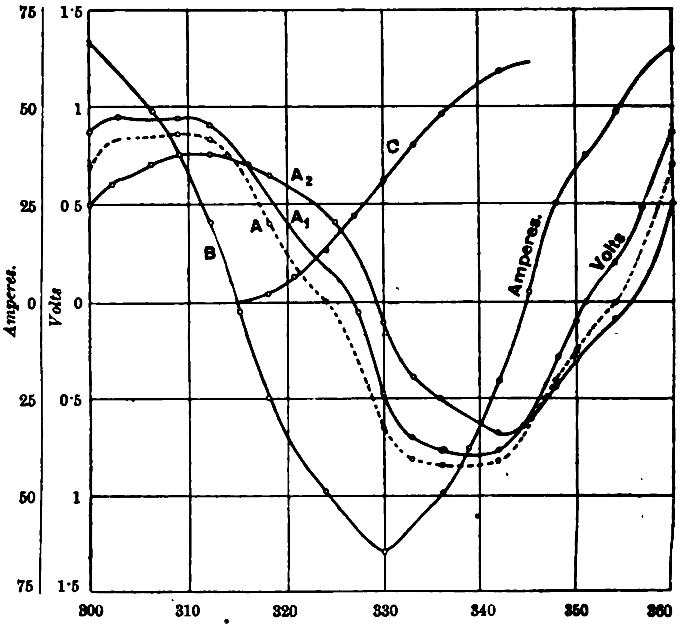

Fig. 2.—Frequency = 142·5 ∿ per sec. Max. Current 65·4 amperes.

duced between them. The potential difference was then measured between one of the plates and the exploring electrode. The curves obtained with a frequency of 142·5 per second are given in Fig. 2, and show a considerable phase

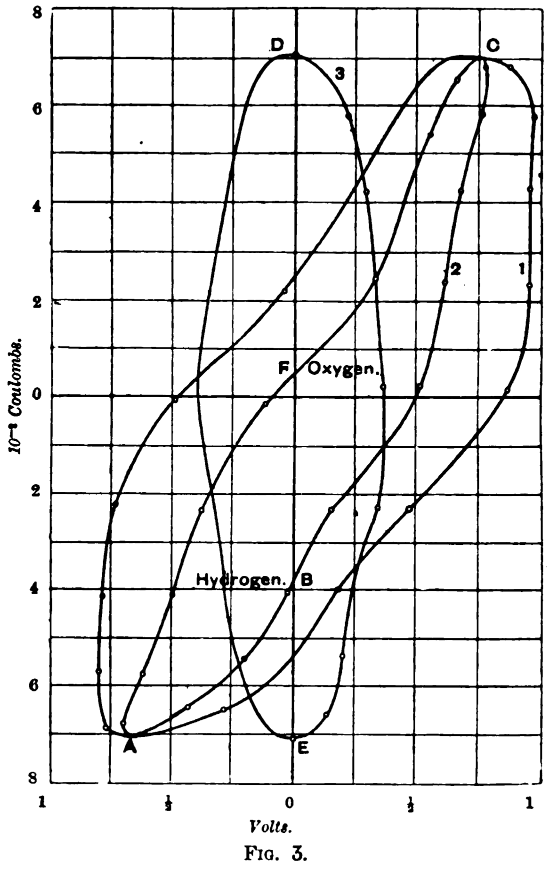

Fig. 3.

difference. The curve A_1 so obtained gives the volts absorbed at any time by the evolution of gas, together with that due to ohmic resistance. From experimental evidence it was estimated that this resistance was approximately 0·0056 ohm. By correcting curve A_1 for this loss of potential difference curve

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A_2 is obtained and gives the volts at any time absorbed in the decomposition of the electrolyte alone. With this frequency and current the energy dissipated on ohmic resistance is seen to be a large proportion of the total energy dissipated. It will be noticed that the curve A_1 is unsymmetrical, whereas the curve A, giving the potentials across the two platinum plates, is symmetrical.

The curve C in Fig. 2 is the integral of B, and therefore gives the number of coulombs that have passed at any time. On plotting volts as given by curves A_1 and A_2 in terms of coulombs, curves 1 and 2 in Fig. 3 are obtained. The area of the first gives the total energy spent in the cell; that of the second is a measure of the energy dissipated by electrolytic hysteresis.

From observations with a Clark cell it was possible to state which gas was being evolved at the plate during a given half-period. Thus oxygen begins to be directed to the plate at the point A (Fig. 3), as the coulombs are then a maximum, and the current changes sign. But it is being evolved upon a hydrogen plate, and the E.M.F. aids the current as far as the point B. The work done on the plate represented by the area A E B, is therefore negative. At B the hydrogen has been all removed, and from B to C the work represented by B C D is positive. Similarly the area C D F represents work returned by the plate during evolution of hydrogen on an oxygen surface, and the area F A E is a measure of the work done on the plate during the evolution of hydrogen on a hydrogen surface. In this manner the product of volts by coulombs is obtained, corresponding to hydrogen evolved upon an oxygen surface.

The conclusion arrived at is that about one-tenth of a coulomb suffices to fully polarise 150 sq. cm. of platinum, or 0·00000007 gramme of hydrogen is sufficient for 1 sq. cm. of platinum. From which it is inferred that "0·00000007cm. is probably a magnitude comparable with the distance between molecules of hydrogen when this body is compressed to a density comparable with the density of liquids."

SOME POINTS CONNECTED WITH THE PREPARATION OF PURE IRON BY ELECTROLYSIS.*

BY PROF. W. M. HICKS, F.R.S., AND L. T. O'SHEA, B.SC.

We have recently had occasion to prepare for a special investigation considerable quantities of pure iron by electrolysis. Although this has frequently been done before by others, we have not been able to find any published account of the details to be attended to to ensure success. As the process is a tedious one, and cost us much time and trouble to discover the best conditions, it may be useful to put on record some of the difficulties met with and the means adopted to overcome them.

The most complete account of the past attempts to prepare iron by electrolysis is given by Varrentrapp (*D. P. J.*, 187-150), who describes the precipitation of iron from solutions of ferrous sulphate, with or without the addition of ammonium chloride, by means of the current from a single Daniell's cell, using iron wire as the anode.

Lenz (*Jour. für Pr.*, 108-438) adopted Klein's process of using a solution of ferrous and magnesium sulphate carefully neutralised with magnesium carbonate. More recently, Classen, in his book, "Quantitative Analyse durch Electrolyse," describes methods for the electrolytic deposition of iron from solutions of ferrous salts containing a large excess of ammonium oxalate, and also refers to the methods adopted by Rudorf, Brand, and E. F. Smith for the analysis of iron compounds by electrolysis.

As many of the difficulties we met with are not referred to in these publications, we hope that the following notes may be found useful by those who, in the future, require to use this method.

The Solution.

It is generally admitted that the electrolyte should be neutral, and we found it absolutely impossible to prepare coherent masses of iron if the solution contained free acid.

* Paper read before the British Association at Ipswich, Section A.

The electrolyte used was a 5 per cent. solution of crystallised ferrous chloride, to which was added sufficient ammonium chloride to form the double chloride $FeCl_2 2NH_4Cl$. Stronger solutions than this can doubtless be used, but the above strength was adopted as offering the most suitable resistance for the regulation of the current and the fall of potential between the electrodes. The amount of iron salt in solution should, however, not be allowed to get too low, because when nearly all the iron salt is decomposed the solution becomes alkaline from the decomposition of the ammonium salt, and ferrous hydroxide is precipitated by the ammonia thus set free; it may be roughly stated that the amount of iron salt in solution should not fall below from 20 to 30 per cent. of its original strength. To avoid this difficulty, we adopted the plan of daily determining by titration the amount of iron removed from the solution, and adding its equivalent in ferrous chloride. As this was done by siphoning off a certain volume of the electrolyte, an amount of ammonium chloride equal to that removed in the solution was added with the ferrous chloride.

It is very essential that the solution be free from ferric compounds, for their presence seems to lead to the formation of ferric hydroxide, which settles in large quantities at the bottom of the cell, and is often deposited on the cathode, whilst considerable frothing accompanies its formation. It appears, also, that the production of ferric hydroxide ceases as soon as the whole of the ferric compound is decomposed, for in the early stages of our work we were troubled with the formation of this substance whenever we started with a fresh quantity of electrolyte, or added more ferrous chloride to replenish that in use, but after the current had passed for some time ferric hydroxide ceased to form. We effectually overcame this difficulty by shaking the ferrous chloride with reduced iron and filtering just before using. This had the effect of reducing any ferric salt to ferrous before entering the electrolyte. So long as this was done the ferric hydroxide ceased to be deposited on the plate, and the amount which was deposited at the bottom of the cell was small even after working for three weeks.

The Current.

There seems no doubt that, to get the best results, both the terminal volts and the current density must lie within certain limits. This requires regulation by the resistance of the cell itself. The constitution of the electrolyte just given was found to meet the necessities of the case. Classen (*loc. cit.*) gives a density of 0·5 to 1 ampere per 100 sq. cm. for purposes of electrolytic analysis, whilst for steel facing S. P. Thompson ("Dynamo-Electric Machinery") gives 0·5 to 1·5 ampere per 100 sq. in., say 0·08 to 0·25 ampere per 100 sq. cm. We found it was desirable to strike the deposit with a current density of 0·2 ampere per 100 sq. cm., and when the cathode was completely covered to reduce the density to from 0·15 to 0·18 per 100 sq. cm. Although we found it undesirable to exceed these limits, it is possible to considerably reduce the density, and we have used 0·08 ampere per 100 sq. cm. with success.

The current was obtained from a single storage cell, "E.P.S." pattern, having a voltage of 2, in series with a cell of dilute sulphuric acid and lead electrodes. This reduced the voltage to nearly the right value. In some cases we used two depositing cells in parallel without the lead H_2SO_4 cell. A small external resistance then regulated the potential difference between the electrodes to about 0·7 volt.

The Electrodes.

The cathode was a sheet of the thinnest copper procurable, stiffened by mounting on a sheet of glass. In connection with this only two points are of special importance.

Firstly, the well-known necessity of absolute cleanliness. After various trials, the following method was adopted to ensure this. The copper sheet was flushed with nitric acid and water mixed in equal volumes and well rubbed with cotton wool, then thoroughly washed with water and scrubbed with fine sand and excess of a strong potassium cyanide solution. This had the effect of completely removing any copper oxide, and of producing a bright polished surface. Care is necessary

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that excess of potassium cyanide be used, otherwise a film of copper cyanide may be left on the plate. After well washing with water, the plate was quickly placed in the cell.

The second point is the necessity of completely immersing the cathode in the electrolyte, for the ammonium chloride acts on the copper wherever the latter and the electrolyte come in contact with the air. Copper is dissolved and then deposited on the neighbouring freshly-deposited iron.

To avoid this, and also prevent the deposit from forming anywhere but on the front of the plate, the back and all parts of the front except where the deposit was to form were coated with Brunswick black, so that practically the cathode was wholly immersed in the electrolyte. We previously ascertained that the solution had no action on thoroughly dried Brunswick black.

The anode consisted of rolled Swedish iron, containing 0·029 per cent. sulphur and 0·049 per cent. carbon. As our object was to prepare iron free from these two constituents, we enclosed the anode in a porous cell. The carbon collected at the bottom of this in the form of a black mud, whilst the sulphur passed into solution as sulphuric acid, and it was impossible to avoid some of this passing through the porous cell. This, however, was reduced to an extremely small quantity by changing the solution in the anode cell twice daily, it being replaced from the electrolyte, withdrawn as before explained from the cathode cell, and diluted so as to contain 1 per cent. ferrous chloride. This enabled us to obtain the iron quite free from sulphur.

By taking these precautions a firmly coherent deposit of iron was obtained which presented a surface of almost silver whiteness and of a somewhat velvety appearance, but, as Varrentrapp and Lenz point out, it contained numerous small holes of a conical shape. These are doubtless due to the formation at starting of small microscopic bubbles which prevent the iron from being deposited. The bubbles appear to grow with time, so that unless cleared away the area of iron shielded by them increases and a conical pit is produced. As the surface of iron under them is quite dry and they are partially shielded by the hole itself, it is very difficult to clear them away by rubbing. It was attempted to do this by means of an automatic scraper, which passed every 15 minutes over the surface of the plate, but it was not completely successful. It will probably be better to have an automatic arrangement whereby the cathode is raised bodily out of the electrolyte and exposed to the air for a few seconds, when the bubbles will break of themselves.

When the apparatus was in working order the iron was deposited at the rate of about 3 grams per 100 sq. cm. in 24 hours.

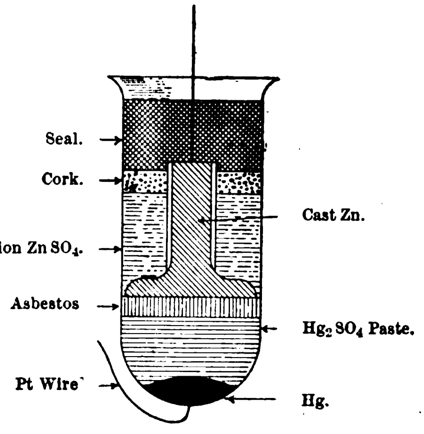
With the above precautions the process worked continuously and without interruption.

A PORTABLE CLARK CELL.*

BY HENRY S. CARHART.

The form of Clark cell adopted as a legal standard by Act of Congress is the modified H form, designed by Dr. Kahle, of Berlin. This form as a primary standard I recommended to the committee of the National Academy of Science as preferable to the one adopted by the English committee, chiefly for the reasons that it contains no foreign material—such as cork—to affect the E.M.F., and a saturated solution of zinc sulphate is always in contact with the zinc amalgam. In the English test-tube cell the zinc rod dips down into the solution, and its upper portion is often in a less dense solution than the other end. That this is so I have demonstrated by letting such cells stand for long periods, and in every case zinc has been removed from the rod near the surface of the solution and transferred to the lower end, where it was deposited as a ring or enlargement.

I have found it possible to so modify the test-tube form as to make the cell portable and still free from the above objection. The materials correspond precisely with the legal requirements. The cell is illustrated in the cut. The zinc is cast with a foot which nearly fits the tube, and this foot holds down the purified asbestos so as to prevent the displacement of the mercury and the mercurous sulphate during transportation. Only a single thin slip of cork is used, and this is specially prepared and finely boiled in paraffin. The zinc stem is turned down so as to leave the foot as a flat plate. The stem is then covered with a glass tube, cemented to it by a non-conducting wax. Fine crystals of zinc sulphate are mixed with the mercury salt, and more are placed on top of the zinc plate. Thus the zinc is in contact with liquid only at the bottom of the solution and in the presence of the crystals.



This cell is rather troublesome to set up, but with proper care and skill a cell can be made which has none of the objections of the English form, except the presence of the cork, and moreover it is portable. One of these cells was compared with one made in accordance with the legal instructions, and the relative E.M.F.'s were represented by the following numbers:—

Legal form..9,808·3
Portable form ....9,808·6

Even this minute difference, which can hardly be measured with accuracy, may have been due to a slight difference of temperature, or to the well-known lag of the E.M.F. behind temperature changes.

AN ELECTRIC JIB CRANE.

The accompanying illustration shows an electric jib crane, made and used by the Sandycroft Foundry and Engine Works Company at its works at Sandycroft, Chester. The illustration shows the crane in the act of lifting from a railway wagon a billet of steel, weighing one ton, to deposit it near one of the furnaces. The billet, it seems, is destined to be heated for forging into the "Sandycroft" shoes and dies. This handy lifting apparatus was made by the Sandycroft Company under patents granted to Dr. N. S. Keith.

A 3 H.P. bi-polar motor is geared to the winding drum through an electromagnetic clutch on the lowest wheel disc, and may run continuously. When lifting, the clutch is brought into engagement by the movement of an electric switch at the operator's left hand. When lowering the load the switch is opened; the clutch then disengages, and the operation is controlled by the brake, the handle of which is shown in the operator's right hand. By another switch on the same switchboard another electromagnetic clutch is thrown into engagement with suitable gearing connected with the motor, for slewing the load to the right or left.

The electro-magnet at the billet on the end of the chain weighs 300lb., and takes $5\frac{1}{2}$ amperes at 110 volts to excite it to its working magnetisation, when it will lift a weight of iron or steel exceeding two tons. This electro-magnet is controlled through a switch on the switchboard, or else through one con-

* From the *Electrical World*. The cut shown by our contemporary did not exactly correspond with the description, as was pointed out by Prof. Carhart. We have therefore taken the liberty of re-drawing the cell to fit the description given.

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indeed reply that since the profits are of electrical origin, preference should rightly be given to electrical methods. But let that pass. We need only point to unimpeachable figures obtained from actual experience to justify our assertion that for the economical, æsthetic and effective lighting of main streets, big squares and open spaces, the arc light has no equal. And even for side streets gas will find itself hard pressed wherever municipalities supply their own current, unless the durability of the incandescent mantle, when exposed to the vicissitudes of an outdoor life, is markedly increased.

The need for more light out of doors which is genuinely felt by the general public does not arise merely from the vast vehicular and pedestrian traffic which takes place nowadays after dark, but is due also, as M. Blondel points out in an article which will be found in another column, to the fact that every advance in private lighting inevitably involves a corresponding improvement in public lighting. The two progress *pari passu*, and as M. Blondel assures us that "our requirements will not be *absolutely* satisfied until artificial lighting becomes equivalent to that of the average daylight," the prospect for ratepayers and for borough surveyors is somewhat alarming. Decidedly better street lighting, however, is undoubtedly the need of the hour; even the St. James's Vestry, which rejoices in the distinction of having within its jurisdiction some of the worst-lit streets in London (and that means much), is bestirring itself, and is—will it be believed?—contemplating the erection of no less than 69 arc lamps. Under these circumstances, it is very desirable that those responsible should not only inform themselves as to what has been done elsewhere, but should master the scientific and theoretical aspect of the question. The essential simplicity of the problem has, indeed, been not a little obscured by a fine display of mathematics, and a handbook on the art of public lighting couched in lucid language and avoiding unnecessary elaboration is much wanted. Pending the advent of some such manual, lighting engineers cannot, perhaps, do better than digest the contents of a Paper on "The Distribution and Measurement of Illumination," read before the Institution of Civil Engineers in May, 1892, by Mr. Trotter, and the contents of his Paper read recently before the British Association at Ipswich are also greatly to the point. Of course, we are all aware that the number of inconstant and incalculable factors in street lighting problems render the predetermination of an illumination "characteristic" anything but a triumph of scientific foresight. Nevertheless, a study of the goal to be aimed at, and an examination of the theoretically best way of attaining it, will not be mere waste of time. Indeed, the pressing question—at any rate for those who are to pay the piper—is whether public arc lighting is to be *improved* or *extended*. Is the money to be spent merely in augmenting the number of lamps in streets already electrically lighted, and in extending the blessings of the arc to streets which have not hitherto experienced them; or is the same sum to be laid out to a better advantage by a more intelligent appreciation of the problem in hand and a bolder use of available optical appliances?

And what is the goal to be aimed at? At one time many were led astray by that Will-o'-the-wisp—uniform illumination. To give a street uniform illumination is not, indeed, beyond the resources of science, but it is decidedly beyond the resources of the ratepayers, unless, of course, the lighting is to be uniformly poor. Then, again, others appear to have contented themselves with merely intensifying the old "pilot-light" system; the boundaries between pavements and carriage ways are defined by lines of lamps, and distribution is neglected altogether. At one end of the scale we have an unattainable ideal—if ideal it be, which is extremely doubtful—at the other end we have a disgraceful ideal. Is there no happy mean, and if there is, is it worth a little trouble and study and experiment to attain? One evening last summer we took an evening stroll and soon found ourselves stepping from the dimly lighted though by no means religiously gas-lighted side streets, into a broad main thoroughfare illuminated by 14 ampere arcs under large ground-glass globes. The contrast between the two methods was most striking. Having nothing more pressing to do, we amused ourselves by trying to analyse our sensations; why was there such a warmth and such an exhilarating effect? The outcome of our cogitations was that our pleasurable feelings were not due to a good dinner, for we had not dined, nor to a fat balance at the bank, but to the beautifully adjusted luminous maxima and minima—the former not too painfully brilliant, the latter not too painfully dark—and to the existence of an appreciable amount of diffused light. It is satisfactory, therefore, to learn on M. Blondel's authority that "The public is indifferent as to the uniformity of illumination. They wish to have a street not only moderately well lighted as a whole, but also to have some places more brilliantly illuminated." Towards the attainment of this end a little scientific consideration of the general problem would be helpful. Alas! the science that exists is somewhat too abstruse for that much over-tasked biped—the borough surveyor.

But what, it may be objected, is the use of making all this pother about such an unremunerative job as public lighting? There is, however, a healthy maxim to the effect that what is worth doing is worth doing well. And, although jobs which have to be done at cost price or less cannot be recommended to dividend-earning concerns, street lighting contracts are occasionally entered into by companies to propitiate the parochial powers that be, or as an outward and visible electric sign of considerable advertising value. In either case the job were preferably done well than ill. And by well, we do not merely mean lavishly, but scientifically, economically, creditably. The greater part of our public arc lighting is, however, destined to be done at its cost price by municipalities. Here considerations of the public purse and the public advantage should be paramount, and surely no municipal engineer worth his salt will rest content to do as others have done before him, and argue that he has done all that is required of him merely because the total candle-power now runs into millions instead of thousands.

REVIEW.

Alternating Electric Currents. By E. J. Houston, Ph.D., and A. E. Kennelly, D.Sc. (New York: The W. J. Johnston Company. 1895.)

This little book is the first of a projected series of small elementary treatises intended to deal in a non-mathematical and plain-spoken manner with various subjects of practical electrical interest. It is refreshing to find that these distinguished authors, Drs. Houston and Kennelly, have written a whole book without feeling it necessary to use a single mathematical formula; and our pleasure at this was enhanced when we found that, even with this limitation, they had succeeded in conveying, in an intelligible and interesting way, the main facts about alternate-current machinery. The book is intended for a certain class of reader—the non-technical man; and the style adopted by the authors is eminently adapted to reach that class. The explanations in the text are assisted by a number of neat illustrations and diagrams. The book is neatly and strongly bound.

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GAS ENGINE ELECTRIC SUPPLY STATIONS.—IV.*

Coatbridge.

The gas engine electric supply station of the Scottish House-to-House Electricity Company, at Coatbridge, near Glasgow, was inaugurated at the end of March, 1894. It was the second station of this type to be put in operation in the United Kingdom; and in many respects its design and construction were a great improvement upon the Morecambe station. On the other hand, owing to the differences between the electrical systems adopted in these two stations, difficulties and troubles arose in the later one which have been absent from the earlier. We have seen that at Morecambe a continuous-current system, with electrical storage, is in use, and it has been shown how the presence of the storage plant has influenced the running of the engines. At Coatbridge, not only could no electrical storage be used, owing to the fact that an alternate-current system had been adopted, but the gas engines were not even permitted to run independently of one another. They were, so to say, tied hand and foot, yoked together by the irksome necessity of running their alternators in parallel. These facts may afford some explanation of the decision of the Scottish House-to-House Electricity Company, in the early part of this year, to abandon gas plant, and to run their station by steam power.

Notwithstanding this important change, which places Coatbridge outside the category of gas engine stations, it will be instructive briefly to study the construction of the station at the time of its inauguration. A view of the interior of the engine room is shown in Fig. 1. This room forms part of a substantial stone structure adjacent to the North British Railway; and is situated in a district which abounds in iron and steel works, noisome odours, and an exemption from the usual laws as to nuisance from smoke and smell. Here carbon monoxide or water gas may hold almost undisputed sway—disputed only, at any rate, by the sulphureous odours from the blast furnace and the slag pit. The scale plan of the buildings, in Fig. 2, shows the general arrangement and size of the several rooms, &c.; but it should be remarked that the offices, store and testing rooms, &c., which lie to the left of the engine room, have been omitted. Adjoining the engine room is an almost detached building, which contains the gas generating plant; and beyond this are the gas coolers, scrubbers and holder.

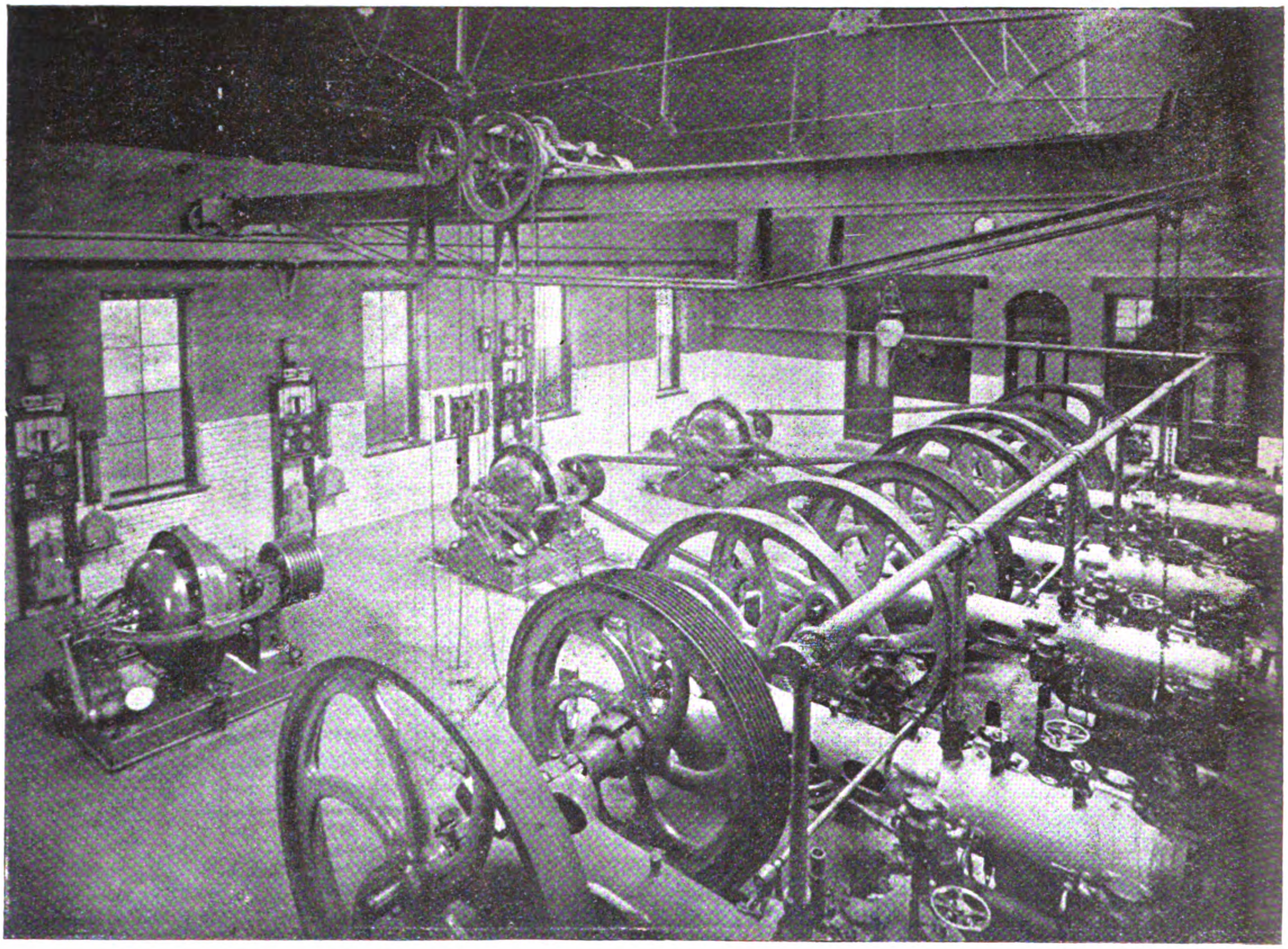

Fig. 1.—Coatbridge Gas Engine Electric Supply Station. Interior of Engine Room.

There are two gas producers, each capable of generating gas for about 120 B.H.P. These are a modification of the Dowson gas producer, and are fitted with an apparatus for conveniently removing clinkers, invented by Mr. J. W. Hartley. A transverse section of the plant is shown in Fig. 3. Anthracite is used in the producer furnace and is subjected at white heat to a blast of air and superheated steam. The gas produced is of the same composition as Dowson gas. After passing through the cast-iron cooling stack and the hydraulic dust-box, the gas is scrubbed in the coke scrubber and filtered through sawdust. It then passes into the gas holder. Steam is generated in two small vertical boilers, which are fired with coke. The steam is used both for the generator blasts and

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occasionally for starting the gas engines. The gas plant is so arranged as to minimise the cost of conveying the fuel from the railway to the furnaces. The fuel may be loaded direct from the truck on to the charging platform, and the level of the gas producers is lowered into a pit, so that the bell-mouths are at a convenient elevation for receiving the charges of anthracite. The gas holder is 15ft. in diameter and is 10ft. deep.

In the engine room there are three sets of gas engines, driving alternators by means of cotton ropes. The gas engines are of the double-acting, two-cylinder, side-by-side "Kilmarnock" type, and were built by Messrs. Dick, Kerr and Co., by whom the whole of the gas plant was supplied. The engines work on the "Otto" cycle, and run at a speed of 180 revolutions per minute, each complete engine developing 120 I.H.P. The engines are controlled by high-speed "Buss" governors, which reduce the quantity of the explosive charge down to one-third of full power, and at lower powers cause some of the explosions to be missed. At full power there are two explosions during every revolution of the engine. In order to minimise the fluctuation of speed, each engine was provided with three heavy flywheels; the middle wheel being grooved for a rope drive of eight 1in. ropes. Mordey alternators, constructed by the Brush Electrical Engineering Company, are driven at 600 revolutions per minute, developing a normal output of 50 kilowatts each. In order to start the gas engines a steam starter is used, the construction of which is shown in Fig. 4. A steam pipe runs along the side of the engine room, behind the engines, and a branch pipe communicates with the steam starter on each engine. The starter comprises a steam chamber, communicating with the compression chamber of the engine cylinder, the connecting passage being opened or closed by a valve actuated by a hand lever. The engine is first brought on to an early part of the forward stroke, with the starting valve closed. Opening now this valve will give a forward stroke of sufficient energy to bring the crank once round, the starting valve being promptly closed at the end of the forward stroke. A succession of well-timed impulses produced in this way will soon get the engine up to speed, when the gas and air and ignition valves may be put into action; and no doubt the condensed steam soon disappears from inside the cylinder.

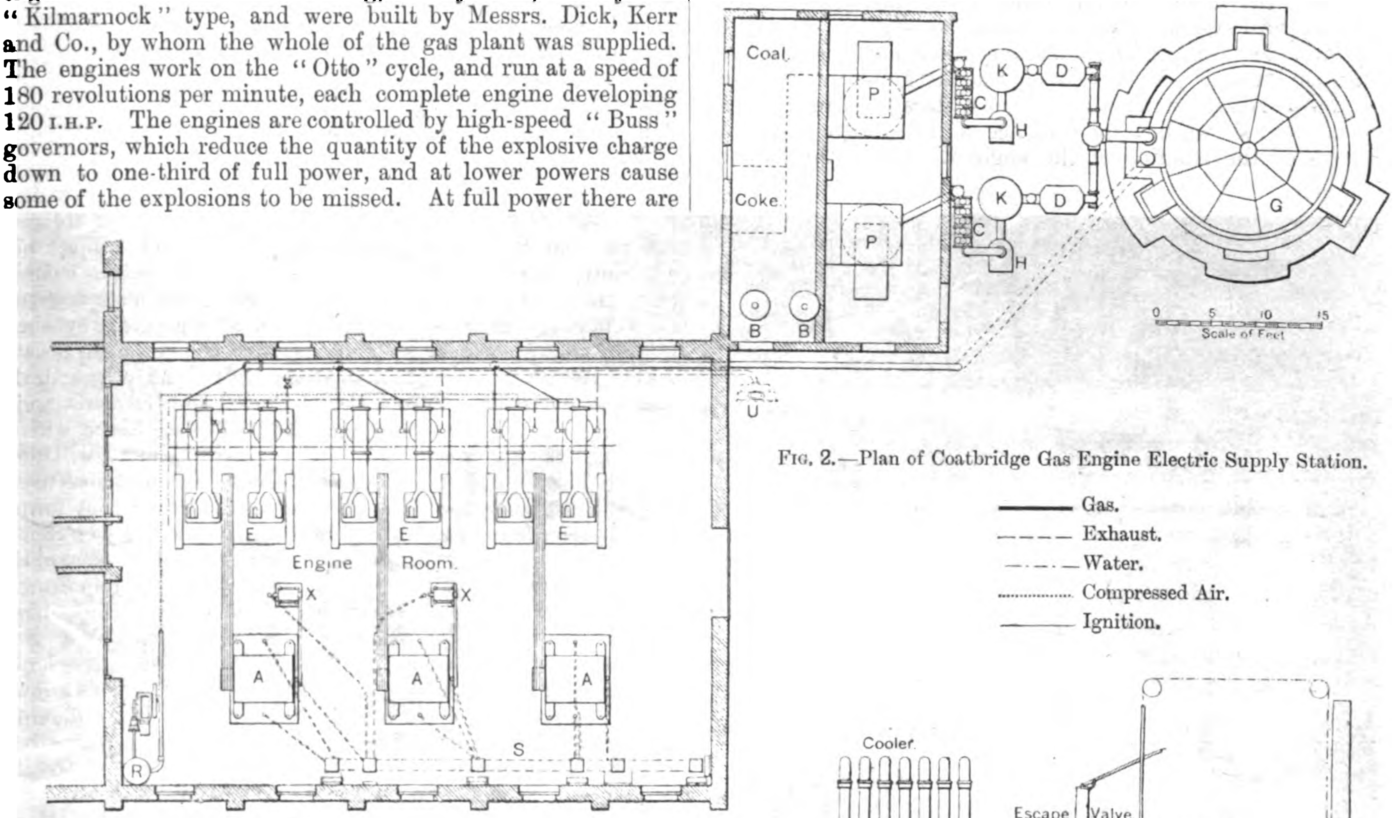

FIG. 2.—Plan of Coatbridge Gas Engine Electric Supply Station.

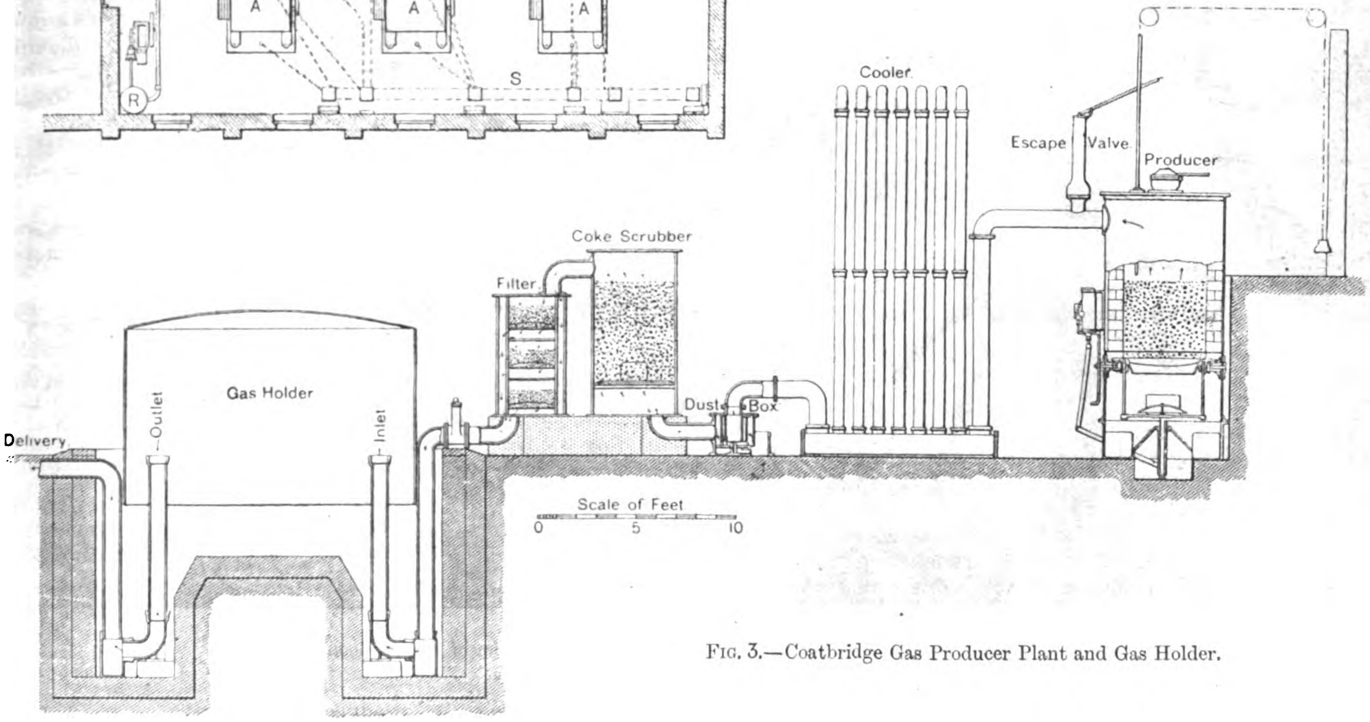

FIG. 3.—Coatbridge Gas Producer Plant and Gas Holder.

In conclusion, we may note one or two details as to the cost of running the Coatbridge gas engine station. The first item of expense, the anthracite, costs 12s. 6d. per ton; and at this price the average cost of fuel per unit sold is from 0·6 to 0·7 penny. Sawdust for renewal of the scrubbers costs 2s. 6d. per week. Ignition tubes have been a serious item; each tube lasting only one day, four tubes being required on each engine at the same time, and each tube—of wrought iron—costing 3d. Thus the item of ignition tubes has

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amounted to 1s. per diem per engine, or £1. 1s. per week for the entire station. Ignition tubes, however, can do better than this! Oil, too, has been an item the cost of which cannot be ignored. About ¾ gallon per engine per diem is consumed and, not being filtered, is not re-used. The cost of this item is therefore about £1. 12s. per week for the entire station. For steam raising, about 2½ tons of coke are consumed per week. The quarterly output of the station, at the time about which we are writing, may be taken at about 12,000 Board of Trade units. The price charged for the supply of energy to customers is 5d. per unit.

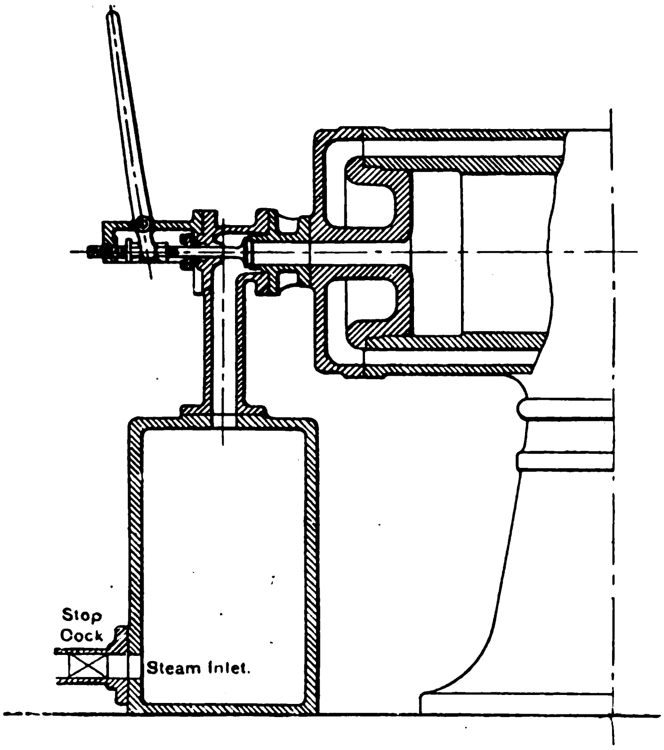

Fig. 4.—Steam Starter for Gas Engines at Coatbridge.

We are indebted to Mr. Francis Teague, the resident engineer at Coatbridge, for much of the information published in this article; and to the Scottish House-to-House Electricity Company and Messrs. Dick, Kerr and Co., for permission to publish the illustrations which accompany it.

MAGNETIC UNITS.*

The question of magnetic units may be said to present three issues—one relating to the need of specific names, another to the magnitude of practical units, and a third to the selection of names. In regard to the first, our English contemporary, *The Electrician*, which had always expressed itself in opposition to specific names for magnetic units, in summing up a recent and extensive correspondence on the subject in its columns, frankly admitted a strong drift of opinion favouring such names. It is gratifying that the soundness of the American view has thus been confirmed, and still more so that the British Association has added its formal approval. As to the action of the British body on the second issue, we believe a grave mistake has been made in creating a new unit. In their reports on the International Congress proposals of the American Institute of Electrical Engineers, the national electrical associations of both France and Germany officially arrayed themselves strongly against the making of new magnetic units and in favour of the C.G.S. system for practical use, and the national American body has definitely committed itself to the same position. The British Association, therefore, can scarcely hope in view of this to ever see its unit of magnetic flux enter into international use, and consequently its creation is little less than a misfortune to the British electrical profession, and a menace to international scientific unity. As to the names adopted, did we not have the highest respect for the British Association we might have difficulty in escaping from the thought that its action lacked international courtesy. The American system of units was thoroughly discussed before its committee, and it must have been known that it had already entered extensively in use in this country; in the light of this it was certainly inconsiderate to appropriate the names here adopted and apply them in an entirely different manner in another system. In one case the name of the C.G.S. unit of magnetic flux is applied to a new unit of the same quantity, and in another the name of the C.G.S. unit of magnetic intensity to the C.G.S. unit of M.M.F. As the B.A. system, like the American system, is merely proposed as a provisional one subject to international approval, it would have been infinitely better to have either adopted the gilbert in one case, or, as should have been done in the case of the unit of flux, used another name. To sum up, as the matter now stands, there are two sets of practical magnetic units before the world on trial previous to final international action on the subject of such units, which action will probably not be taken before 1900. Of the two sets, the American forms a complete system and is already in extensive use; it was originated by the British Association itself 20 years ago, and therefore can boast in this respect the sanction of that body. As a practical system it meets the approval of the French and Germans, and there is every reason to believe that they, five years hence, when the names shall have become firmly fixed in this country, will not seriously object to their definite adoption for international use. On the other hand, the B.A. units are inconsistent; they form an incomplete system and one which cannot practically be completed; by including a new unit, determined continental opposition is actually invited; and, perhaps most important of all, the student, whose needs are most concerned, has another burden added instead of being relieved. We are inclined to believe that if the British Association, instead of attempting to settle a question of extreme importance in a few hours, had put it over to another meeting, quite a different result would have been attained. As it is, there seems to be no hope of its proposals finding acceptance outside of Great Britain, and it remains to be seen if they even secure support there. Should they, however, finally secure favourable action from an international electrical congress, Americans can only say, "Very well, gentlemen, if you all decide to adopt new 'practical' units which we don't think we want, as we work very comfortably without them, we will, nevertheless, adopt them in the interest of international unity; we only filled in the dreary waste that existed by giving temporary names to C.G.S. units."

It is to be sincerely regretted that the British Association, which in the past has done such excellent work for the advancement of electrical engineering, has just promulgated two proposals for practical magnetic units which are inconsistent, burdensome and equivocal. It is a matter for congratulation that the British Association has recognised the existing necessity among electrical engineers of adopting specific names for magnetic units. It is to be regretted that they cannot be congratulated upon their selection of such names. It is very doubtful if these practical units and names will meet with general adoption, on account of the grave objections which may be urged against them.

The most important objections are perhaps the following:—

1. The units are inconsistent. The suggested unit of flux belongs to the practical system of the ohm, volt, ampere, coulomb, joule and watt, while the suggested unit of M.M.F. belongs to the C.G.S. system. The practical system is virtually based on the earth-quadrant, the 10^{-11} gramme, and the second, while the C.G.S. system is based on the centimetre, gramme and second. Consequently, none of the equations relating to the magnetic circuit, such as $\Phi = \frac{F}{R}$, can be carried out with these two units, unless factors are introduced which are difficult to remember.

2. The units are incomplete. If units for the four quantities—flux, M.M.F., intensity and reluctance—had all received either "practical" or C.G.S. values, and had been so christened by the British Association, at least a complete and comprehensive system would have been created. As it is, with the two hybrid units offered, it is necessary for the student to first make himself acquainted with the C.G.S. system in learning the fundamental relations of the magnetic circuit, and then to learn the new "practical" unit value of magnetic flux. The labours of the student, instead of being lightened, are thus needlessly increased by the proposed change. Again, if in the future it should be desired to complete the magnetic system by the addition of a practical unit of reluctance, this

* From the *Electrical World*, October 5, 1895.

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unit will have a value of one hundred millionth of the C.G.S. unit, and the reluctances of usual dynamo circuits will be of the order of hundred of billionths (10^{-11}).

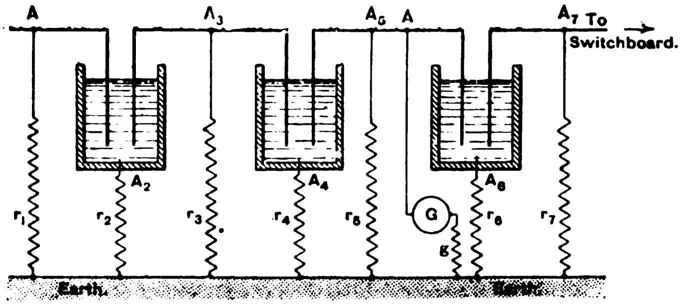
3. The names proposed for the units are equivocal. If the Committee of the British Association could not see fit to accept the units provisionally adopted by the American Institute of Electrical Engineers, it would at least have been conducive to the interest of electrical engineering to suggest names that were not already extensively used with entirely different meanings. The serious objection is that they have selected the name weber for a unit of magnetic flux one hundred million times greater than the American unit of the same name. They have also selected the American unit of M.M.F., here called the gilbert, and have proposed to name it the gauss, which is the name for the American Institute unit of flux density. Assuming that the British Association will use these new names, the perplexity of a student in finding two webers of different values and two gausses with entirely different meanings can best be imagined.

If the new British Association system of magnetic units possessed even the merit of consistency and completeness, there might be some hope of its adoption in America, if only for the true interests of engineering progress, but the American Institute system, being a consistent and complete system—namely, the C.G.S. system, which has been in international use for the last 20 years, and originally created by the British Association, it cannot be expected that it should be replaced by the incomplete hybrid system proposed.

A SIMPLE METHOD OF MEASURING THE INSULATION RESISTANCE OF STORAGE BATTERIES.

BY E. S. JACOB.

The insulation resistance of dynamos, leads, &c., is easily measured when no current is flowing; it is ordinarily obtained with the Wheatstone's bridge, the ohmmeter, or, more roughly, with a high-resistance galvanometer, calibrated with a given number of cells in circuit. In the case of a storage battery, however, owing to the different E.M.F. existing in the circuit, as soon as the cells are filled with acid, none of these methods can be used; on the other hand, the resistance measured before filling has absolutely no value for practical purposes. If the earths were equally distributed over the battery, it would be possible to get some result by means of a high-resistance galvanometer alone; but this is rarely the case, and apart from the fact that the earths are of unequal resistance, they are sometimes due to the containing vessels, of which the potential is rather uncertain, and sometimes to the leads which connect the battery to the switchboard. The following simple method obviates these difficulties, and gives immediately the joint resistance of all the earths at whatever points of the battery they may be situated.



Connect any point of the battery through a sensitive high-resistance galvanometer to earth; the deflection will be a minimum at a certain point of the battery, and will gradually increase on receding from it in either direction; the point chosen should give a large deflection on the galvanometer scale. Now, keeping the connections as before, insert in the galvanometer circuit a resistance such that its deflection may be reduced to, say, about one-half of its former value. Then, if

c be the current through the galvanometer in the first case;
c^1 be the current through the galvanometer in the second case;
g be the resistance of the galvanometer circuit in the first case;
g^1 be the resistance of the galvanometer circuit in the second case; and
R be the insulation resistance of the battery,

$$R = \frac{c^1 g^1 - c g}{c - c^1}.$$

Let $A_1\,A_2\,A_3 \ldots$ &c., be points of the battery (containing vessels, or leads) connected to the earth;
$r_1\,r_2\,r_3 \ldots$ &c., be the resistances between the points $A_1\,A_2\,A_3 \ldots$ and the earth;
$c_1\,c_2\,c_3 \ldots$ &c., be the currents flowing from $A_1\,A_2\,A_3 \ldots$ to the earth, when the galvanometer is connected;
$E_1\,E_2\,E_3 \ldots$ &c., be the E.M.F. between the point A (where the galvanometer is connected to the battery) and the points $A_1\,A_2\,A_3 \ldots$

Let all the currents be supposed to flow from the battery to earth; then

$$c_1 r_1 - c g = E_1,$$
$$c_2 r_2 - c g = E_2, \text{ \&c.}$$
$$c g - c_6 r_6 = E_6,$$
$$c g - c_7 r_7 = E_7, \text{ \&c.,}$$

and $$c_1 + c_2 + c_3 + \ldots + c = 0.$$

Hence $$\frac{E_1 + cg}{r_1} + \frac{E_2 + cg}{r_2} + \ldots + \frac{cg - E_6}{r_6} + \frac{cg - E_7}{r_7} + \ldots + c = 0$$

When the resistance of the galvanometer circuit becomes g^1, c become c^1.

Then, in the same way as above, we have

$$\frac{E_1 + c^1 g^1}{r_1} + \frac{E_2 + c^1 g^1}{r_2} + \ldots + \frac{c^1 g^1 - E_6}{r_6} + \frac{c^1 g^1 - E_7}{r_7} + c^1 = 0.$$

Subtracting the second equation from the first,

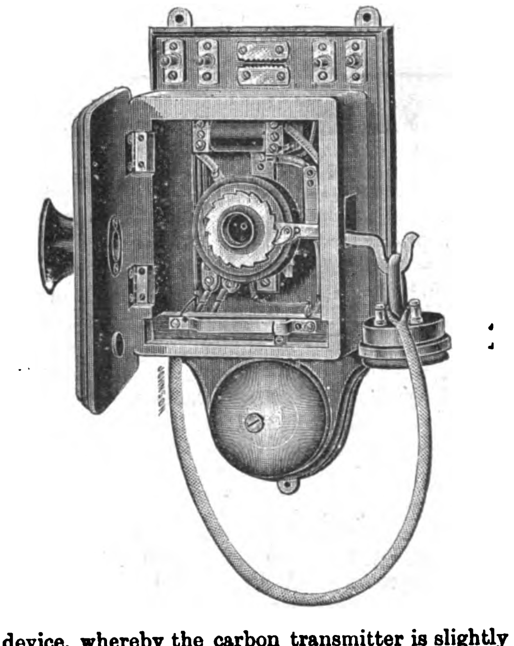
$$(cg - c^1 g^1)\left(\frac{1}{r_1} + \frac{1}{r_2} + \ldots\right) + c - c^1 = 0,$$

or $$R = \frac{cg - c^1 g^1}{c^1 - c}.$$

All the apparatus used in this method is such as forms part of a set of ordinary testing instruments, and the results are true under every condition; the same method might be used for measuring the insulation of a complicated network, *e.g.*, a five-wire distribution, while current is passing.

AUTOMATIC REVOLVING TELEPHONE TRANSMITTER.

Owing to the liability of some types of carbon-granule telephone transmitters to occasionally get out of order, through the settling of the carbon into a compact mass, Messrs. Gent and Co. have intro-



duced a device, whereby the carbon transmitter is slightly rotated on its axis each time it is used. The accompanying illustration shows one of their automatic revolving transmitters, so arranged that the rotation shall be effected by the switch hook. The lever of the hook actuates a pawl and ratchet motion on the transmitter. In a later form of the apparatus the rotation is effected by the ringing key.

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ELECTROLYTIC COPPER-REFINING IN NORTH AMERICA.*

BY E. SEDERHOLM.

In America they do not electrolyse ores and matters direct, only converter copper with 98 to 99·3 per cent. and blister copper with 99·5 per cent. of Cu being thus treated. Pitched wood is employed in the construction of the vats, and they are lined with lead, which is in the end more satisfactory, as is done in the new works in Salt Lake City, or they are used without such lining, as at Great Falls, in the works of the Boston and Montana Copper and Silver Mining Company. There is a space of from 30cm. to 60cm. between the lowest portions of the electrodes and the bottom of the vat, to allow for the accumulation of slime and solid matter ; and a cock is provided for the withdrawal of the slime into a channel, communicating with all the vats, and leading to a single reservoir. Along each side of the vat runs a square copper rod, one rod forming the positive, the other the negative lead, the anodes being so suspended that the supports rest on one of these rods at one end, but are insulated from the other rod by means of a strip of wood. The cathodes are similarly but conversely connected and insulated. A pipe placed above the vats admits the fresh solution, and each vat has an overflow pipe connected with a common reservoir. The solution is here brought up to the right acid strength ; or if very impure the copper is extracted electrolytically or by means of iron, refined, and cast into anode plates again. The Chicago Copper Refining Company crystallise out the copper sulphate, and separate the arsenious oxide by re-crystallisation. There is a good market for both products.

The dynamos are of all possible types, the voltage depending upon the number of baths in series. In the larger works the machines are generally separately excited. The voltage of the older machines was from 6 to 30 volts, but now the terminal voltage ranges from 100 to 200. At the Great Falls installation four Thomson-Houston four-poled dynamos, excited by two smaller machines, are used, and each generator gives a current of 1,000 amperes and 200 volts, the number of baths in operation being 288. As it is important that the voltage should not be too high when the solutions are impure, the difference of potential in the baths is controlled by altering the space between the electrodes. The current varies from 70 to 150 amperes, which is much higher than that recommended in Europe.

In America the systems of Smith, Stalman and Hayden are used; the first (English patent 17,340, 1888) in one works only and the latter (English patent 2,071, 1888) in many. In all of them the electrodes are placed in series, and (with some modifications) each plate serves both as cathode to the preceding plate and as anode to that which follows until the original plate has been completely replaced. In Smith's process they are arranged horizontally, cotton cloth stretched between each layer separating the plates, the top plate forming the anode. In the older multiple system the anodes are cast direct from the reverberatory furnace or converter into plates 2·5mm. to 3mm. thick. By running from the converter, as proposed by Thofern, labour is saved, but the metal is less homogeneous ; and being unequally attacked in the vats it tends to break up, so that large fragments of copper may fall with the slime to the bottom of the bath, which seriously interferes with the economical working of the process. The cathodes are usually thin sheets of electro-deposited (not rolled) copper, and the process is ultimately allowed to proceed until they are 8mm. to 12mm. thick. The solution generally contains initially 150 to 200 grammes of crystallised copper sulphate and 50 grammes of sulphuric acid per litre, and must be kept up to this strength throughout. For very large currents a stronger solution is employed. In practice the electrodes are removed every second day, the anodes being cleansed from slime and the cathodes being freed from projections. Both are then returned, unless the former are dangerously thin, when they are re-cast.

Many different methods have been proposed of treating the anode slime. Hot, strong sulphuric acid has been employed, and this dissolves most of the silver, which is then precipitated by granulated copper ; but the acid is wasted by this process. The silver obtained is fairly pure (99·5). The undissolved silver is in combination with selenic and antimonic acids, and is accompanied with some gold. Ulke dissolves out the whole of the copper by means of warm dilute sulphuric acid, through which air is blown, leaving a residue which may contain 90 per cent. of silver. The process generally employed is to smelt the slime so that the copper passes into the slag, which is then treated in the blast furnace, and a metal carrying 60 to 90 per cent. of silver results ; this is cast into ingots, which are passed on to the silver refinery.

The St. Louis Smelting and Refining Company and another large works in Pittsburg are using the Moebius process (English patent 16,554, 1884), in which silver is separated electrolytically from gold and other metals. The principle on which this process depends is, that when silver to be refined is made the anode in a weak nitric acid bath, the silver passes into solution as nitrate through the action of the electric current, and is redeposited in the metallic state upon a silver plate, which constitutes the cathode. The anodes are suspended from aluminium wire, which it is stated is not attacked by the nitric acid. With 70 vats in series, and a current of 180 amperes and 100 volts, 14 kilos of silver are obtained from each vat in 24 hours, giving a total of 980 kilos. The current density employed is 300 amperes per square metre.

* From *Dingler's Polytechnic Journal*, 1895, No. 296, pp. 284—288.

CORRESPONDENCE.

MAGNETIC UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : Prof. Perry has written to me objecting to Mr. Baily's rule about mean volts, as given in his letter on p. 762.

Of course it is very plain what kind of average was intended, as also it is very obvious that the mean voltage of an alternator is zero if alternate pulses are not rectified in sign ; but Prof. Perry considers that the more useful and appropriate sort of average for which to give a rule, would be the square root of mean square, being the quantity indicated by a voltmeter, and conveniently to be called *effective* volts ; and with this contention I am disposed to agree. In that case, as Prof. Perry says, the numerical factor needed to multiply the weber-amplitude and the frequency, to give the volts, would not be 4, but would depend on the form of the oscillation curve, and, for the case of a sine curve, would be $\pi\sqrt{2}$, which is about 4·44.

In stating the rule, such as it is (and no particular importance attaches to it—it was merely given casually as an illustration of the use of the term "weber-turns"), it would have been well to state that it was the *maximum* magnetic induction or the weber *amplitude* that was intended to be used in the technical phrase "weber-turns," and not the *mean* webers, about which there would be the same kind of ambiguity as there is about mean volts and averages in general.

I had hoped Prof. Perry would have written these simple remarks himself, but as he has not, I have endeavoured to give the gist of his criticisms, though he would doubtless have expressed them with more unction.

While on the subject, perhaps the following additional note to the Paper published in your issue for August 2nd, p. 450, may interest some of your readers :—"(23*a*) The expression weber-turns, to signify the product of the total field into the number of spires surrounding it, though at first sight not in precise correspondence with the phrase ampere-turns where the current circulates in the spiral instead of forming its core, is really accordant with it, because a spiral and its core are geometrically interchangeable."—Yours, &c.,

OLIVER J. LODGE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : Having seen Dr. Lodge's letter, I have to add that Mr. Baily's rule is not universally true for all kinds of periodic currents. If the periodic law of W (the weber-turns), however complicated it may be, is such that the time from maximum W to minimum W is half a period, and if it also happens that the maximum positive W is equal to the maximum negative W, then the mean voltage during this particular half period is equal to the maximum W multiplied by four times the frequency.—Yours, &c.,

JOHN PERRY.

October 23, 1895.

THE MAGNETIC FORCE INSIDE ANY CLOSED CIRCUIT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : The slip made by Mr. Colard in the second formula he sent you is a very obvious one, and is due, I cannot help thinking, to the adoption of Prof. Minchin's notation. His first formula,

$$F = \Sigma \frac{\sin a}{p}, \quad . \; . \; . \; . \; . \; . \; . \quad \text{(i.)}$$

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gives a simple expression for the magnetic force on a unit magnetic pole at a point in the plane of a closed polygon of wire carrying unit current. In this formula, a represents an angle of the polygon, and p the perpendicular from the point on the line joining the feet of the perpendiculars on the two sides containing the angle. From this theorem we have to pass on to the case of a plane closed curve. In this case sin a is ultimately equal to the circular measure of the angle between two consecutive tangents, and p is the perpendicular on the tangent to the *pedal curve*. If we took p to have its usual meaning—namely, the perpendicular from the point on the tangent to the curve—we should get the second formula given by Mr. Colard. His second theorem is therefore

$$F=\int\frac{d\theta'}{p'}, \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(ii.)}$$

where θ' is the angle the radius vector of the pedal curve makes with a fixed line, and p' is the perpendicular on the tangent to the pedal curve, the integral being taken round the curve. Hence we can calculate the magnetic force inside a closed plane curve merely by considering the pedal curve.

For example, the pedal curve of a parabola with respect to its focus is the tangent at its vertex. In this case, $p'=$ constant $=a$; the magnetic force at the focus due to unit current in the parabolic wire

$$=\int_{-\frac{\pi}{2}}^{+\frac{\pi}{2}}\frac{d\theta'}{a}=\frac{\pi}{a}.$$

The formula (ii.) easily leads to many other theorems. For example, we can prove that in any closed curve

$$F=\int\frac{r\,d\omega}{p^2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(iii.)}$$

where r is the radius vector, p the perpendicular on the tangent and ω the angle which p makes with a fixed line.

The formula (ii.) seems worth trying in a good many cases, and our thanks are due to Mr. Colard for suggesting this method.—Yours, &c., A. RUSSELL.

Faraday House, Charing Cross-road.

ALTERNATE-CURRENT WAVE FORM DELINEATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It would be a pity if M. Blondel's claim to priority over Messrs. Barr, Burnie and Rodgers' alternating wave tracer, and their half acknowledgment of the claim, were to draw attention from the essential novelty of their contrivance, which confers on it its chief value. The "new element" is not only the "mirror actuated by a cam," but the automatic movement of the contact brush so as to practically produce a wave of shorter period. M. Blondel moves a drum by clock-work. The other instrument shows the wave form on a screen at once.—Yours, &c., W. M. HICKS.

Dunheved, Endcliffe-crescent, Sheffield,
October 20, 1895.

SHAPE OF E.M.F. CURVE AND IRON LOSSES OF TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you allow me to offer a few criticisms on Mr. C. P. Feldmann's article on the above subject appearing in your last week's issue?

Reference is made to the method of tracing the idle current of a transformer, and the method is ascribed to a Mr. A. Hill. On looking up the Index to Vol. XXXIV. of *The Electrician*, I failed to discover any contribution by a gentleman of that name, but found a series of articles on "Principles of Transformer Design," by Mr. A. Still. May I recommend Mr. Feldmann to consult Vol. XXVI. of *The Electrician*, where he will find, in a series of articles by Mr. S. Evershed ("The Magnetic Circuit of Transformers: Closed *versus* Open"), a very complete account of how to draw the idle current curve of a transformer, including the component required to balance eddy currents in the core.

The whole of Mr. Feldmann's article is marred by a blunder which is hardly credible in a writer of his reputation. An examination of the curves, along with the explanation given in the text, reveals the astounding fact that he proceeds to derive the curves of magnetic induction (*see* Figs. 5 and 6) from those of the primary E.M.F. (Figs. 1 and 2) by *differentiating* (instead of integrating) the latter! He then (correctly enough) differentiates the magnetic induction curves and obtains the curves of secondary E.M.F. Hence comes about the wonderful result that a transformer, whose primary E.M.F. is represented by the curve in Fig. 1, yields a secondary E.M.F. curve of the shape shown in Fig. 7!

It is obvious, from the above remarks, that Mr. Feldmann's article would have to be entirely re-written to be of any value.
—Yours, &c., ALFRED HAY.

University College, Nottingham,
October 21, 1895.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

SPECIAL NOTICE—The 1895 (thirteenth) edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is READY. In addition to the old well-known features of the book, which are brought up to date, a quantity of new and useful matter has been added, rendering the book more than ever indispensable to the Electrical, Engineering, and Allied Trades. Price, 7s. 6d., post free 8s. 3d., abroad 9s. The Edition for 1896 is in active preparation, and orders for Advertisements and Subscriptions can now be sent in.

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The following New Books and Editions of "THE ELECTRICIAN" SERIES *can be obtained of the Booksellers or direct from the Publishing Offices:—*

LABORATORY NOTES AND FORMS.—With the above title, we have ready a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of this series is the saving of the time of the teacher and his assistants, and to serve as a record of the work done by the student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen nett; in sets of any three 1s. nett; or the set of Twenty Elementary (or Advanced) Exercises can be obtained price 5s. 6d. nett. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. nett, or in handy portfolio, price 12s. nett, or bound in strong cloth case price 12s. 6d. nett (*now ready*). Strong portfolios can be had, price 1s. each. A full prospectus sent post free.

"THE WORK OF HERTZ."—By Dr. O. J. Lodge, with man original illustrations, price 2s. 6d. nett, is now ready.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is now ready. The book is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free. Prospectus post free.

A LARGE-SHEET TABLE, giving full particulars of the Electricity Supply Stations throughout the Kingdom, can now be supplied mounted on stout board, with cord for hanging. Price: Varnished, 3s. 6d.; Unvarnished, 3s. —each post free. A Map showing positions of Supply Stations throughout the country is mounted on the back of the Table, and a Coloured Map of Metropolitan Electric Lighting Areas and a large sheet of Electricity Supply Statistics are also mounted on some copies, the price of which complete, post free, is 5s.

A SHEET TABLE showing Total Capital Outlay and Receipts and Expenditure for the year 1894 of the Statutory Electric Supply Undertakings of the Metropolis is now ready, printed on thick paper. price 6d.

A SHEET TABLE giving similar particulars in relation to Provincial Statutory Electric Supply Undertakings is now ready, printed on thick aper, price 6d.

"ELECTRIC MOTIVE POWER."—A new work, by Mr. Albion T. Snell with this title, is now ready, containing the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d. post free (abroad 11s.).

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by Messrs. W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—By Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

'THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E Kennelly and H. D. Wilkinson, price 6s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d. post free.

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Tenders Invited.—*Extension of Time.*—The Municipal Authorities of Tongres have extended the time for sending in tenders for the electric lighting of the town until November 8th. Tenders to the Conseil Municipale, Hotel de Ville, Tongres, Belgium.

——— The Electric Lighting Committee of the Bedford Urban Sanitary Authority require tenders for the supply and delivery of a surface condenser and air pump and of a centrifugal pump with engine. Tenders by November 1st to the Clerk (Mr. T. S. Porter), Town Hall, Bedford.

——— The Markets Committee of the Manchester Corporation invite tenders for the supply of two duplicate sets of vertical compound-condensing engines at the Foreign Animals Wharf, Mode Wheel. Tenders to the town clerk (Mr. W. H. Talbot) by November 5th.

Electric Lighting Schemes Invited.—The Battersea Vestry offer premiums of £50, £30 and £15 for the best three schemes, reports, designs and estimates for a system of electric lighting for the parish of Battersea. Schemes must be delivered to Mr. W. Marcus Wilkins, the Vestry Clerk, before 12 o'clock (noon) on Thursday, December 12th next.

Tenders Accepted.—The Manchester Corporation have accepted the tender of Messrs. Bolton and Sons for the supply of 15 tons of copper strip for their electricity works.

——— The Metropolitan Asylums Board have accepted the tender of Messrs. Muirhead and Co. for fitting up additional telephones at the new blocks of the Gore Farm Hospital at £72, and, subject to the sanction of the Local Government Board, the tender of the Callender Company for supplying and laying two new electric light cables at the hospital ships, at a sum of £125, has been accepted.

——— The Richmond (Surrey) Town Council have received the following tenders for an extension of the fire alarm service to Kew and Petersham :—

	£	s.	d.
Callender Company (for cables only) (*accepted*)	£165	6	0
Newland and Co.	371	0	0
Harrison, Coles and Co.	317	5	0
Consolidated Telephone Company	299	10	0
Julius Sax and Co.	250	0	0
F. E. Stuart (for instruments only)	46	7	6

(All of London.)

——— The Madras Railway Company have accepted the tender of the Brush Company for the supply of the necessary plant and apparatus for lighting the Arkonam Railway Station by electricity.

——— The tender of Messrs. F. A. Glover and Co., of Queen Victoria-street, E.C., has been accepted for wiring and fitting up the Cripplegate Institute for the electric light. The tender does not include electroliers, fancy fittings, or portable lights. The total number of lights will be 311, and the amount of the tender is £369. 11s.

Tenders Received.—The Newport Corporation have received 11 tenders for wiring the Provision Market and Public Baths for the electric light. The borough engineer's estimate for the work was £800. The following is the list of tenders sent in :—

	£	s.	d.
Sax (J.) and Co. (London)	£1,211	15	0
Binko (H.) and Co. (London)	1,200	0	0
Walker (S. F.) and Co. (Cardiff)	1,137	0	0
Fowler, Lancaster and Co. (Birmingham)	1,024	1	7
Maddren (T.) and Co. (Cardiff)	940	0	0
Bennett and Druce (Preston)	844	0	0
Baker and Co. (Newport)	829	0	0
Pettit and Hards (London)	719	0	0
Electrical Installation Company (London)	699	12	0
Arnold and Co. (Newport)	665	7	6
Alger and Sons (Newport)	630	10	0

Sales by Auction.—In reference to the announcement in our last issue of the sale by public auction of the works and plant of Poole and White, Limited (in liquidation), the auctioneers, Messrs. Wheatley Kirk, Price and Goulty, 49, Queen Victoria-street, E.C., and Albert-chambers, Albert-square, Manchester, notify us that the sale has been postponed *pro tem.*

Sale by Auction.—Messrs. Percy Huddleston and Co. will sell by public auction on Tuesday next, the 29th inst., at the Newton Heath Cable Works, Newton Heath, Manchester, some important plant and machinery, loose tools and utensils of an electric cable and wire works. The sale is announced to commence at 11 for 12 o'clock prompt, and catalogues may be had on application to the auctioneers, 72, Finsbury-pavement, London, E.C., or 20, Chapel-walks, Liverpool. Further particulars appear in our advertisement columns.

Dissolutions of Partnership.—The partnership business of electric wire manufacturers hitherto carried on by Messrs. John, Frank and Riley Patchett, under the styles of Patchett Brothers and the Northern Electric Wire Company, has been dissolved. Debts by Messrs. F. and R. Patchett, who continue the business.

——— Messrs. T. M. Heywood and P. R. Fergus, who have hitherto carried on business as electricians at Mount Stuart-square, Cardiff, under the style of Fergus and Co., have dissolved partnership. Debts by Mr. T. M. Heywood, who continues.

Appointment.—Mr. J. T. Dunn, D.Sc., has been appointed principal of the Northern Polytechnic Institute, Holloway, N. Dr. Dunn was until recently principal of the Plymouth Municipal Technical School.

Liquidations.—It was resolved on September 21st that the St. Martin's Electrical and Manufacturing Company (Limited) be wound up voluntarily. This resolution was confirmed on Oct. 10th, when Messrs. T. D. Dundas and C. Hancock were appointed liquidators.

——— Notice is given that creditors of Baird, Thompson and Co., Limited (in liquidation), must send in particulars of their claims to the liquidator, Mr. Isaac Coop (Davies, Tait and Co.), 46, Queen Victoria-street, London, E.C., on or before December 3rd next.

——— Creditors of the Hope Jones Electric Organ Company must send in particulars of their claims to the liquidator (Mr. R. S. Blease, C.A.), Fenwick-street, Liverpool, on or before December 14th next.

——— A meeting will be held at 26, Waterloo-street, Birmingham, on November 24th next, for the purpose of receiving an account of the winding-up of Armstrong's Glass Company (Limited).

Removals.—Mr. T. Harding Churton has removed his works and stores from Park Cross-street to larger and more convenient premises at 36, Great Wilson street; but all communications should be addressed to the offices, 5, South-parade, Leeds.

Russell and Co.—We are requested by Earl Russell to announce that, in consequence of the pressure on his time entailed by being a member of the London County Council, he has been compelled to relinquish the business of electrical contractor hitherto carried on by him under the style of Russell and Co., at 11, Queen Victoria-street.

Consolidated Telephone Construction and Manufacturing Company (Limited).—This Company announce that, owing to the expiry of the lease of their present works at the end of the current year, they recently purchased the freehold of the Overstone works, Coventry, together with a large plot of adjoining land, so as to give plenty of room for extension of business. The offices of the Company will remain in London, and due notice of any change in their location will be given. It is also stated that the services of the principals and most of the present staff have been retained, thus ensuring a continuance of the excellent workmanship for which this Company is justly noted.

Catalogue.—A copy of the new price list of "Brockie-Pell" arc lamps has been sent to us, and we note that these lamps have recently been considerably reduced in price. Messrs. Johnson and Phillips, who are the makers of the Brockie-Pell lamps, are to be congratulated upon the success which this lamp has met with, and on the general style and convenient arrangement of the catalogue.

College Calendar.—We have received a copy of the 1895-96 Calendar of the University College of North Wales. Very full particulars of the various classes and lectures are given.

Aberdeen.—The installation of the electric light in the extended buildings at Marischal College is now complete. The work has been carried out by Messrs. Shirras, Laing and Co., and about 730 lamps are employed.

Alleged Delay in the Transmission of Telegraph Messages between Paris and London.—In reply to a complaint as to the time taken in the transmission of telegraphic messages between Paris and London, the following letter from Mr. G. von Chauvin (representative in England of the Western Union Telegraph Company) appeared in *The Times* of the 18th inst. :—

"252, Gresham-house, Old Broad-street, London, E.C., Oct. 17th.

"Sir: In your issue of to-day I notice a letter signed 'Arbitrage' complaining of delay on telegraphic messages between Paris and London, and contrasting it with that experienced on messages to New York. The remedy suggested is an increase of the number of lines, and no doubt correctly, as the manner of working the wires, at all events on this side of the Channel, is not likely to be the cause of the delay. It is no doubt desirable that a greater number of telegraphic connections with the Continent should be provided, as the delay on messages exchanged between this country and the Continent is not only in itself a source of inconvenience to the public, but drives a considerable amount of the great international traffic which would otherwise pass over the English lines on to cables starting from Continental countries. A mere multiplication of existing facilities would not, however, it seems to me, entirely meet the case. During the stormy periods of the year a partial or entire breakdown in the telegraph lines leading to the coast is of more or less frequent occurrence, and the telegraphic communication now with one, now with another, foreign country is either greatly delayed or for a time entirely suspended. The remedy would be the establishment of underground lines serving, to begin with at least, the main routes of international communication, and avoiding the possibility of a severance of communication between the large English centres and the coast stations where the submarine cables terminate. Underground lines have for a long time been successfully worked in Germany. Their first cost is considerable, but the cost of maintenance is small, and by laying a

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number of wires at once the cost per line of communication can be much reduced. But it would seem to me that the important point to be considered is the immunity from interruption. A total interruption between this country and the countries served, say, for instance, by the Eastern Company's system, might under easily-conceivable circumstances cost this country more money than would suffice for the establishment of an underground line from London to the Eastern Company's terminus, which would not only guarantee an unbroken continuity of service in times of need, but would be a boon at all times. From a long experience of the manner in which the telegraph department of this country is worked, I feel convinced that those responsible for its conduct are only too glad to take up and carry out every improvement, provided the necessary funds be allowed by those who have their keeping. I venture to suggest, therefore, that an expression of public opinion that a safer and more reliable means of telegraphic communication with the coast than that afforded by overhead lines should be established would produce advantageous results.—Yours, &c., "G. VON CHAUVIN."

ASSOCIATION OF MUNICIPAL CORPORATIONS.—The general meeting of this Association was held at the Westminster Palace Hotel on Friday last, Sir Albert K. Rollit, M.P., presiding. The Town Clerk of Southport (Mr. J. D. Williams) moved "That a request be addressed to the Board of Trade to promote a Bill in Parliament for the purpose of amending Section 9 of the Electric Lighting Act (1882) so as to provide that the annual statement of accounts should be made up to such date as the Council, with the approval of the Board of Trade, might from time to time appoint." The resolution was seconded and duly passed.

BANGOR (IRELAND).—At the last meeting of the District Council it was decided to make inquiries as to the advisability of applying for a Provisional Electric Lighting Order.

BEXHILL (SURREY).—The Urban District Council have been approached by the promoters of a syndicate for lighting the district electrically, and an application for the Council's consent to a Provisional Order has been referred to the Highways Committee.

BIRMINGHAM CENTRAL TRAMWAYS COMPANY.—The Public Works Committee of the Birmingham Corporation have decided to recommend that this Company be allowed to introduce the overhead system of electric traction on their Nechells route.

BOLTON.—At the last meeting of the Gas and Electricity Committee it was decided to recommend the Town Council to adopt the Brighton method of charging for electric current. At the same sitting the Chairman of the Committee (Alderman Miles) and Mr. J. H. Rider were deputed to attend the forthcoming conference on the revised regulations of the Board of Trade as to the supply of electricity.

BRANDON AND BYSHOTTLES (DURHAM).—A special meeting of the District Council was recently held for the purpose of considering an estimate submitted by the Corlett Electrical Engineering Company, of Newcastle, for the lighting of the district by electricity. The Company offer to put down plant capable of maintaining 50 32 c.p. lamps for £480. The question of the cost of lighting the various wards in the district was discussed at great length, and various figures as to the cost, &c., were given by the Chairman. It was conceded that, on the basis of these figures it would be cheaper for the Council to adopt a system of electric lighting than gas. One member (Mr. Barnes) said that he was hitherto strongly in favour of gas lighting, but after the figures which had been read by the Chairman he could not oppose the proposal to light the district electrically. A resolution that the principal streets in the district be lighted by electricity, subject to satisfactory estimates as to cost being obtained, was unanimously carried. The Council intend to apply for a Provisional Order.

BRISTOL TRAMWAYS COMPANY.—The returns for the first complete week's working of the electric tramways prove the popularity of the line and the anxiety of the inhabitants of the city to test the advantages of electric traction. During the week no less than 92,516 passengers were carried.

BULUWAYO (SOUTH AFRICA).—The Buluwayo Waterworks Company are making rapid progress with their electric lighting scheme. It is stated that all the generating plant has been shipped, and that before many months have elapsed the installation of the electric light at Buluwayo will be an accomplished fact. It will be remembered that until two years ago Buluwayo was the home of Lobengula. Such is the march of events!

CARDIFF.—The Corporation have applied for sanction to borrow an additional sum of £12,882 for electric lighting purposes, and a Local Government Board inquiry will shortly be held in connection with the application.

CENTRAL LONDON RAILWAY COMPANY (LIMITED).—At the sitting of the Commissioners of Sewers on Tuesday, notice was received from this Company of their intention to sink a shaft for the purpose of investigating the state of the foundations of the Bank of England before starting work on the proposed subways opposite the Mansion House.

COSELEY (STAFFS.).—At the meeting of the District Council on Tuesday last a long debate arose on the question of the lighting of the streets. A proposal to canvass the ratepayers to ascertain whether the majority were in favour of the introduction of the electric light was rejected, and eventually the Council decided to continue the present system of gas lighting.

DAMAGES FOR AN ELECTRIC SHOCK.—In the Bloomsbury County Court last week an action was brought by a workman named Arnold against Harrod's Stores (Limited) for damages for personal injuries. The plaintiff, who was engaged by the defendants in some work on a building at Brompton, received a shock from an electric wire, and he alleged that his hand was so badly burnt he was unable to work for nearly five weeks. He contended that the accident was attributable to the defendants' negligence, as their engineer (Mr. Peters) should have informed him that certain wires which he was handling were "alive." After evidence had been given by Mr. Peters, Mr. D. C. Bate and others on behalf of the defendants, His Honour (Judge Bacon) found for the plaintiff £10 damages and costs.

DEVONPORT.—At the meeting of the City Council last week the Highways and Streets Committee presented their report on the notices that had been given by the County of London and Brush Provincial Company and the Great Western Electric Light and Power Company of their intention to apply for Provisional Orders for Devonport. The report, which recommended the Council to oppose the applications and to keep the supply of electricity in their own hands, was adopted. The Committee were authorised to take the necessary steps to apply for a Provisional Order.

DOCKS LIGHTING.—The Mersey Dock Board have decided to erect some additional arc lamps on the Prince's landing stage for the convenience of steamers, and a sum of £500 is to be expended on electric lighting at the Canada Lock and Huskisson Docks.

DOUGLAS (ISLE OF MAN).—The Manx Legislative Council on Tuesday approved the bill authorising the construction of a new tramway system in Douglas by the Isle of Man Tramways Company, and an extension for a term of 21 years of the concession from the Douglas Town Commissioners to the Company of the present tramway skirting Douglas Bay.

DOVER.—The work of erecting the iron brackets across Snargate-street for the suspension of the arc lamps for lighting this very narrow thoroughfare has been commenced.

GLASGOW.—At the meeting of the Police Commissioners on Monday, the Watching and Lighting Committee reported that on the suggestion of Bailie Guthrie a Sub-committee had been appointed to consider and report on the question of the electric lighting of the city, and particularly on the kind of lamp to be used for such lighting. The City Electrical Engineer (Mr. W. Arnot) and the Inspector of Lighting are members of the Sub-committee.

GLOUCESTER.—A deputation from the Corporation visited Bristol last week for the purpose of inspecting the new electric tramways and the Corporation electricity station. The Gloucester Corporation are considering the advisability of applying for a Provisional Electric Lighting Order, and a proposal is also under consideration for introducing a system of electric traction on the Gloucester tramways, the current being supplied to the Company by the Corporation.

HAMPSTEAD (LONDON, N.W.).—At the last meeting of the Vestry, on the recommendation of the Lighting Committee, it was decided to lay an electric light main in Boundary-road at a cost of £156. It was also reported that the Committee had considered the question of lighting the High-road, Kilburn, and they recommended that, on certain conditions, this thoroughfare be lighted by means of 24 arcs placed on rests in the middle of the road. By this arrangement the traffic would be regulated, and the illuminating power of the lamps would be greater than if the lamps were placed at the sides of the street. The cost of providing and erecting these arc lamps, rests, cable connections, &c., would be £1,009. 4s., and the annual up-keep of each lamp was estimated at £29. 13s. 6d. The Committee therefore recommended that the Willesden District Council be informed that the Vestry will light the street electrically, provided they agree to pay half the initial outlay and annual cost of maintenance. This proposal was, after a brief discussion, agreed to by the Hampstead Vestry. The Lighting Committee also reported that at the present time they were supplying current to an equivalent of 17,000 c.p. lamps to private consumers, and they had applications in hand for over 3,000 more.

HANLEY.—Mr. G. W. Willcocks, M.I.C.E., held a Local Government Board inquiry at Hanley, on the 16th inst., into the application of the Town Council for permission to borrow £20,000 for the purpose of extending the electric light works and mains. Mr. A. Challinor (the Town Clerk) stated that the assessable value of the borough was £182,238, and the outstanding debt amounted to £195,460, including £30,000 for electric lighting. There was no opposition to the application, and the proposed loan was to extend the buildings, boiler plant and switchboard required for the new alternator, and to extend the mains in different parts of the town. So far the Corporation had limited the supply of current to consumers within the compulsory area, but the demand was continually increasing, and was now so great that although the markets were wired and fitted

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up for the electric light, it was not considered safe to connect them with the mains until further generating plant had been provided. The result of the first six months working (ended December 31st last) was that a profit of £31 was made after providing for working expenses, interest, and sinking fund. The Borough Engineer and Surveyor (Mr. Joseph Lobley, M.I.C.E.) and the Corporation electrical engineers presented a report, which was unanimously approved at a Council meeting on April 30th last. The report divided the work in connection with the proposed extensions into six sections, and the following is a summary of the recommendations:—(1) Extension of mains to Market, Bath, Hope, Clough, Charles, Trinity, Stafford, Tontine, Jasper, Bethesda and Broad-streets, Etruria, Regent, Stoke, Victoria, Avenue and Park-roads, Piccadilly, Pall Mall, Birch-terrace, Snow-hill and Park-avenue. These include high and low-pressure mains, and for a second circuit of 30 arc lamps. The estimate for these cables, including laying, is £5,508. (2) Extension of the buildings at the generating station (leaving room for an additional boiler, condenser and steam alternator when the same are required), two new boilers and appurtenances, 16 sub-stations, 20 transformers, 25 junction boxes, and 30 arc lamps and posts. The estimate for this list is £5,900. (3) Two Ferranti rectifiers for both the present circuit of 30 arc lamps and for the new circuit, the present arc dynamos and engines being retained as reserve; also 30 incandescent street lamps complete on new roads round the park, and 60 ditto in other parts of the town where mains are being laid. Extension of switchboard and excavations and railings at works. The estimated cost of this work is £1,242. (4) In consequence of the demand for energy within the compulsory area, considerable extensions have been made to the machinery, mains, sub-stations and transformers, amounting to £2,650, and to the buildings, furniture, excavating, drainage and formation of ground, amounting to £2,000; sundries, £200. Total, £4,850. (5) Provision for contingencies, £1,000, special regard being had to mains being laid to supply manufacturers with motive power. (6) Meters and switches provided on consumer's premises, £1,500, including £250 already expended. Mr. Lobley gave a detailed explanation of the purposes for which the loan was required, and Messrs. Cowell and Sutherland (the electrical engineers and joint managers of the electricity works) showed the increase in the number of lamps connected, which was now considerably above the capacity of their present generating plant—viz., an equivalent of 10,000 8 c p. lamps. After the termination of the inquiry the inspector visited the works, and proposed new lines of mains and arc lamps.

Illinois Central Railway Company.—This Company announces that it has decided to adopt a system of electric traction on its suburban lines. The work of electrically equipping the lines will shortly be commenced.

Islington (London, N.).—At their last meeting the Vestry resumed the consideration of the Electric Lighting Committee's report, which stated that a further sum of £25,000 would be required for the purpose of completing the electric light undertaking. The report was adversely criticised by several of the members, and the electrical engineer (Mr. A. Gay) attended and made a personal statement in support of the Committee's position, after which the report was agreed to. It is reported that the Vestry have already received applications for current equivalent to 9,237 8-c.p. lamps, and this is a fairly good proof that the Vestry's electric light undertaking is likely to be as decided a success as the schemes of the St. Pancras and Hampstead Vestries.

Kettering.—A proposal for lighting the principal streets of the town by electricity has been before the Town Council for some time, and the Lighting Committee are canvassing the ratepayers with the view of ascertaining the amount of local support likely to be given to the scheme. It is stated that the feeling in favour of the introduction of the electric light is decidedly on the increase.

Kingstown (Dublin).—At their last sitting the Town Commissioners decided to apply for a Provisional Order.

Lancaster.—At the meeting of the Town Council on Wednesday last the resignation of the borough electrician (Mr. A. S. Barnard) was formally received and accepted. It was suggested "that future appointments should be made for a term of years so as to avoid repeated changes in the officials." So far as we can understand no suggestion was made to increase the handsome salary attached to the office, viz., £120 per annum. If the Council considered this question they might possibly discover the cause of the "repeated changes in the officials."

Light Railway in Derbyshire.—The proposed construction of a light railway between Derby and Ashbourne is exciting much local interest. The suggested motive power is electricity, and two numerously-attended meetings in support of the scheme were held last week. In the first case a number of local landowners, farmers and tradesmen assembled at the Guildhall, Derby, on Friday last. The Chairman (Mr. C. E. Newton) said the matter deeply affected the town of Derby and the agricultural interests of the county. He appealed for subscriptions to meet the preliminary expenses for obtaining Parliamentary powers, which he said would be over £700. In the discussion which followed the various speakers favoured the principle of the scheme, and a resolution was passed expressing approval thereof, endorsing the steps taken by the local committee for furthering the project, and declaring the desirability of taking steps to obtain the necessary Parliamentary powers. The other meeting was held on Saturday at Ashbourne. Mr. A. C. Duncombe, who presided, explained the scheme at great length and heartily supported the proposal, as he said he was persuaded that the railway would prove of great value to the agricultural interests of the county. It was also stated that Sir H. Oakley (General Manager of the Great Northern Railway Company) had promised to assist the promoters of the scheme as far as possible; the light railway with its goods traffic would run into the yard of the Great Northern Company, where the goods could be easily and cheaply transferred. A resolution heartily approving of the scheme was also adopted at this meeting.

Llandudno.—The District Council have been requested to sanction the construction of an electric tramway in the town. It is proposed to use storage batteries.

Llandrindod Wells.—The District Council have received proposals from a Birmingham firm for the lighting of the district by electricity, and a special meeting of the Council is to be held to consider and discuss the matter.

Macroom (Cork).—A scheme for the lighting of this town by electricity is being prepared by a local syndicate. It is acknowledged that artificial lighting of some kind is absolutely necessary, and electric lighting ought to prove very much cheaper than any other form of illumination, especially as water power is available in the vicinity of the town.

Newcastle-on-Tyne.—The Improvement Committee have presented a report on the working of the tramways. The report was considered by the City Council at their meeting on Wednesday, and recommends the adoption of a cable system. The cost of the proposed scheme, including engine-houses, engines, track, and conduit, but exclusive of land for power station, is estimated at about £125,000. By an arrangement the lessees of the present tramways agree to work the cable system. The Corporation are to grant a new lease to the Company for 21 years, and the Company are to pay to the Corporation half-yearly rent at the rate of 6¼ per cent. per annum on the total cost of construction and equipment, and on so much of the debt on the portion of the existing tramways proposed to be cabled as will be unprovided for after giving credit for all material displaced. The lessees are also to pay to the Corporation interest at the rate of 3 per cent. per annum upon the cost of purchasing the site for the power station. The report was adversely criticised by several members, who urged the Corporation to follow the example of Leeds and adopt a system of electric traction. The further consideration of the matter was adjourned until Monday next.

Newington (London, S.E.).—The Vestry of St. Mary, Newington, have engaged Messrs. Kincaid, Waller and Manville to advise them on the question of the adoption of an electric lighting scheme.

Port Adelaide (South Australia).—From latest advices we learn that the Port Adelaide Corporation have decided to light the principal streets of the town by electricity, and the tender of the South Australian Electric Light and Motive Power Company for carrying out the scheme has been accepted.

Queenstown.—A special meeting of the Town Commissioners was held on Tuesday last to consider the best mode of lighting the town. The Commissioners have on many previous occasions discussed this question, and it is satisfactory to be able to record that they have at last made up their minds to apply for a Provisional Electric Lighting Order. 6s. 11d. a thousand for gas ought to be sufficient to induce any local authority to come to a similar decision. The Commissioners and the local gas company have been at loggerheads for a considerable time past over the price and quality of the gas supplied for the lighting of the streets, and though several applications for a reduction in the price had been made, the gas company resolutely declined to entertain any such proposal. The Commissioners have decided to erect four arc lamps, partly as an experiment and partly to demonstrate to the ratepayers the great advantages of the electric light.

Ramsgate.—The coastguard station on the cliffs at Ramsgate has been put in telephonic communication with the harbour, the object being to enable information of disasters on the Goodwins to be more speedily communicated to the Ramsgate tug and lifeboat.

Sunderland.—The report of the Highways Committee, presented at the last meeting of the Town Council, recommended that the electric light mains be extended to the St. John's Wesleyan Lecture Hall, Ashbrooke-road; that mains be purchased for laying along Vine-place, Homeside and Green-terrace, at a cost of £188, and that additional meters be purchased at a cost of £106. 11s. 6d. The report was duly approved.

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St. George's (London, S.W.).—At the last meeting of the Vestry, Mr. Bromwich again raised the question of lighting the streets by electricity. He complained that they were 10 years behind the time in the matter, and he urged his fellow members to bestir themselves and to take the question into serious consideration. The Surveyor, in reply, stated that he was preparing a report on the subject at the instance of the Works Committee, and it would shortly be presented.

St. Pancras (London, N.W.).—At the last meeting the Vestry, several new applications for current were announced. Mr. Hodgson raised a debate on the action of the Electricity Committee in increasing the pressure at which electric current is supplied to new customers from 110 to 220 volts, but after some discussion it was decided to support the action of the Committee.

Swadlincote (Burton).—The Water and Lighting Committee of the District Council are considering a proposal for lighting the Stanton Ward by electricity.

Taunton.—The Electric Light Committee have applied to the Board of Trade for a further extension of one year to complete the work of laying underground mains and removing the overhead wires. They also require a further loan of £3,000 for electric lighting purposes, and the Finance Committee have been authorised to raise this amount.

Telegraphic Messages per Telephone.—The National Telephone Company announce that the charge of 1½d. per message hitherto made to their customers for sending telegrams to the Post Office by means of the telephone, has been abolished, and telegrams can now be transmitted and received without extra charge over and above that due to the Post Office. Before subscribers can use the telephone for this purpose the District Manager must be communicated with and a deposit left with the Company sufficient to cover the cost of telegrams likely to be sent during a month.

The Metric System.—It is stated that the Mexican Government have decided to adopt the metric system of weights and measures as from September 16, 1896.

The Provincial Telephone Service.—A conference took place in Bradford on Tuesday last between delegates from the various Chambers of Commerce in the West Riding of Yorkshire and representatives of the National Telephone Company, for the purpose of discussing and considering complaints against the present management of the telephones, and to urge for a reduction of the annual subscription. The chair was occupied by Mr. T. A. Duncan (President of the Bradford Chamber of Commerce), and representatives from the Bradford, Halifax, Huddersfield, Heckmondwike, Birstall, Yeadon, Keighley, Ossett, Cleckheaton and Wakefield Chambers were also present. The National Company were represented by Alderman Franklin (a Director), Messrs. W. E. L. Gaine (General Manager), J. C. Chambers (provincial superintendent), and N. B. Sutcliffe (District Manager). Mr. Gaine went through the various complaints. He said that any arrangement to make one subscription cover the six areas into which the West Riding was divided would have to be done with the concurrence of the Government, and he understood they would be disinclined to amalgamate these areas. As to the question of providing their subscribers with pass cards and copies of the general directory free, he thought the existing charges were reasonable, but the Company would carefully consider any proposals for making the local lists more convenient and useful. The proposed extension of the time of conversation from three to five minutes was entirely in the hands of the Government, as was likewise the erection of additional trunk lines; by their agreement with the Post Office they were bound not to extend these trunk lines without the Postmaster-General's consent. He had gone carefully into the matter, and he was of opinion that in order to meet the present traffic additional trunk lines were required as follows:—From Bradford: Two to Huddersfield, two to Halifax, three to Dewsbury, two to Wakefield, and one to Harrogate. From Huddersfield: Two to Halifax, two to Leeds, and two to Dewsbury. From Halifax: Two to Leeds. From Leeds: Two to Dewsbury, four to Wakefield, and two to Harrogate. The question of the annual charge was next dealt with. Mr. Gaine alluded to the fact that subscriptions to Continental telephone exchanges were low as compared with the rates paid by the National Company's subscribers. This fact he attributed to the numerous obstacles to the development of the service that had been put in their way. He also adduced some figures in favour of this contention, and said that under the present conditions he could not hold out any hope of a reduction, but the Company would do all in their power to make the service efficient. A discussion followed, and eventually a motion was passed to the effect that a memorial be forwarded to the Postmaster-General urging (1) the necessity for additional trunk lines being provided without delay, and (2) that the six areas into which the West Riding district is divided should be combined into one area.

Weybridge.—At the last meeting of the District Council a draft of the proposed contract with the local gas company was submitted, and after several alterations had been made therein the further consideration of the matter was postponed. Some time ago the Council wrote to the Board of Trade asking if the Weybridge Provisional Order (1891) could be transferred to them instead of being revoked, and the Board have now replied to the effect that the only way to avoid the proposed revocation was by the purchase of the Weybridge Electricity Works by the Council. It was, therefore, decided to ascertain on what terms the Weybridge Electric Supply Company would transfer the Order to the Council.

Wimbledon (Surrey).—At the last meeting of the District Council it was stated that the Local Government Board would shortly hold an inquiry into the application of the Council to borrow money for an electric lighting scheme. The resolution recently passed by the Ratepayers' Association relative to the scheme was presented, and an application from the Association asking the Council to receive a deputation of their members on the subject was refused.

Workhouse Lighting.—Some time ago a Bedford firm wrote to the Great Berkhampsted Board of Guardians offering to instal the electric light at their workhouse. The proposal was discussed at the last meeting of the Board, but in the absence of figures as to cost, &c., the consideration of the matter was postponed.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

October 10, 1895.

19,002. H. Brecknell. Bristol. An improved wheel trolley for single-wire system of electric traction.

19,027. W. L. Wise. London. Improvements in electric metering apparatus. (W. S. Barstow, United States)

19,067. F. Warren. London. Improvements in electric signalling apparatus.

October 11, 1895.

19,104. F. E. Buxton. Manchester. An improved method of making and applying electric rail-bonds. [Date applied for under Patents, &c., Act, 1883, Sec. 103, April 15, 1895, being date of application in United States.]*

19,130. P. C. D. Castle. Liverpool. New or improved chemical substance and the application thereof to industrial purposes, such as rubber, gutta-percha, or celluloid substitutes, insulations of electrical conductors, coverings for ships' bottoms, or wall and floor coverings.

October 12, 1895.

19,177. H. O. Johnson. London. New or improved electric lantern for velocipedes.

19,199. A. G. New and A. J. Mayne. London. Improvements in dynamos.

19,204. J. R. Gibson. London. Improvements relating to electric signalling in open circuits.*

October 14, 1895.

19,245. R. Wood. London. Improvements in dynamo-electric generators and motors.

19,256. F. J. Beaumont and F. Hallows. London. An improved electricity meter for registering the amount of current consumed on direct or alternating polyphase, triphase, or quadruplephase circuits.

19,260. J. E. Horea and A. Olteanu. London. Improved electrical apparatus for preventing the collision of railway trains.

19,272. E. R. Kesterton. London. Improvements in or relating to the steering of electric or steam carriages, cycles, bath chairs, or other like vehicles.

October 15, 1895.

19,275. R. J. Bott. London Improvements in electric incandescent glow lamps.

19,304. W. L. Wise. London. Improvements in phosphorescent electric lighting. (The Moore Electrical Company, United States.)*

19,317. J. la Burt. London. Electric railways.

19,318. J. G. Smith and R. G. Vassar. London. Improvements in combined telephone and signalling systems.*

19,337. W. P. Thompson. Liverpool. An improved means for connecting the filament in incandescent lamps with the source of current. (The Phönix Süddeutsche Glühlampenfabrik Gesellschaft, Germany.)

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SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1894.

12,483. SHREWSBURY AND OTHERS. Electric batteries.
18,328. FLETCHER. Telegraphy.
19,184. DAVIS. Electric heaters.
19,220. WHYTE and MUIRHEAD. Electric ship logs, &c.
22,819. TYER. Lock and block electric apparatus for railways.
22,973. BROWN. Storage batteries.

1895.

7,782. VOIGT and HAEFFNER. Electric resistances.
12,329. MERKEL and DUFFEK. Telegraphic systems.
13,405. MARR. Electric telephone systems.
14,492. PRIETO. Electric lamps.
15,365. DINGLE and URQUHART. Electric switches.
15,513. DONEY. Dynamo electric machines.
15,886. WOLLASTON. Electric batteries.
16,008. DILLBERG and RABBIDGE. Telephonic instrument.

COMPANIES' MEETINGS AND REPORTS.

Froggatt's Electric Lighting Company (Limited).

An extraordinary general meeting of this Company was held at Winchester House, Old Broad-street, on Monday (Mr. A. de Murrieta in the chair) to consider two resolutions: (1), as to the appointment of a committee of the shareholders to confer with the Directors on the conduct of the business in the past, and also as to the future management of the business and the steps to be taken to promote the success of the Company, and (2), empowering the Committee, at its discretion, to make a report to the shareholders.

The SECRETARY (Mr. A. S. Hiley) having read the notice convening the meeting,

The CHAIRMAN, in proposing the first resolution, stated that, in accordance with an undertaking given by the Board, the present meeting had been called for appointing a committee to confer with the Directors. The Board had no names prepared to act as the committee, preferring to leave its election to the shareholders' initiative. He then invited the nomination of candidates.

Mr. KEEBLE wished to know the necessity for the proposed committee, the proper committee for managing the Company's affairs being, he contended, the Directors.

Mr. WILDEY said he did not think it was necessary to discuss the point just raised. The report showed a profit for twelve months of £239. He saw the light in omnibuses and they heard remarks about it, and the question was—Where had all the money gone to? He thought that there was every reason why they should have a committee, and he would second the resolution.

Mr. KEEBLE replied that the Chairman explained at their recent meeting the causes why a dividend had not been paid, and made a statement, upon which the shareholders adopted the report. The Chairman also mentioned the grounds on which he had reason to suppose that the business would be successful in the future. He hoped a committee would not be appointed unless they made a report to the shareholders; but, in his opinion, the appointment of a committee was useless, and he regarded it as the beginning of proceedings which might wreck the Company. He proposed an amendment providing that, instead of having any discretion vested in them in such a matter, the committee should report to the shareholders the result of their conference with the Directors.

Mr. HAYWARD seconded the amendment, and proposed an addition to it (which was accepted by Mr. Keeble), that the committee should present their report to the shareholders within 28 days.

The CHAIRMAN said he thought that if they limited the period to 28 days the Directors would oppose the amendment, but they did not otherwise object to the amendment. In leaving it to the discretion of the Committee to report or not to the shareholders the result of their conference with the Board, it had been thought that certain matters might be privately discussed the publication of which might be detrimental to the interests of the Company. He submitted the amendment, and declared it lost, and afterwards put the original motion, which he declared carried.

Mr. Keeble and four other shareholders demanded a poll, and the Chairman said that the poll would be taken on the following day, and the meeting was adjourned to yesterday (Thursday) at four o'clock, for the declaration of the result.

At the meeting yesterday,

The CHAIRMAN read the result of the poll as follows: In favour of the resolution, 19,224 votes; against it, 11,578. He therefore declared the resolution carried.

Mr. CAPEL CURE then proposed the appointment of Mr. Stanhope (a former Director) and Mr. Curling Hunter as members of the committee.

Mr. KEEBLE proposed the appointment of Mr. Hayward.

The CHAIRMAN said the resolution he would propose was—

"*That Mr. Stanhope, Mr. Hunter and Mr. Hayward, being shareholders of the Company, be, and they are hereby appointed to act for the purposes specified in the preceding resolution.*"

Mr. C. DE MURRIETA seconded the motion.

Mr. KEEBLE moved an amendment to the effect that the Committee report the result of their conferences to a meeting to be called for that purpose.

The SOLICITOR stated that the amendment should have been proposed on the previous resolution.

The CHAIRMAN accordingly ruled the amendment out of order, and put the resolution, which he declared carried.

The proceedings then terminated.

Eastern Extension, Australasia and China Telegraph Company (Limited).

The report of the Directors for the half-year ended June 30th last, to be submitted to the forty-fourth ordinary general meeting, which will be held at Winchester House, Old Broad-street, London, E.C., on Wednesday next, the 30th instant, at 2 o'clock, states:—

The gross receipts, including Government subsidies, have amounted during the period to £264,138. 10s. 5d., against £247,681. 2s. 4d. for the corresponding half-year of 1894. The working expenses, including £29,323. 19s. 7d. for cost of repairs to cables and expenses of ships, absorb £95,254. 14s., against £80,295. 3s. 10d. for the corresponding period of last year, leaving a balance of £168 883. 16s. 5d. From this is deducted £3,984. 3s. 2d. for income tax, £31,895 for interest on debentures, debenture stock, and contribution to sinking fund, leaving £133,004. 13s. 3d. as the net profit for the half-year. Two quarterly interim dividends of 1¼ per cent. each, amounting to £62,500, have been paid for the half-year under review, leaving £70,504. 13s. 3d. to be carried forward.

The working of the Australasian tariff arrangement for the fourth year of guarantee, ended April 30th last, resulted in the guaranteed figure being slightly exceeded owing to the exceptionally heavy gold mining traffic that was exchanged with Australasia during the latter part of the year.

The maintenance ships have, as usual, been kept employed during the half-year under review on the various sections of the Company's cables, but owing to the cables being duplicated the traffic has in no instance been interrupted.

Brazilian Submarine Telegraph Company (Limited).

The following report of the Directors of this Company, for the half-year ended June 30 last, will be presented to the forty-fourth ordinary general meeting, to be held at 174, Winchester House, Old Broad-street, E.C., on Wednesday next, the 30th inst., at 12 o'clock noon:—

The revenue for the period amounted to £108,205. 14s. 5d., and the working expenses to £21,129. 4s. 11d. After providing £3,200 for debenture interest and sinking fund, and £1,790. 1s. for income tax, there remains a balance of £82,086. 8s. 6d.; to this is added the sum of £4,324. 0s. 9d. brought forward from the preceding half-year, making a total of £86,410. 9s. 3d. A quarterly interim dividend, amounting to £19,500, has been paid, and £30,000 transferred to the reserve fund. The Directors now recommend the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 2s. per share (both free of income tax), which together will amount to £32,500, leaving a balance of £4,410. 9s. 3d. to be carried forward. The dividend and bonus are payable on the 31st inst.

The receipts for the half-year include the sum of £1,500 dividend to December 31st last on the Company's shares in the African Direct Telegraph Company (Limited). The various sections of the Company's lines are in good working order.

The retiring Directors are Lord Sackville A. Cecil and the Duke de Loulé, who, being eligible, offer themselves for re-election, as do the auditors, Messrs. Deloitte, Dever, Griffiths and Co. and Messrs. Gane, Jackson and Jefferys.

Monte Video Telephone Company (Limited).

The following is the report of the Directors of this Company for the year ended July 31, 1895, which will be presented to the shareholders at the annual general meeting to be held at Winchester House, Old Broad-street, London, E.C., at 12 o'clock noon, on Thursday next, the 31st inst.:—

The statement of accounts for the period shows a net profit of £7,232. 18s. 5d. This amount, added to the balance of £577. 18s. 8d. brought forward from last year, leaves a sum of £7,810. 17s. 1d. available, after providing for working expenses in Monte Video and London and for loss in exchange, and after writing off amounts for bad debts and depreciation of office furniture. The working expenses in Monte Video have been somewhat heavier than usual owing to a succession of severe storms which occurred during the early part of the year, when much damage was done to the plant. At the cost of revenue, however, the property has been maintained in good working order.

After placing £1,000 to reserve account and £500 to the depreciation fund, the Directors recommend the payment of a dividend of 4 per cent. on the Preference shares absorbing £5,600, and leaving the sum of £710. 17s. 1d. to be carried forward to next year.

In accordance with the Articles of Association, Mr. Charles H. Sanford retires from the Board, and, being eligible, offers himself for re-election, as do the auditors, Messrs. Gérard Van de Linde and Son.

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NEW COMPANIES, STATUTORY RETURNS, &c.

BRITISH ELECTRICAL MANUFACTURING AND ENGINEERING COMPANY (LIMITED).—This Company was registered on October 18th, with a capital of £20,000, in £5 shares, to manufacture, erect, use and deal in telephones, telegraphs, electric bells and all other electrical apparatus; to carry on the business of manufacturers of and dealers in electrical generators, motors, accumulators, electrical elevators, carbons, steam and other engines, iron, copper and other wires, electrical conductors and other apparatus used in connection with the generation, accumulation, supply or utilisation of electricity. The subscribers, with one share each, are: P. Capps, H. D. Monk, F. C. Smith, J. Hill, J. Davis, F. A. Braithwaite and C. A. Cox. One Director is to be nominated by Messrs. Laing, Wharton and Down, and he is to remain in office so long as they are interested in the Company.

DOUGLAS SOUTHERN ELECTRIC TRAMWAYS (LIMITED).—This Company was registered on October 21st with a capital of £50,000, in 30,000 Seven per Cent. Preference shares and 20,000 Ordinary shares of £1 each, to enter into an agreement with the General Traction Company (Limited), to acquire, equip and work with electric, mechanical, or other motive power, carry on and maintain railways, tramways, roads and auxiliary railways in the Isle of Man, or elsewhere in the United Kingdom, and to carry on the business of electrical and mechanical engineers, electricians, and suppliers of electric light. The subscribers, with one share each, are: W. S. Graff Baker (electrical engineer), W. P. J. Fawcus (engineer), G. W. Lowcock (electrical engineer), J. H. Beech, H. Taffs (electrician), A. E. Tanner and T. S. Turnbull.

HYDRAULIC POWER IMPROVEMENTS COMPANY (LIMITED).—This Company was registered on October 17th, with a capital of £10,000, in £1 shares, to enter into an agreement with Jean Molas, civil engineer, High-road, Tottenham, London, N., for the acquisition of certain patents, and to carry on business as mining and mechanical engineers, concessionaires, makers of hydraulic lifts, &c.

SIEMENS BROS. AND COMPANY (LIMITED).—The annual return to August 27th has been filed. The capital is £500,000, in £100 shares, all of which have been taken up. Calls amounting to £85 per share have been paid.

SPANISH NATIONAL SUBMARINE TELEGRAPH COMPANY (LIMITED).—The annual return to August 29th has been filed. The nominal capital amounts to £500,000, in 49,900 £10 shares and 1,000 £1 shares; 23,719 of the former class have been taken up, and of these all but four have been issued as fully paid.

THAMES VALLEY LAUNCH COMPANY (LIMITED).—An agreement, dated the 27th inst., has been made by this Company with Mr. W. R. Edwards, electrical engineer, of Weybridge, for the sale of the business of launch and boat builder and owner, and electrical engineer carried on by the vendor, for £1,500, payable by the allotment of 300 fully-paid shares of £5 each.

VEALE AND COMPANY (LIMITED).—The annual return of this Company has been filed. The nominal capital is £10,000, in £1 shares, and 4,904 of these have been taken up: 3,839 have been issued as fully paid, and the full amount has been called and paid on the remaining 1,065 shares.

WESTRALIAN ELECTRIC LIGHTING AND SUPPLY COMPANY (LIMITED).—This Company has entered into an agreement with Westralia (Limited) for the purchase of a certain exclusive concession to supply electricity for various purposes, granted by the Municipal Council of Coolgardie, Western Australia, for £45,000, of which £40,000 is to be satisfied by the allotment of 40,000 fully-paid shares of £1 each.

CITY NOTES.

MEMORANDA.—Bank rate, 2 per cent. (Feb. 22, 1894). Price of silver, 31 $\frac{1}{16}$d. per oz. (Oct. 24th). Consols (2¾ per cent.) 107⅝–107 $\frac{7}{16}$ for money, 107 $\frac{5}{16}$—107 $\frac{7}{16}$ for account; 2½ per cent. 105½—106¾ (Oct. 24th). Stock Exchange Settling Days: Consols, Nov. 6th; Stocks and Shares Continuation Day, Oct. 28th; Ticket Day, Oct. 29th; Pay Day, Oct. 30th.

AMAZON TELEGRAPH COMPANY (LIMITED).—The first ordinary general meeting of this Company will be held at Winchester House, Old Broad-street, London, E.C., on Thursday next, the 31st inst., at 12 o'clock.

CASTNER-KELLNER ALKALI COMPANY (LIMITED).—This Company is inviting subscriptions for 200,000 £1 shares, payable 2s. 6d. on application, 2s. 6d. on allotment, 2s. 6d. on January 1st next, and the balance as may be required. The capital of the Company is £300,000, in £1 shares, and the prospectus states that, in view of an arrangement made between the Aluminium Company (London), owners of the Castner patents, and MM. Solvay et Cie. (Brussels), owners of the Kellner patents (except for Austria), the Company has been formed for the purpose of manufacturing caustic soda and bleaching powder by electrolysis under the combined patents of Mr. H. Y. Castner and Dr. C. Kellner in Great Britain and Ireland and the British colonies, except Canada. New works are to be erected by the Company at Runcorn, where, it is stated, the processes have been worked experimentally with satisfactory results for some time past. The vendors take the remaining 100,000 shares in part payment of the purchase-money, and the Directors of the Company are: Messrs. F. Burton, Hamilton Y. Castner (Director of the Aluminium Company), F. Hardcastle, Dr. C. Kellner, William Mather (Mather and Platt, Limited) and Sir H. E. Roscoe. The offices are 13, Abchurch-lane, E.C., and the secretary (*pro tem.*) is Mr. G. H. Clarkson. The lists opened yesterday (Thursday) and close to-day.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended October 20th were £927, against £932 in the corresponding week of 1894, a decrease of £5. The total receipts for the half-year amount to £13,701, against £13,863 for the corresponding period of 1894, a decrease of £162.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The revenue return of this Company for the quarter ended September, 1895, is as follows: Sale of current for public lighting, £3,182, against £3,141 in the corresponding quarter last year; private lighting, &c., £11,600, as compared with £7,676; estimated revenue from other sources, £400, against £416; total £15,182, as compared with £11,233, or an increase of £3,949. There was an equivalent of 170,827 8 c.p. lamps connected up to the Company's mains on September 30th, an increase of 11,577 8 c.p. lamps, against 13,724 8 c.p. lamps in the corresponding quarter of 1894.

DOUGLAS SOUTHERN ELECTRIC TRAMWAYS COMPANY (LIMITED).—During the week this Company, which has been formed for the purpose of acquiring an exclusive concession for the operation of an electric tramway (on the overhead system) upon the Douglas Head Marine Drive, invited applications for 20,000 Seven per Cent. Preference and 10,000 Ordinary shares of £1 each, payable 5s. on application, 5s. on allotment, and the balance on December 1st next. The nominal capital of the Company is £50,000, divided into 30,000 Preference and 20,000 Ordinary shares of £1 each. The concession is for a term of 10 years, and at the expiration of this period the Douglas Head Marine Drive (Limited) (the grantors of the concession) have the option of either purchasing the undertaking on certain conditions stated in the prospectus, or of renewing the concession for a further period of 21 years upon agreed terms. The Company has entered into a contract with the General Traction Company, Limited (the vendors) for the acquisition of the tramways in working order, with certain specified plant, rolling stock, buildings, &c., and for the assignment of the concession and all the rights and privileges thereunder. The estimated cost of the construction and equipment of the first 2½ miles of the tramway is £29,000, payable £25,000 in cash and £4,000 in Ordinary shares or cash. The consulting engineers (Messrs. Kincaid, Waller and Manville) have reported favourably to the Company on the scheme, and the prospectus states that it has been estimated there will be sufficient profit to pay a dividend of 11 per cent. per annum on the Ordinary shares of the Company, besides paying the interest on the £20,000 Preference shares. The Directors of the Company are Messrs. J. S. Goldie-Taubman, J.P. (Speaker of the House of Keys), who will act as Chairman, W. Turton, W. P. J. Fawcus, W. S. Graff Baker and G. W. Lowcock. The offices of the Company are at 71, King-street, Manchester, and 11, Athol-street, Douglas, Isle of Man, and the secretary is Mr. F. R. Rowe. The lists opened on Saturday and closed yesterday Thursday.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announce the payment by warrants on November 1st of interest for the half-year ended October 31st on their Four per Cent. Mortgage Debenture Stock. The transfer books of the Company will be closed from the 27th inst. to November 1st, both days inclusive.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY (LIMITED).—This Company announce the payment by warrants on November 1st next of interest on their Four per Cent. Mauritius Subsidy Debentures. The transfer books will be closed from the 27th inst. to the 1st proximo, inclusive.

LEIPZIG ELECTRIC TRAMWAY COMPANY.—This Company, which has been formed by the Allgemeine Elektricitäts Gesellschaft and some German banks, recently invited subscriptions for £162,500 (one half of the nominal capital of the Company) at 138 per cent., and according to a Munich paper applications for £614,000 were received. There will be about 15 miles of tram line with a total length of track of about 27 miles. For the construction and equipment of the tramway the Allgemeine Elektricitäts Gesellschaft will receive £291,800, and, according to concession, the line must be opened in 1896.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—The traffic receipts of this railway for the week ended 20th inst. amounted to £1,104. The amount for the corresponding week last year was £888; increase, £216.

SOCIETE ANONYME ELECTRICITE ET HYDRAULIQUE.—The Directors of this Company have declared a dividend at the rate of 5 per cent. per annum for the year 1894-95.

SOCIETE ANONYME L'ELECTRO-HYDRAULIQUE.—A Company bearing this title, and having a capital of £10,000, has been formed in Brussels for carrying on an electro-chemical and metallurgical business.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Tuesday next, the 29th inst., a special settling in 143,971 shares (5s. paid) of the Smelting Company of Australia (Limited).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—At a meeting of the Board of this Company held yesterday (Thursday) it was decided that, after placing £7,876 to the Debenture Redemption Fund and £5,000 to the reserve fund, the Directors would (subject to audit) recommend at the forthcoming meeting a dividend at the rate of £2. 10s. per cent. per annum, free of income-tax, for the six months ended June 30 last, as against a dividend at the rate of £2 per cent. per annum for the corresponding period of 1894, carrying forward £5,803. The dividend will be payable as follows—3s. 9d. per share to the Ordinary shares and 3s. 9d. per share to the Preferred Ordinary shares.——The Company's traffic receipts for the week ended October 18th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,009.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the half-month ended October 15th are £2,094, as compared with £1,901 in the corresponding period of 1894.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share	Last Dividend.	Name	Previous Week's Price, Oct. 16.		Price Wednesday. Oct. 23.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 19. Highest	Lowest
			TELEGRAPHS.					£ s. d.		Highest	Lowest
1,012,[illegible]0	Stock	11 0	Anglo-American ... xd	45	47	45	47	4 15 9	Jan., Apr., July, Oct	46½	45½
2,99[illegible]0	Stock	22 0	Do. Preferred ... xd	86	87	84	85	5 5 11	" "	87½	85¾
2,993,[illegible]0	Stock	5/0	Do. Deferred ...	7½	7¾	7½	7¾	..	" .. "	7 9/16	7½
£173 400	100	4%	*African Direct Teleg. 4% Deb. (Reg. & Bearer)..	102	105	102	105	3 16 11	January and July	..	..
130,000	£10	3/0	Brazilian Submarine ...	14	14½	14	14½	4 9 8	Mar., June, Oct., Dec.	14⅜	..
£75,000	£100	5%	* Do. 5 per Cent. Bonds (2nd Series, 1906) ...	111	115	111	115	4 7 11	June and December	..	..
10,000,000	$100	7%	Commercial Cable Capital Stock ...	164	168	164	168	4 3 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine ...	13	14	13	14	5 14 4	February and August	..	..
6 000	10	10%	Do. Preference 10 per Cent. ...	20½	21½	20½	21½	4 13 0	" "	..	—
12,931	5	2/0	Direct Spanish (fully paid) ...	4	5	4	5	4 0 0	April and October	..	—
6,000	5	10%	Do. Preference 10 per Cent. ...	9¾	10½	10	10½	4 5 3	" "	..	—
£[illegible]0,000	Stock	4½%	Do. 4½% Debentures of £50 each ...	101%	107%	104%	107%	4 5 1	" .. "	..	—
60,710	20	2/0	Direct United States Cable, 1877 ... xd	8¾	9½	8¾	9½	4 6 6	Jan., Apr., July, Oct	..	..
400,000	10	2/6	Eastern ... xd	17⅛	17⅜	17⅛	17⅜	3 14 4	" "	17 5/16	17¼
70,000	10	6%	Do. 6 per Cent. Preference ... xd	18	18½	18	18½	3 4 10	" "	..	..
£[illegible]297,8[illegible]7	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock ..	129	132	129	131	3 1 5	May and November	130½	..
£102,100	100	5%	* Do. 5 per Cent. Debentures, 1899 ...	107	110	107	110	4 11 9	February & August	..	..
250,000	10	2/6	Eastern Extension ... xd	18	18½	18	18½	4 2 2	Jan., Apr., July, Oct.	18½	18 1/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock ...	128	131	128	13[illegible]	3 1 4	February & August	..	..
£54,100	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900...	103	107	103	107	4 14 7	January and July	..	..
£80,600	100	5%	*Eastern and S. African 5 p. Cent. Mor. Deb., 1900..	103	107	103	107	4 14 7	" "	1[illegible]4	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909 (regd.)	108	111	108	111	3 12 5	February & August	108¾	108½
£200,000	£25	4%	* Do. 4% Mauritius Sub. Debs. (regd.) ...	114%	117%	114%	117%	3 9 5	May and November	—	..
180,227	10	1/3	Globe Telegraph and Trust ... xd	10⅛	10⅜	10⅛	10⅜	3 19 6	Jan., Apr., July, Oct.	10⅜	10⅛
1[illegible]0,042	10	6%	Do. 6 per Cent. Preference ... xd	17	17½	17	17½	3 9 7	" "	17⅛	17
150,000	10	5/0	Great Northern ...	21¾	22¼	21¾	22¼	3 16 8	Jan., April, and July	22	..
£180,000	100	5%	* Do. 5 per Cent. Debentures, 1883 issue ...	103	106	103	106	4 14 9	March & September	104	..
17,000	25	37/6	Indo-European ...	50	53	50	53	4 14 4	May and November	51½	..
37,548	10	2/6	London Platino-Brazilian ...	..		..		..	" "	..	..
£100,000	100	6%	* Do. 6 per Cent. Debentures ...	106	110	106	110	5 9 7	March & September	..	..
£100,000	£100	4%	*Pacific European Tel. 4% Guar. Debs. "Red" 1942	109	112	109	112	3 11 5	..	..	..
11,839	8	4/0	Reuter's ... xd	5½	6½	5½	6½	..	April and October	..	..
3,381	£100 Cert.	25/0	*Submarine Cables Trust 6 per Cent. ...	127	132	127	132	4 10 11	" "	129½	..
15,609	10	2/0	West African Telegraph ...	5½	6½	5½	6½	..	January and July ..	..	—
£233,300	100	5%	* Do. 5 per Cent. Debentures (red.) ...	104	107	104	107	4 13 11	March & September	..	..
30,000	10	2/0	West Coast of America ...	1½	2	1½	2	..	January and July ..	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902 ...	100	105	100	105	7 15 4	June and December	..	..
88,321	10	6d.	West India and Panama ...	¾	1	⅞	1⅛	..	..	1½	..
34,563	10	6%	Do. 6 per Cent. 1st Preference ...	10½	10¾	10½	10¾	5 14 3	May and November	10⅝	10½
4,669	10	6%	Do. 6 per Cent. 2nd Preference ...	8½	9½	8½	9½	6 13 4	" "	9⅜	9
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1917 (red.) ...	111	114	111	114	4 8 6	June and December	..	..
64,242	15	6/0	Western and Brazilian ...	10½	10¾	10½	10½	4 3 11	May and November	10½	10
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred ...	6½	7	6½	7	..	—	6 11/16	6½
33,129	7½	1/6	Do. 5 per Cent. Deferred ...	3¾	4¼	3¾	4¼	..	—	..	..
£165,200	100	6%	* Do. 6 per Cent. Debs., Series "A" 1910 ...	103	107	103	107	5 12 2	February & August	..	..
£206,400	100	6%	* Do. 6% Mort. Debs., Series "B" 1910 ...	103	107	103	107	5 12 2	" "	..	..
$1,177,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds ...	113	118	113	118	6 1 9	May and November	..	..
£164,300	£100	6%	* Do. 6 per Cent. Sterling Bonds (red.) ...	100	103	100	103	5 17 1	March & September	..	—
			TELEPHONES.								
44,000	5	2/6	Chili Telephone (fully paid) ...	3½	4	3½	4	..	—	..	..
224,850	10/0	1½d.	Consolidated Telephone Const. & Maintenance ..	1/16	3/16	1/16	3/16	..	May and November	..	—
171,504	£1	8¼d.	Oriental Telephone and Electric (fully paid) ...	9/16	11/16	½	⅝	..	Yearly	—	..
484,597	5	2/6	National ...	6⅛	6⅜	6⅛	6⅜	3 18 5	June and December	6 5/16	6⅛
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref. ...	16	18	16	18	3 6 8	" "	15¼	..
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid) ...	15	16	15	16	3 15 0	" "	..	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref. ...	6¼	6½	6¼	6½	3 16 11	—	6 7/16	6 1/16
1,100,000	Stock	3½%	* Do. Debenture Stock, 4½% (red.) ...	106	108	106	108	3 5 5	January and July ..	106	..
58,000	5	3/0	United River Plate ...	2¾	3¼	2¾	3¼	..	" "	..	..
£146,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.) ...	92	97	92	97	5 4 5	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	5/0	City of London Electric Lighting (fully paid) ...	13	14	13	14	1 14 6	—	13¾	13
40,000	10	6/0	Do. 6% Cumulative Pref. (fully paid) ...	15	16	15	16	3 15 0	—	15⅝	15½
£100,000	Stock	5%	* Do. 5% Debenture Stock (red.) ...	133	137	133	137	3 13 8	June and December	..	..
19,900	£5	..	Electricity Supply Co. for Spain ...	..		..		..	—	..	..
£30,000	£5	2/0	Charing Cross and Strand Electricity Supply Corp.	5¼	5¾	5¼	5¾	..	—	..	—
£57,400	£100	5%	Do. 5 per Cent. Debentures, 1900 ...	—		..		..	—	..	..
8,322	£5	..	House-to-House Electric ...	—		—		..	—	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	—		—		..	—	—	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid) ...	..		..		..	January and July	—	..
45,000	£5	3/0	Liverpool Electric Supply (fully paid) ...	7⅞	8⅛	7⅞	8⅛	..	—	..	..
111,000	5	..	London Electric Supply ...	..		..		..	—	..	—
49,900	£10	6/0	Metropolitan Electric Supply (fully paid) ...	11¼	11¾	11¼	11¾	2 11 1	..	..	..
150,000	Stock	4½%	* Do. 4½% Debs. ...	117	119	117	119	3 16 5	June and December	118½	..
6,452	£10	2/0	Notting Hill Electric ...	8½	9½	8½	9½	..	—	..	..
..	..	..	Rand Electric ...	7/16	½ prem	5/16	7/16 prem	..	—	..	..
19,980	£5	2/0	St. James and Pall Mall ...	8¼	8¾	8¼	8¾	..	—	8½	8¼
20,000	£5	7%	Do. 7 per Cent. Preference ...	9	10	9	10	3 10 0	—	9½	9¼
59,900	5	2/6	Westminster Electric Supply (fully paid) ...	8½	9	8½	9	3 1 1	..	8⅝	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering ...	1½	1¾	1½	1¾	3 11 8	—	1 11/16	1 7/16
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative ...	2	2¼	2	2¼	5 6 8	—	2 3/16	2 1/16
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures ...	111	114	112	115	3 19 6	March & September	114	—
28,180	5	3/0	Crompton and Co., 7 per Cent. Cumulative Pref ..	1½	2	1½	2½	..	January and July	1 1/16	—
89,261	5	1/6	Edison and Swan United ...	1¾	2¼	1¾	2¼	..	..	..	..
£100,000	Stock	4½%	Do. 4% Mortgage Debenture Stock ...	104	107	104	107	4 5 1	..	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid) ..	..		—		..	..	—	..
110,000	2	..	Electric Construction ...	⅝	⅞	⅝	⅞	..	..	¾	..
12,845	2	2 9½	Do. 7 per Cent. Cumulative Pref. ...	2	2½	2	2½	5 11 0	..	2¼	..
91,195	2	...	Elmore's Patent Copper Depositing ...	¾	1	¾	1	..	..	..	—
20,000	5	..	Fowler-Waring Cables (fully paid) ...	¼	¾	¼	¾	..	..	..	..
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works ...	19	20	19	20	3 15 0	February & August	19½	..
£200,000	100	4½%	* Do. 4½ per Cent. Debentures, 1896 ...	100	102	100	102	4 8 3	March & September	..	—
15,995	£10	..	International Okonite Ordinary ...					..	—	—	..
16,000	£10	..	Do. 8 per Cent. Preference ...	..		..		..	December and June	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 5s. paid) ...	⅛	⅜	⅛	⅜	..	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance ...	43	45	43	45	4 0 0	March and July	43½	..
£150,000	100	5%	* Do. 5 per Cent. Bonds ...	104	107	104	107	4 4 7	January and July	..	—
37,514	£5	—	Woodhouse and Rawson Ordinary (£3 15s. paid)..	..		..		..	..	..	—
41,098	£5		Do. Preference (fully paid) ...	..		..		..	..	..	—
£100,000	10	6/0	W. T. Henley's Telegraph Works Ordinary ...	14	14½	14	14½	4 1 4	..	14⅜	14
£30,000	10	7/0	Do. 7 per Cent. Preference ...	15½	16½	15½	16½	4 4 0	..	16	15¾
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock ...	103	109	10[illegible]	1[illegible]0	4 2 5	..	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	1½%	City and South London Railway ...	38	40	38	40	3 2 6	May and November	38	..
7,6[illegible]0	10	5%	Do. 5% Perpetual Preference ...	14½	15½	14½	15½	3 4 9	..	—	..
£10,171	Stock	4%	Do. 4% Perpetual Debenture ...	134	136	134	136	2 19 9	May and November	..	..
87,500	£10	2½%	Liverpool Overhead Railway ...	11¾	11⅞	11¾	11⅞	1 17 11	—	—	—
10,000	10	5%	Do. 5% Preference ...	15	15½	15	15½	3 4 9	..	..	—
1[illegible]5,000	Stock	4%	Do. 4% Debenture ...	112	114	112	114	3 10 2	January and July	—	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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